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Economic Analysis of Adoption of Improved Rice Varieties by Small Holder Farmers in Manipur

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ABSTRACT

The study analyzes adoption of improved rice varieties by resource poor small holder farmers in Manipur state. For the present study six districts *viz.* Imphal East, Imphal West, Ukhrul, Chandel, Churachandpur and Tamelglong comprising of both valley and hill areas were randomly selected. From these selected districts, a total of 300 paddy cultivating households were randomly selected comprising of 150 adopter farmers and 150 non- adopter farmer. Descriptive statistics, Ordinary Least Square Regression Analysis and Binomial Logit Model were used to analyse the data collected from farmers. Among the adopter's group, maximum farmers adopted RC Maniphou-10 followed by RC Maniphou-7. Non adopter farmers cultivated local traditional cultivars. It has been found that the average cost of cultivation of rice for adopter group was Rs 46975 / ha as compared to Rs. 43242/ ha for non-adopter. In both the groups, maximum expenditure on cost of cultivation was incurred on human labour comprising more than 50 % of the total expenses. Adopter farmers receive an average net return of Rs. 42341 / ha compared to only Rs. 28502 /ha for non-adopter farmers. The benefit cost ratio was work out to be 1.90 and 1.66 for adopter and non-adopter group respectively. Regression analysis revealed that adopter farmers can increase the yield by using more of fertilizer and plant protection chemicals. Among the various socio economic factors affecting the adoption of improved rice varieties, age has a significant and negative effect while literacy level, family size, yield and number of training programme attended have a positive and significant effect. The study suggested that more emphasis should be given to young and educated farmers for higher adoption of improved rice varieties in the state.

1. Introduction

Rice is the staple food crop for more than 60% of the world population. Rice provides 20% of the world's dietary energy supply as compared to 19% for wheat and 5% for maize. India is the second largest producing country of rice in the world next to China with a production of 159.7 million tonnes in year 2016 (World Rice Statistics 2016). Rice occupies about 35 per cent of the total area under food grains and contributes around 41 percent to the total food grain production in the country (Agricultural Statistics at a Glance 2014). It plays an important role in the national food security by supplying affordable cereals at every corner of the country through the public distribution system. Rice is the major crop of the people of Manipur in term of area, production and consumption in the state. In the last decades rice production in the state has increased from 435.93 ('000 tonnes) in 2004-05 to 482.25 ('000 tonnes) in 2014-15 (Economic Survey Manipur 2015-16). During the year 2013-14, the productivity of rice in the state was 2703.29 kg per hectare and is above the national average which was 2424 kg per hectare. But inspite of higher productivity than the national average the state is still deficit in rice production and is dependent on other states like Punjab and Haryana to meet its local requirement.

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The state comprises of both hill and valley areas. Though valley area constitute for only 10 per cent of the total geographic area of the state, it account for 64 per cent of the total rice production in the state. The state agro climatic condition is very much suited for cultivation of rice and is also considered as a hotspot for origin of some important rice germplasm. Irrigation facilities are very much limited and almost all farmers are dependent on monsoon for rice cultivation. Also due to industrialization and other developmental work the area under agricultural field is decreasing day by day. Also due to changing climatic condition farmers are facing a number of problems like flood, drought, delayed monsoon, shower at harvesting time, occurrence of new pest and diseases, *etc.* Hence, in order to increase rice production and to sustain the crop farming as a whole new technological innovation in term of high yielding variety seed, modern inputs, effective plant protection measures, *etc.* have to be adopted. Taking into consideration the changing climatic condition and shortage of rice in the state, ICAR Research Complex at Imphal have released a number of rice varieties for solving the problem of the farmer in the state. The present study is an attempt to examine the socio economic status, cost and return, resource use and factors affecting the adoption of improved rice varieties by small holder farmers in Manipur State

2. Materials and Methods

2.1 Sampling Procedure

A multi-stage stratified random sampling procedure was adopted for the study. In the first stage six districts where improved rice varieties were cultivated was randomly selected. These six districts were Imphal East, Imphal West, Chandel, Churachandpur, Ukhrul and Tamenglong. In the second stage, from each district, two villages where improved rice varieties were cultivated were randomly selected. In the third stage, the list of farmers adopting improved rice varieties were obtained from the concern KVK of the districts.

From this list, 150 farmers were randomly selected which comprises of the adopter group. Also, to compare the impact of adoption, a matching sample of conventional rice cultivating farmers from the same area was also selected. Thus, the ultimate sample consisted of 150 adopters and 150 non-adopters or conventional rice cultivators. Primary data were collected during the year 2014-15. The information collected include various aspects of farming like age, farming experience, educational level, landholding pattern, occupational pattern, expenses on various activities on rice cultivation, income level, reasons for adopting improved varieties, *etc.*

2.2 Analytical Approach

Descriptive statistics was used to analyze socio economic characteristics of sample household. Gross returns were obtained by multiplying yield with the prevailing prices of rice in the study area. Net returns were calculated by subtracting total cost from gross returns. Benefit cost ratio was obtained by dividing gross return with the total cost. In order to examine the input output relationship production function regression analysis was conducted. The specification of production function used in the present study is as follows:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6)$

Where, Y = Value of rice yield per household (Rs.),

X_1 = Expenditure on seed per household (Rs.)

X_2 = Expenditure on machine labour per household (Rs.)

X_3 = Expenditure on human labour per household (Rs.)

X_4 = Expenditure on fertilizer per household (Rs.)

X_5 = Expenditure on plant protection chemicals per household (Rs.)

X_6 = Miscellaneous expenses per household (Rs.)

Both linear and Cobb Douglas types of production function were tried in the present study.

To study the factors affecting the adoption of improved rice varieties Binomial logit model was employed. The expression of the model is given below.

The Logit model is $Ln\left(\frac{Pi}{1-Pi}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_n X_n + \varepsilon$

where,

P_i takes the value 1 if i^{th} household adopt improved rice varieties

P_i takes the value 0 if i^{th} household do not adopt improved rice varieties

Ln is the natural log

β_0 is the intercept

Xi's is the prediction variable

$\beta_1, \beta_2, \ldots\ldots\ldots \beta_n$ are the slope coefficients to be estimated

ε is the random error term

Variables considered for the study are given below:

Variables	Variable description
Family Size	Number of members in a household
Age	Age of head of household (years)
Education	Educational level of head of household 0 for illiterate, 1 for primary, 2 for secondary, 3 for graduation, 4 for post-graduation
Land holding	Size of landholding of household (Hectare)
Yield	Yield of rice at the time of harvest in quintals per hectare
Training Attended	No of training attended on rice

3. Result and Discussion

The socio economic profile of the respondent household is given in table 1. It was found from the study that the average age of the adopter and non-adopter group was 48 and 51 years respectively. Adopter group have a relatively higher family size *i.e.* 6.02 as compared to 5.65 for non-adopter. The average land holding between the two groups are almost the same *i.e.*1 ha approximately. Adopter farmers were higher in education status compared to non-adopter. Adopter groups were more knowledgeable as they have a higher interaction with the extension personnel and experts through participation in training programme.

Table 1. Socio Economic Profile of Respondent

Particulars	Adopter	Non Adopter
No of farmer sample	150	150
Av Age	48	51
Av Family size	6.02	5.65
Av land holding (ha)	0.98	0.97
Av no of training attended on rice	3.24	1.85
Education status		
Illiterate	3	5
Less than Matriculate	15	42
X std	68	57
XII std	42	28
Graduation	22	18
Total Farmer	150	150

As per the source of information regarding the improved rice varieties adopter farmers get information from ICAR, KVK and state agriculture department. On the other hand, non-adopter gets information on new varieties from friends, neighbours and through radio.

3.1 Rice varieties adopted by the Farmers

It has been found from the study that adopter farmers were cultivating climate resilient rice varieties released by ICAR Manipur Centre which include RC Maniphou 5, RC Maniphou 7, RC Maniphou 10, RC Maniphou 11 and RC Maniphou 12 respectively. Among the various rice varieties adopted maximum of the farmers *i.e.* 75 per cent prefer RC Maniphou 10, followed by RC Maniphou 7 with 10 per cent while the rest 15 per cent farmers cultivated RC Maniphou 5, RC Maniphou 11 and RC Maniphou 12 respectively. The reasons for adopting the improved varieties are given in table 2.

Table 2. Adoption of Rice Varieties by FLD farmers

Varieties Adopted	No of farmers	%	Reason for Adopting
RC Maniphou 5	4	3	Taste, tolerant to drought, Photo insensitive.
RC Maniphou 7	15	10	Yield, less disease, tolerant to lodging, tolerate to water logging/ temporary flooding.
RC Maniphou 10	112	75	Yield , taste, less pest and disease incidence, tolerant to lodging
RC Maniphou 11	14	9	Yield, pest and disease tolerant
RC Maniphou 12	5	3	Yield, taste, short duration
Total	150	100	

On the other hand, the non-adopter farmers cultivate local traditional cultivars which are giving less yield, prone to diseases and susceptible to flood and drought.

3.2 Cost of Cultivation of Rice

The details of cost of cultivation of rice for the adopter and non-adopter group are given in table 3. It was found that in both the groups the expenses on human labour which comprising of manual sowing, transplanting,

Table 3. Cost of Cultivation of Rice (Rs./ Ha)

Particulars	Adopter	Non-Adopter
Seed	1242.25 (2.64)	1024.59 (2.37)
Machine Labour	7957.30 (16.94)	7587.87 (17.55)
Human Labour	25942.53 (55.23)	24886.91(57.56)
Fertilizer	4520.37 (9.62)	3470 (8.02)
Plant protection chemicals	2101.02 (4.47)	1540.62 (3.56)
Misc	1676.45 (3.57)	1705.61(3.94)
Interest on working capital	1545 (3.29)	1271.25 (2.94)
Depreciation	1990 (4.24)	1755 (4.06)
Total Cost	46974.92 (100)	43241.85 (100)

Figure in parenthesis indicate percentage to total.

weeding, harvesting, threshing, *etc.* accounted for more than 50 per cent of the total expenses on cost of cultivation. The expenses on machine labour which comprises of ploughing, puddling of soil, leveling, transportation, *etc.* accounted for 16 to17 per cent of the total expenses followed by fertilizer 8 to 10 percent and plant protection chemicals 3.5 to 4.5 percent respectively. The miscellaneous expenses comprising of expenses on making bund, maintaining water level at field, pilling of harvested crop, *etc.* accounts for 3.5 to 4 per cent of the total expenses. Overall, the average per hectare cost of cultivation of adopter's group was higher *i.e.* Rs. 46974.92 as compared to non-adopter which was only Rs. 43241.85 respectively. Higher cost of cultivation for adopters and higher return as compared to non-adopters were also observed in the study conducted by Bhowmick BC (2005).

3.3 Return from rice cultivation:

The details of the return from rice production are given in table 4. A perusal of the table reveal that the yield of the adopter group was higher *i.e.* 4.96 tonnes per hectare as compared to the non- adopter which recorded only 4.01 tonnes per hectare. The gross return of adopter group was works out to be Rs. 89316 per hectare while for non-adopter it was Rs.71744 per hectare respectively. The net return was higher for the adopter group which was Rs. 42341 per hectare compared to non-adopter which was only Rs.28502 per hectare. The benefit cost ratio of adopter group was found to be higher *i.e.* 1.90 compared to non-adopter, which was only 1.66 respectively. Higher yield of adopter farmer and higher return were in consonance with the findings obtained by Saka J. O and Lawal B. O (2009).

Table 4. Return from Production of Rice

Particulars	Adopter	Non-Adopter
Yield (t/ha)	4.96	4.01
Gross Return (Rs/ha)	89316	71744
Net Return (Rs/ha)	42341	28502
Benefit Cost Ratio	1.90	1.66

***3.4 Input Output Relationship**:*

The input output relationship of the rice cultivation is given in table 5. A perusal of the table reveal that for the adopters group fertilizer and plant protection chemicals were statistically significant at 1% and 5 % level of significance. The R square value of 64 % revealed that 64 per cent of the variation in rice yield is explained by the variables taken in the model. It reveals that the yield of rice could be increased by using more of fertilizer and plant protection chemicals. In case of non-adopters group the R square value is 74 % which reveal that 74 per cent of the variation in rice yield is explained by the variables taken in the model. Here, the expenses on machine labour is negatively significant at 1 % level of significance revealing that with increase in expenses on machine labour the yield of rice is going to be decrease. Expenses on human labour and miscellaneous are significant at 5% and 1 % respectively which reveal that the yield of rice could be increase by increased use of human labour and miscellaneous expenses. Similar findings were also found by other studies conducted by Alarima *et al.* (2013) and Devi LG and Singh YC (2015).

3.5 Factors affecting adoption of improved rice varieties

Binary logistic regression model is used to analyse the factors affecting the adoption of improved rice varieties. The detail of the result is given in table 6. The binary logit model was estimated by using maximum likelihood method. The farmers adopting improved rice varieties were given value P = 1 while for non-adopters the value of P was assigned as 0.

Table 5. Result of regression analysis of Adopter and non-Adopter farmers

Particulars	Adopter		Non-Adopter	
	Coefficients	Standard Error	Coefficients	Standard Error
Intercept	17452.456	2956.518	9724.782	1217.878
Seed	-4.527	5.055	7.001	3.929
Machine	-0.051	1.038	-1.669***	0.594
Human	-0.031	0.361	1.107**	0.169
Fertilizer	3.132***	0.607	-0.259	0.635
PPC	2.634**	0.941	1.997	1.298
Misc	0.494	1.254	4.561***	0.881
R Square	64 %		74 %	
No of observation	150		150	

*** and ** denote significance at 1 per cent, 5 per cent level of significance

The P-value for the model fit statistic is less than 0.05 and highly significant at ($p<0.001$) with six degree of freedom, indicating that at least one of the parameter in the model is non-zero. The Cox and Snell R-square is 0.39, indicating that 39 percent of the variations in probabilities of adopting improved rice varieties was explained by the covariates defined in the logistic model. The study reveal that age is negatively significant which implies that with the increase in age the chances of adoption of improved rice varieties goes on deceasing. The odd ratio reveals that one unit increases in age decreases the odd of adopting improved rice varieties by 6.1 per cent. Literacy level, family size, yield and number of training programme attended are positively significant at 1% level of significance. The odd value states that a unit increase in education level increases the odd of adopting improved rice varieties by 101 per cent. It also implies that household with higher education level have a higher probability to adopt improved rice varieties. More educated farmers are able to understand things better and are able to take more risk and challenges. Higher family size means that there are more family labour and workforce which help in executing the field work. The odd value states that a unit increases in family size increases the odd of adopting improved rice varieties by 58.3 per cent. Land holding is not significant which implies that the adoption of improved rice varieties is independent of the size of land holding. Yield is an important factor affecting the adoption of improved rice varieties. The odd value states that a unit increases in yield increases the odd of adopting improved rice varieties by 17.1 per cent. Higher yield of the variety leads to higher probability of adoption. Also the number of training programme attended which is also a proxy for contact with extension personnel and experts helps in adoption of improved rice varieties. The odd value states that a unit increases in training programme attended increases the odd of adopting improved rice varieties by 137.7 per cent. Similar findings were also obtained in the study made by Saka J. O and Lawal BO (2009) and Devi KS and Ponnarasi T (2009).

Conclusions

Due to change in the climatic condition over the years farmers are changing from traditional farming practices to improved climate resilient farming practices and adoption of improved high yielding rice varieties is one among them. Among the various improved rice varieties adopted maximum of the farmers prefer RC Maniphou 10. Though the cost of cultivation of adopter group was higher as compared to non-adopter, the yield and net return of adopter group were higher. BC ratio of adopter farmers was 1.90 compared to only 1.66 for Non adopter. Considering the input-output relationship, adopter group can increase the yield by using more of fertilizer and plant protection chemicals. In case of non-adopter group, the yield can be increased by using more of human labour and miscellaneous expenses and by reducing the expenses on machine labour. Among the various factors affecting the adoption of improved rice varieties, age have a negative effect while literacy level, family size, yield and number of training programme attended have a and positive effect on the choice for adoption of improved rice varieties.

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Table 6. Factors affecting adoption of improved rice varieties

Variable	Coeff	Std. Error	Wald	Odd Ratio
Age	-0.063***	0.017	13.123	0.939
Literacy level	0.699***	0.166	17.776	2.011
Family size	0.459***	0.123	13.854	1.583
Land Holding Ha	0.250	0.198	1.598	1.284
Yield	0.157***	0.023	48.841	1.171
Training attended	0.320**	0.095	11.283	1.377
Constant	-9.293	1.555	35.714	0.000
Logistic Regression Model Fitness Attributes				
Number of observations	300	-2 Log likelihood		265.009
LR (Likelihood ratio) chi^2 (6)	147.83	Cox and Snell R-square		0 .395
Prob > chi^2	0.0000	Naglekerke's R-square		0.527

*** and ** denote significance at 1 per cent, 5 per cent levels