How profitable is rice cultivation in hills of North Eastern region of India? A case study of Manipur

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ABSTRACT

The present study was conducted in Senapati Hill district of Manipur to work out the costs and returns in paddy cultivation and to determine the factors affecting the adoption of HYVs of rice. A sample of 60 farmers was randomly drawn from three villages of Kangpokpi block of the selected district. The costs and returns per hectare were calculated based on variable costs and fixed costs, and probit model was applied to determine the factors affecting adoption of HYVs.The state has registered negative annual growth (-0.48%) in the case of the area under rice during 2000-01 to 2011-12. Per hectare cost of cultivation for HYVs (₹ 51260.92/ha) was calculated to be higher as compared to local paddy (₹ 47093.22/ha) as the cultivation of HYVs of paddy involved higher amount of fertilizer and labours in weeding, harvesting and threshing activities than local paddy. Farmers who have mass media exposure, who are young and who get desired fertilizer in time have a higher probability of adoption of HYVs of rice. The net returns were negative for both, HYVs of paddy (- ₹ 629.09/ha) or local paddy (-₹ 9393.00/ha) which may be the reason for declined in rice area. Cultivation of HYVs of rice is more beneficial compared to local rice. So, the government should take proper initiative for adoption of HYVs of rice to make the state self-sufficient in rice production.

Keywords: Rice, cost of cultivation, profitability, probit

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Manipur, one of the seven states in the North East Hill (NEH) region is predominantly an agrarian state. Rice based agriculture and allied activities are the largest source of livelihood for the majority of rural masses and the mainstay of the state's economy. Agriculture sector contributes a major share to the total State Domestic Product and provides employment to about 52.19% of the total workers in Manipur (GoM, 2011). Before

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1980, there was self-sufficiency in rice production, except under abnormal monsoon conditions but, now there is deficit every year, as the population has increased by 12.05% during 2001-2011, whereas the state has registered negative annual growth (-0.48%) in the case of area under rice during 2000-01 to 2011-12. The productivity of rice has annually grown by 1.10% only during the same period (Singh *et al.* 2013). The productivity of hill rice (1.2 MT/ha for TE-2011-12) is much lesser than the rice grown in Valley (3.35 MT/ha for TE-2011-12) (GoM, 2012). Moreover, there is no scope of increasing area under valley districts. To feed the rapidly growing population, it is essential to increase the production of rice as it is the staple diet of the people of the state. The improved technology and high-yield variety (HYV) programme launched by the government has played a vital role towards self-sufficiency in food grain production in the state as the yield of HYVs is higher than that of traditional/local varieties.HYVs of rice generate additional employment as it is labour intensive in comparison to local varieties and it also helps the socio-economic transformation of farmers. But the question arises that whether the cultivation of HYVs is profitable or not? The answer to this may have a bearing on adoption of HYVs in the state. Hence, the present study was undertaken to examine the comparative cost and return in paddy cultivation and to determine the factors responsible for the adoption of HYVs in Manipur.

Materials and Methods

The study was conducted in Senapati district which is one of the hill districts of Manipur state. Multi-stage sampling technique was adopted for the present study. Senapati district was purposively selected as rice yield was highest among the five hill districts. Kangpokpi block was chosen randomly from Senapati district. Three major paddy growing villages were selected randomly from the selected block. At the final stage, after the complete enumeration of the farmers of three selected villages, 60 rice growers were selected by using Probability Proportional to Size Sampling methods. To meet the objectives of the study, both primary and secondary data were collected. Primary data were collected from the sample farmers through a personal interview with the help of pre-tested and well-structured schedule during *kharif* season 2012. The available secondary data on area, production, and yield of rice were collected for the period of 2000-01 to 2011-12 from Department of Agriculture, Government of Manipur.

Temporal and spatial analysis were applied to attain the first objective. Linear trend lines for area, production and yield of rice were estimated. Compound annual growth rate (CAGR) was calculated by using log-linear model.

$$\text{Log } Y = a + bt$$

Where, Y = dependent variable (*e.g.* area, production and yield)

t = time

a = intercept and

b = slope coefficient

$$\text{CAGR} = \{\text{EXP (b)-1}\} \text{ X } 100$$

Cost conceptsbased on variable costs and fixed costs was appliedto work out the cost of cultivation of paddy.

For returns analyses following measures were used:

Gross Farm Income (GFI) = Value of primary product + Value of by-product

Net return including family labour = GFI − Total cost including family labour

Net return excluding family labour = GFI − Total cost excluding family labour

To investigate factors affecting adoption of HYVs of rice probit model is applied because the response variable (Y=adoption of HYVs) has been captured by binary responses (HYV=1, local=0). Since, 10 farmers were growing both, local and HYVs of rice they were not included in probit analysis.

$$f(I_i) = \frac{1}{\sqrt{2}} exp\left(-\frac{z^2}{2}\right)$$

Given the assumption of normality of *I* with *E(I/X)=0* and *Var(I/X)=1*, the pdf(probability density function) is and CDF (cumulative density function) is

$$F(I_i) = \frac{1}{\sqrt{2}} \int_{-\infty}^{I_i} exp\left(-\frac{z^2}{2}\right) dz$$

Table 1: TE averages for area, production and productivity of rice in Senapati district

Year	Area (000'ha)			Production (000'MT)			Productivity (MT/ha)		
	Jhum	Terrace	Total	Jhum	Terrace	Total	Jhum	Terrace	Total
TE 2002-03	8.89	3.30	12.51	7.78	7.64	16.19	0.87	2.31	1.30
TE 2005-06	9.37	3.18	12.77	6.34	6.39	13.33	0.68	1.99	1.04
TE 2008-09	8.93	3.27	12.41	6.45	5.27	12.18	0.72	1.62	0.98
TE 2011-12	7.34	2.45	9.80	6.85	4.73	11.58	0.89	1.93	1.14
CV (%)	16.8	21.46	18.08	29.81	32.66	27.79	23.84	22.42	19.69
CAGR (%)	-2.08	-3.15	-2.58	-0.99	-5.37	-3.62	1.12	-2.29	-1.08

CV and CAGR pertains to the period 2000-01 to 2011-12

Table 2: Socio-economic characteristics of sample farmers

Particulars	
Age (respondent)	40.38
Family size (No.)	7.37
Literacy rate (Per cent)	81.77
Land holding (Ha)	0.59
Irrigated land (Per cent)	24.45

Table 3: Per hectare cost of cultivation of paddyfor local varieties and HYVs of paddy

Cost items(₹/ha)	Local		HYV		Overall	
A. Variable costs						
1 Seed	1013.00	(2.15)	1021.84	(1.99)	1009.48	(2.04)
2 Fertiliser	1909.78	(4.06)	3002.75	(5.86)	2534.33	(5.13)
3 Plant protection Chemical	410.94	(0.87)	330.61	(0.64)	345.79	(0.70)
4 Hired labours	14382.67	(30.54)	15298.25	(29.84)	14905.86	(30.15)
5 Bullock and machine Labours	9282.22	(19.71)	9283.33	(18.11)	9282.86	(18.77)
Sub total	26998.60	(57.33)	28936.78	(56.45)	28078.32	(56.79)
6 Interest on working capital @ 4%	539.97	(1.15)	578.74	(1.13)	561.57	(1.14)
Total Variable costs (1+2+3+4+5+6)	27538.58	(58.48)	29515.52	(57.58)	28639.88	(57.92)
B. Fixed cost						
1 Family labour	6224.44	(13.22)	8206.33	(16.01)	7356.95	(14.88)
2 Land revenue	80.00	(0.17)	80.00	(0.16)	80.00	(0.16)
3 Rental value of land/ha	12000.00	(25.48)	12000.00	(23.41)	12000.00	(24.27)
4 Depreciation	1249.09	(2.65)	1459.07	(2.85)	1369.08	(2.77)
Total fixed cost (1+2+3+4)	19553.53	(41.52)	21745.41	(42.42)	20806.03	(42.08)
C. Total cost including family labour (A+B)	47093.22		51260.92		49445.92	
D. Total cost excluding family labour (C-B1)	40868.78		43054.59		42088.97	

Note: Figures in parentheses denote the percentage to the total cost of cultivation (C)

Table 4: Returns from paddy cultivation

A. Output (MT/ha)	Local	HYV	Overall
1 Main product : Paddy (MT/ha)	2.40	2.91	2.69
2 By-product: Straw (MT/ha)	0.82	0.58	0.68
B. Income over variable cost and fixed cost	(₹/ha)	(₹/ha)	(₹/ha)
1 Total cost	47093.22	51260.92	49445.92
2 Main product: grain	36063.33	49464.33	43721.05
3 By-product: straw	1636.89	1167.50	1368.67
4 Gross return/Gross farm income (GFI) (2 + 3)	37700.22	50631.83	45089.71
5 Net return including family labour (4-1)	-9393.00	-629.09	-4356.21
6 Net return excluding family labour [4 - D (Table 3)]	-3168.56	7577.24	3000.75

Table 5: Factors influencing adoption of HYVs _ Probit estimates

				Number of observation = 50	
				LR chi 2 (5) = 27.68	
Log Likelihood= -19.809				Prob> chi 2 = 0.000	
				Pseudo R2 = 0.411	
Response variable					
Adoption of HYVs	(1=HYV, 0=Local)				
Explanatory variables					
	Coefficient	SE	z	P > [z]	df/dx
Storage facility #	-0.182	0.546	-0.33	0.738	-0.066
Experience	-0.046*	0.026	-1.76	0.078	-0.016
Mass media#	1.758**	0.808	2.18	0.029	0.421
Land size	1.430	1.354	1.06	0.291	0.510
Fertilizer	0.024***	0.007	3.58	0.000	0.009
Constant	-2.629	1.035	-2.54	0.011	
(#)	df/dx is for discrete changes of dummy variable from 0 to 1				

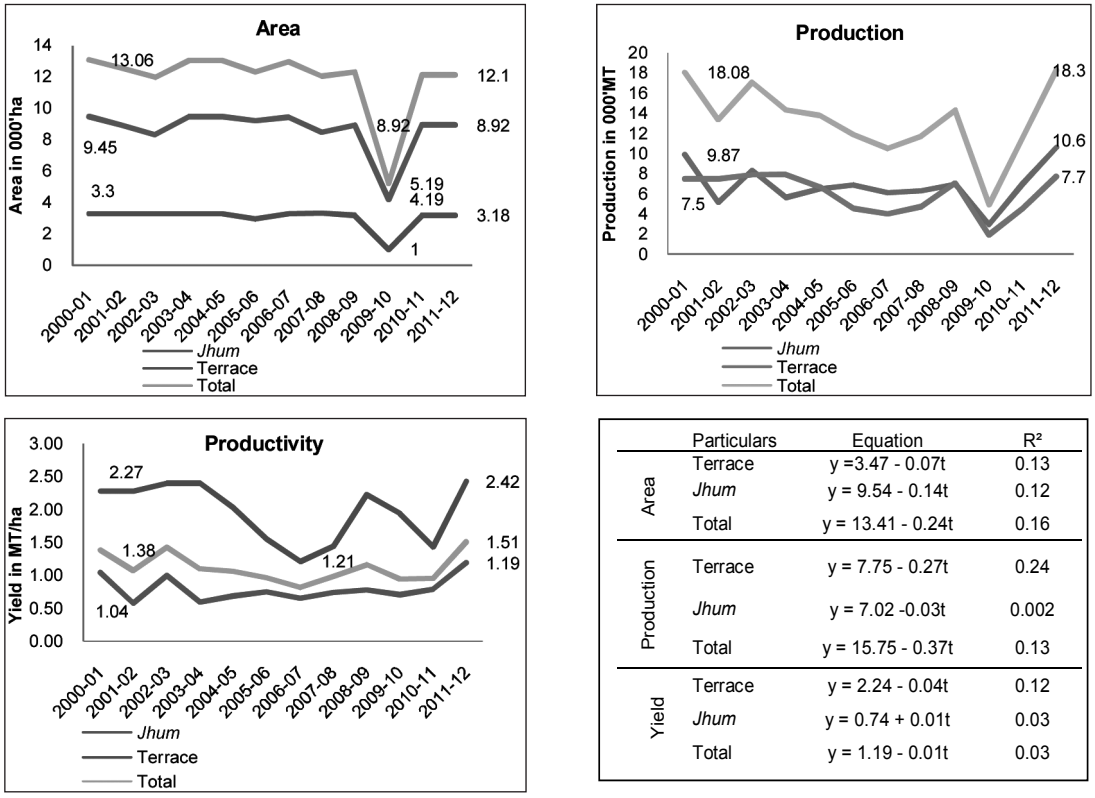
*** denote significant at 1% level of significance
** denote significant at 5% level of significance
* denote significant at 10% level of significance

Using the probit regression (Gujarati, 2003), we estimated the predicted marginal effects and the predicted probabilities of adoption of HYV of rice by the sample farmers. The estimation procedure is based on the method of maximum likelihood.

Results and Discussion

Trends in area, production and productivity of rice in Senapati district

Trends in the area, production and productivity of rice



	Particulars	Equation	R^2
Area	Terrace	y =3.47 - 0.07t	0.13
	Jhum	y = 9.54 - 0.14t	0.12
	Total	y = 13.41 - 0.24t	0.16
Production	Terrace	y = 7.75 - 0.27t	0.24
	Jhum	y = 7.02 -0.03t	0.002
	Total	y = 15.75 - 0.37t	0.13
Yield	Terrace	y = 2.24 - 0.04t	0.12
	Jhum	y = 0.74 + 0.01t	0.03
	Total	y = 1.19 - 0.01t	0.03

Fig. 1: Trends in area, production and productivity of rice in Senapati district (2000-01 to 2011-12)

in Senapati district is shown in fig 1. The area under *jhum*, terrace and whole rice in Senapati have decreased by 5.61% 3.64% and 7.35%; respectively during 2000-01 to 2011-12. The decline in area under rice may be due to allotment of land for maize (2.8' 000MT to 3.89' 000MT) and *kharif* pulses (0.42'000MT to 0.51'000MT). But during the period 2009-10, there was a significant decline in rice area (53.02% from the previous year) which is also evident from the negative slope coefficients of trend lines for the area. A similar trend can be observed for rice production also.

The productivity of rice in terrace during the year 2000-01 to 2011-12 has increased by 1.32%, but there were high fluctuations over the years. Productivity of 1.21 MT/ha in the year 2006-07 was calculated to be minimum productivity in comparison to others years under terrace rice which may be attributed to the very low level of fertilizer consumption in the district during the same year (37.41% decline from the previous year).Moreover, the productivity of *kharif* rice is highly correlated within the quantum of monsoon rainfall (r = 0.81). For *jhum* and whole rice, the productivity of rice has increased by 14.42% and 9.42%, respectively; during the period 2000-01 to 2011-12. The trend for rice productivity under *jhum* and total rice was quite stable as compared to productivity of terrace rice.

TE averages for area, production and productivity of rice in Senapati district is presented in Table 1. The area under terrace rice has not been steady as each increase in area is followed by decrease in next five years which is evident from the higher CV (21.46%) value calculated for the period of 2000-01 to 2011-12, which is a matter of concern.The CV for productivity was maximum for *jhum* rice (23.84%) then that of terrace rice. The CAGR for the area, production and productivity under *jhum,* terrace and total rice in hill districts are worked out to be negative except the CAGR for productivity in *jhum* (1.12%).

Socio-economic characteristics of the sample farmers

Socio-economic features of the farmers are important parameters for determining the level of the farmers' knowledge and the managerial skill of the farmers. Hence, the socio-economic characteristics of the sample farmers are presented in Table 2. The average age of the sample members was 40.38 years. The average family size is worked out to be 7.37. The literacy rate is found to be 81.77%. The average land holding is 0.59 ha and only 24.45% of the sample farmers has the facility for irrigation

Cost and returns structures in local and HYVs of paddy

Input use pattern

Some of the major local varieties of rice cultivated by the sample farmers are *Changlei, Noining, Chalhom, Moirang Phou, AateDesa* and *Kongsang*.Among the HYVs of rice *RCM-9, RCM-5, KD, Dhrum Phou, CAU-R1* and *Sanaphou* were mainly cultivated. The sample farmers who cultivate local paddy have used on an average of 66.08 kg/ha seed which is higher as compared to that of HYVs of paddy (60.11 kg/ha). As per our expectation; the seed rate used in case of HYVs is lower but the difference is not much hence, government agencies need to give proper advice to farmers in this regard. Amounts of urea and DAP applied were higher in case of HYVs of paddy (75.95 kg/ha and 64.43 kg/ha) than local paddy (62.07 kg/ha and 48.57 kg/ha). The number of male labour engaged was lower than female worker involved in different activities, except threshing. In case of transplanting human work employed worked out to be similar for local paddy and HYVs of paddy but in other activities (weeding, harvesting, and threshing) human labour involved were higher in case of HYVs of paddy. Bullock labour and machine labour hours have been calculated to be higher in local paddy as compared to HYVs of paddy because most of the responded farmers cultivate HYVs of rice in lowland (foothills)

Cost of paddy cultivation

Per hectare cost of cultivation of paddy for local varieties and HYVs of paddy is presented in Table 3. The share of variable costs constituted the major proportion, *i.e.*, 57.92% in total cost and it is marginally higher in case of local paddy (58.48%) than HYVs of paddy (57.58%). Within the total variable cost, share of hired labour was calculated to be maximum; followed by Bullock and machine labours, fertilizer, seed and plant protection chemicals in both local and HYVs of paddy. Umasankara (1998) also found similar results in hilly region of Karnataka.

The average expenditure made on seed was observed to be marginally higher in HYVs of paddy (₹1021.84/ha) than local paddy (₹1013.00/ha) which is due to higher prices of seed of HYVs (₹17/kg for HYVs and ₹15 for local paddy). The average cost incurred in fertilizer was 57.23% higher in case of HYVs of paddy as compared to local paddy because HYV technology is highly dependent on magnitude of fertilizer. Similarly, the expenditure on hired labours in case of HYVs of paddy was calculated to be higher (₹ 15298.25) as compared to local paddy (₹ 14382.67) because the cultivation of HYVs of paddy involve more labour in weeding, harvesting and threshing activities than local paddy.

The share of fixed cost in total cost was found to be 42.08%. Among the fixed variables, share of the rental value of land was found to be maximum (24.27%); followed by family labour (14.88%), depreciation (2.77%) and land revenue (0.16%). Similarly, Singh (2012) in his study conducted in Imphal East and Thoubal districts of Manipur reported that the share of imputed rental value of owned land in per hectare as well as in per farm basis constituted the major portion of the fixed cost.The share of fixed cost in total cost is calculated to be marginally higher in HYVs of paddy (42.42%) than local paddy (41.52%). The share of family labour cost is worked out to be marginally higher in case of HYVs of paddy as compared to local paddy.

The total cost of cultivation excluding family labour was calculated to be ₹ 42088.97/ha. The total cost of cultivation excluding family work was estimated to be higher for HYVs of paddy in comparison to local paddy but when it was compared to percentage share in the total cost local paddy it was found higher.

Returns from paddy cultivation

Returns from paddy cultivation are presented in Table 4. The average productivity of paddy (primary product)

found to be significantly higher (17.53%) in the case of HYVs (2.91 MT/ha) in comparison to local paddy (2.40 Mt/ha). Similar finding has been reported by Talukdar and Deka (2005) in the case of summer rice in floodplains of Assam. In the case of by-product (straw), the productivity of local varieties of paddy (0.82 MT/ha) has been worked out to be higher than HYVs of paddy (0.58 MT/ha).

The Gross Farm Income is calculated to be ₹50631.83/ha for HYVs of paddy which is higher by 34.30% than local paddy (₹37700.22/ha) which is due to higher productivity and higher price involved with HYVs as compared to local varieties. The net returns including family labour have been worked out to be negative for both, local (-₹9393.00/ha) and HYVs of paddy (-₹629.09/ha). Similarly, Krishna (2001) reported that the net income was negative with a loss of ₹ 4020.08/ha indicating the unprofitable situation.

Net return excluding family labour for local paddy has been worked out to be negative (-₹3168.56/ha) but for HYVs of paddy it has come out to be positive (₹ 7577.24/ha) because the price of seed, productivity, and cost of family labour were higher in the case of HYVs of paddy than local paddy. The farm business income is significantly higher (₹19325.62/ha) in the case of HYVs of paddy as compared to that of (₹8831.45/ha) local paddy. A similar trend is found in the case of farm investment income and net return over variable cost.

Factors affecting adoption of HYVs of rice

To investigate factors affecting adoption of HYVs of rice Probit model is employed because the dependent variable (adoption of HYVs) has been captured by binary responses. The probit estimates with their probabilities values and the marginal effects are presented in Table 5. Variables *viz.*, experience in rice cultivation, exposure to mass media and per hectare fertilizer used had significant influence on the decision that whether a farmer will cultivate HYVs or not. The experience of the farmer in rice cultivation has turned out to be negative and significant at 10% level of significance. It means that the younger people have a higher probability of adopting HYV in comparison to older people which is as per our expectation. Exposure to mass media has been found out to be positive and significant at 5% level of significance. It implies that those farmers who search or receives information about cultivation of HYVs from mass media have higher chances for adopting HYVs. Fertilizer amount has positive and significant (at 1% level of significance) influence on adoption of HYVs. This implies that farmers who get desired amount of fertilizer in time have a higher probability for adopting HYVs as compared to those farmers who do not get the desired amount of fertilizer in time as the HYV technology is dependent on the magnitude of fertilizer.

Conclusion

The annual growth for the area, production and productivity under *jhum,* terrace and total rice in Senapati district was negative except the CAGR for productivity in *jhum* (1.12%). Adoption of HYVs was more in the case of young farmers and who have mass media exposure. The farmers' adoption (of HYVs) decision and quantum of fertilizer application also has a significant association. In a purely economic sense, the cultivation of either HYVs or local varieties were not profitable but compared to the local varieties, cultivation of HYVs was relatively beneficial. This unprofitability may be the reason for the decline in area under rice in hills which is a matter of concern.It is recommended that the government agencies should educate the farmers to use proper seed rate. Research efforts should be channelized in arresting decline under rice by diverging cost-reducing technology and stabilizing the productivity in hill districts to make the state self-sufficient in rice production.

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