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Farm Mechanisation and Rationality of Labour Use in Indian Agriculture: A Frontier Analysis of Cost of Cultivation Data

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ABSTRACT

The paper examines the effective and efficient use of labour in Indian agriculture in the context of farm mechanisation. It explores the rationality of labour use in paddy production across states with the help of Stochastic Frontier Production Function analysis based on plot level data under the Cost of Cultivation Scheme during 2009-10. The study analyses the productivity, unit cost and farm income differentials and the variation in the extent of farm mechanisation and other inputs use in paddy production between and within states during 2004-05 to 2010-11. It also examines the impact of machine use on the production, productivity, cost and profitability in paddy production in India based on aggregated and disaggregated data. It is observed that there is no rational use of human labour in Indian agriculture (i.e., the present study rejects the hypothesis of equality between marginal productivity of labour and average wage rate). Machine use in agricultural production plays an important role in the increase in productivity and reduction of unit cost of production resulting profitable making farming viable in India. There is a great variation in the degree of farm mechanisation across Indian states but there is a good indication that inequality in input use and the variation in access to modern agricultural technology has decreased among the states during post-WTO period.

Keywords: Labour Use, Farm Mechanisation, Technical Efficiency, Unit cost, Paddy.

JEL: Q12, Q16, J43

INTRODUCTION

The rationality of labour use in agriculture is very important for increase in agricultural production, productivity and farm income. The optimum use of labour resource in agriculture plays a very important role not only in production but in social and political considerations also. In microeconomics under assumption of perfect competition, rationality of labour use implies the equality between marginal productivity of labour with wage rate. Inequality situations (either MP>W or MP<W) of it represent inefficiency in respect of labour utilisation. Equality between aggregate demand for labour and aggregate supply of labour (i.e., equilibrium) ensures macroeconomic rationality of labour use in production. On the one hand, under-employment or disguised unemployment is one of the important features of Indian agriculture but on the other hand, recently, labour in agriculture is becoming scarce in most parts of India. It is a serious issue, particularly in the context of growing farm mechanisation during post-WTO period. The input of farm machineries and

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equipments play a complementary and/or competitive role and may improve production and labour and land productivity in Indian agriculture. The present paper examines the role of mechanisation in agriculture in rational labour use in paddy cultivation based on both unit level data and aggregated data across different states in India. It also analyses the impact of farm machinery on production, productivity, cost and profitability in case of a specific principal crop, i.e., paddy.

Farm Mechanisation and Labour Absorption

Mechanisation of agriculture means use of machinery and farm implements in place of human and bullock labour; it requires greater investment of capital in agriculture. It refers to the replacement of man-power and animal-power by machine-power at different stages of farming operations since from preparation of land to application of inputs and to marketing of agriculture produce. The tractors, power sprayer, harvester combine, pump sets (diesel and electrical), threshers, cane crushers, paddy planters, etc., are usually used in agriculture in the form of machine power. However, mechanisation of agriculture may not always replace labour, it can help labour also to get more production and improve productivity in various ways. With the use of machines, farmers have got enough spare time to do other activities and at least they get leisure time (take rest) for improving their health conditions and quality of life of the family. Mechanisation can help to do very difficult tasks in agriculture in less of time and with less cost. It is also helpful to improve effective use of agricultural resources. Application of high-yielding variety (HYV) seeds and extension of irrigation facilities may be ensured by appropriate mechanisation. The adoption of mechanisation has played a very vital role in the development of agricultural sector and allied activities. It is a part of technological changes that lead to overall agricultural productivity. Mechanisation can be viewed in terms of farm size, unemployment problem, level of economic development, rates of use of other resources, cost of production, diversification and commercialisation of agriculture, specialisation of work, accessibility of credit etc. Mechanisation that replaces animal labour and that which improve the productivity of labour without displacing them may be welcome.

Mechanisation is essential when there is labour shortage. In commercially organised agriculture, labour is generally hired and represents the same type of cost (cash cost or paid-out cost) as cost of other factors. In such a situation the farmers may substitute machine power for labour if that helps him to reduce cost. Thus where both machine and labour represent paid out cost, the normal rationale of factor substitution on the basis of relative costs and relative productivities may be the guiding principle. In a labour surplus country like India, particularly for small farms, family members have to be maintained in any case because they may not have alternative gainful employment opportunities. In this situation, which represent a very substantial portion of the total labour force represent fixed cost and there may be little

incentive to substitute machine for family labour. In large farms where the proportion of hired labour is high and where affluent family members with high performance for leisure and substantial access to more remunerative alternative employment opportunities, may seriously consider substitution of machine for hired labour.

Sen (1962) has given explanation to the most contentious issue in agriculture of the inverse relationship between farm size and productivity based on the assumption of low opportunity cost of family labour in a labour surplus economy like India. According to him small farms are essentially family labour based and their greater intensity of labour use in production results in higher productivity compared to the wage based large farms. Thus, productivity per acre is greater for small farmers (where the proportion of family labour is higher). Besides, the labour based explanation the study of Sen (1964) has also given explanation for this inverse relationship in terms of fertility of land and techniques of production.

It should be remembered that the social cost of machine which displaces hapless labour may be higher than its private cost; on the other hand social cost of labour is less than its private cost since employment is the only source of return to the poor man's only asset, i.e., labour.

On the other hand, biological innovations of various types/characteristics of modern agriculture may involve operations which may not be suitably performed mainly on the basis of human labour. For harvesting huge amount of output resulting from HYV seeds and for quickly preparing land for the next crop where crops are generally of short duration varieties, some degree of mechanisation may become essential. While machines are aid to manpower, recourse to mechanisation may in certain circumstances even increase the scope of employment.

In an economy, where the scope for creation of gainful employment opportunities is very much limited, mechanisation should not be allowed to aggravate the problems of unemployment particularly when mechanisation only displaces labour without increasing total output. Where man-land ratio is high, the issue of mechanisation should be decided on the basis of the objective of maximisation of absorption of agricultural labour supply in the given area of agriculture land. Otherwise poverty will aggravate.

DATA BASE AND METHODOLOGY

Paddy is the single most important principal crop in Indian agriculture spread over all states and different agro-climatic zones in India. To examine the rationality of labour use in paddy production across states in the context of farm mechanisation we have considered both aggregated and disaggregated (plot level) data under the Cost of Cultivation Scheme, Ministry of Agriculture, Government of India (http://eands.dacnet.nic.in/Cost_of_Cultivation.htm). At the micro-level we have considered 6625 paddy plots (summary data) during 2009-10 (out of a total 12725 plots) spread over 13 states (total 18 states) and 10 zones (total 13 zones) based on

the availability of cost of cultivation data on output and important inputs. The extent of mechanisation in Indian agriculture across different states during post-WTO period has been analysed with these data. Relevant data are used to measure the efficiency in paddy production with the help of different methods and econometric techniques. We have used ANOVA technique to examine the variability differences between and within states under study in respect of different concerned variables. Different factors are identified with the help of regression exercises in this regard. The following method is particularly important to examine the rationality of labour use. The study has estimated the following form of Cobb-Douglas Stochastic Frontier Production Function (SFA) (Aigner *et al*., 1977) to measure the efficiency of labour use. The following steps are particularly important in this regard.

1. Estimation of Frontier Production Function (SFA):
   $\text{Ln } Q_i = \text{Ln } \beta_0 + \beta_1 \text{Ln } (A_i) + \beta_2 \text{Ln } (L_i) + \beta_3 \text{Ln } (M_i) + \beta_4 \text{Ln } (F_i) + \beta_5 \text{Ln } (S_i) + v_i - u_i$
   Where Q = Main product (qtls), A = Area of land (ha), L= Human Labour (hrs), M = Machine (hrs), F = fertiliser (kg), S= Seed (kg), Ln = log, v_i =stochastic disturbance term and u_i indicate inefficiency components of the firms such that
   $v_i \sim N(0, \sigma_v^2)$, for $-\infty < v_i < \infty$ (Normal distribution) and
   $u_i \sim |N(0, \sigma_u^2)|$, for $u_i \geq 0$, (half normal distribution).

2. Marginal physical productivity of labour (L) = $MPP_L = \partial Q/\partial L = \beta_2 . (Q_i/L_i)$

3. Marginal value productivity of labour (L) = MVP_L
   $= MPP_L . P$, where P = output price.

4. Compare MVP_L with wage rate (W) either in ratio ($E_i = MVP_L/ W$) or difference ($D_i = MVP_L - W$) form for the i^{th} observation.

6. In respect of D_i, paired t-test is applied to test whether D is significantly different from zero or not for each state/zone/size group. The direction of the difference is also very important to examine scarcity or surplus of labour input in agriculture. There may be following three situations:

   (a) D = 0 (or E =1) indicates rational use of labour
   (b) D > 0 (or E > 1) indicates under utilisation and
   (c) D < 0 (or E < 1) indicates over utilisation situation.

Both (b) and (c) situations represent inefficiency in respect of resource utilisation of farms but with different characteristics. In case of (b), there is a scope for

profitable use of additional resources but removing excess resources in case (c) can increase profit.

It may be mentioned that Bardhan (2003) has examined imperfection in labour market with a t-test method to test the difference between the value of marginal product of labour (assuming Cobb-Douglas production function estimated by OLS method, i.e., on the basis of average production function) and average wage rate. He has explained the variations in labour use across farm sizes in terms of intensity of multiple cropping (a technical progress parameter), fragmentation per acre, the sown area, and the average wage rate.

Some important concepts and variables developed and used in this study are:

TE = Technical Efficiency = Actual output/ Maximum possible output = $e^{-u}i$

UC = Unit cost of main product =
(Total cost - value of by product)/ Total quantity of main product

O/C2 = Value of output (main product +by product) per unit of total (investment) cost (Rs.).It is called rate of returns per Rs. investment in agriculture.

O-A2 = Profit over paid out cost (farm business income), and P-UC = Unit profit

AP_L= Average productivity of labour = Output (Q)/Human labour (hrs.)

VMP_L = Marginal value productivity of labour as defined above.

Farm mechanisation (technological factor 1): M= Machine (hrs),

mech = Machine (hrs)/ Human labour (hrs) in case of plot level data, and
= Machine cost/ Human labour cost in case of aggregated data

Per cent mech = percentage share of machine cost to total operational cost

Fert = per cent share of fertiliser cost to total operational cost (technological factor 2).

RESULTS AND FINDINGS

In the following estimated frontier production function, high value of γ (= 0.821) which is the ratio of the variance of farm specific inefficiency component to the total variance of output (due to statistical chance as well as inefficiency) in SFA implies that about 82 per cent of the difference between observed and frontier output is primarily due to explicit (viz., land, labour, machine, fertiliser and seed) factors. That means inefficiency component dominates statistical chance factor. In other words, it indicates that the variation in productivity performances among sample farmers is not due to statistical chance factors but principally due to individual farm level technical efficiency differences. On an average, technical efficiency score is found to be 0.741 which implies the fact that there is a scope of increase in paddy production in India to the extent of 26 per cent with proper utilization of resources in hand and with existing technology. Such technical efficiency score varies significantly between and within states in India (Jharkhand is the least efficient and Andhra Pradesh is the most efficient state among the 13 states under study) (Table 1).

TABLE 1. EFFICIENCY, PRODUCTIVITY, LABOUR USE AND MECHANISATION IN PADDY PRODUCTION ACROSS STATES IN INDIA, 2009-10

States	Sample size	Yield (qtls/ ha)	Technical efficiency	Machine hrs/ labour hrs.	Machine hrs/ hectare	APL (kg/lab hr)	VMPL (Rs.)	Wage (Rs.)	*D= VMPL-Wage
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	955	55.5	0.868	0.019	13.8	7.4	14.7	21.1	-6.4
Assam	165	32.1	0.863	0.031	20.3	4.5	6.6	13.9	-7.3
Bihar	870	23.7	0.610	0.008	5.8	3.2	6.8	10.1	-3.2
Chhattisgarh	292	26.9	0.639	0.025	9.2	6.8	15.3	12.4	2.9
Himachal Pradesh	42	19.1	0.658	0.024	7.7	5.5	13.7	17.3	-3.6
Jharkhand	170	14.6	0.451	0.007	4.7	2.0	5.7	9.6	-3.9
Karnataka	156	49.2	0.715	0.020	23.9	4.6	10.6	16.6	-6.0
Kerala	400	40.2	0.742	0.029	17.5	7.9	18.1	31.7	-13.7
Maharashtra	69	24.3	0.473	0.007	9.9	1.9	8.8	13.8	-5.0
Madhya Pradesh	106	25.3	0.591	0.014	7.1	4.7	16.0	12.4	3.6
Orissa	903	35.1	0.734	0.012	12.1	3.3	6.1	11.9	-5.8
Tamil Nadu	865	51.1	0.791	0.026	17.8	7.7	15.6	21.2	-5.5
West Bengal	1632	41.0	0.774	0.011	12.7	3.6	6.8	13.3	-6.6
Total	6625	39.4	0.741	0.016	12.8	5.0	10.3	15.9	-5.6
ANOVA - Results									
Between Groups (MSB)		69080.6	5.17044	0.02879	10273.7	0.22664	10965.2	18131.0	
Within Groups (MSW)		132.8	0.04918	0.00019	90.5	0.00093	34.4	15.8	
Observed F-Value		520.4	105.1	151.3	113.5	244.4	319.1	1144.4	

Source: Estimated from the cost of cultivation unit level data, Ministry of Agriculture, Government of India.

Elasticity of output with respect to labour has been higher than that with respect to machine; further elasticity of output with respect to land area is less than 1, i.e., marginal productivity (MPP) of land is less than average productivity (APP) and so AP is declining with increase in land area. As the level of land and labour use increases both average and marginal productivity of the respective inputs will decrease, holding other things constant (estimated elasticity coefficients with respect to level of input use are: -0.806 for labour productivity and -0.693 for land productivity i.e., inverse relations). It is also observed from the estimated multiple regressions that machine use in paddy significantly increases land and labour productivity (about 14 per cent) in India.

Estmated Stochastic Frontier Production Function

$$\text{Ln}(Q) = 0.849+0.406\ \text{Ln}(A)+0.152\ \text{Ln}(L)+0.126\ \text{Ln}(M)+0.344\ \text{Ln}(F)+0.031\ \text{Ln}(S)$$

(z-value) (9.24) (25.02) (14.29) (21.48) (52.99) (2.77)

$\sigma_v = 0.2110$, $\sigma_u = 0.4531$, $\sigma^2 = 0.2498$, and $\lambda = 2.14$, (or $\gamma = 0.821$)

Technical Efficiency = 0.741, Log Likelihood = -2206.47, No. of observations =6625.

Note: All coefficients are statistically significant at 1 per cent level.

From the analysis of unit level data it is found that the extent of farm mechanisation in paddy is higher in Karnataka, Kerala, Tamil Nadu, Assam and Andhra Pradesh as compared to the rest of the States. ANOVA results show that there is a great variation in degree of farm mechanisation between and within states. The variation in labour productivity is explained by the variation in machine use in paddy production. Regarding rationality of labour use (last three columns of Table 1) in paddy it is observed that marginal productivity of labour (VMP_L) is significantly less than the average wage rate (implies over utilisation of human labour) in all states except Madhya Pradesh and Chhattisgarh. This means that there is inefficient or rational use of labour in paddy in India during 2009-10.

TABLE 2. COST, PRODUCTIVITY AND PROFITABILITY IN PADDY PRODUCTION IN 2010-11

States 2010-11	Yield/ha (qtls)	Rank	Unit cost (Rs./qtls)	Rank	Unit profit (Rs./qtls)	Rank	Output-A2 (Rs./ha.)	Rank
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	52.6	2	917.0	7	60.4	9	25316.3	5
Assam	29.6	10	824.3	3	19.3	12	14844.1	12
Bihar	19.3	14	923.4	8	45.0	11	10049.0	14
Chhattisgarh	26.2	12	831.2	4	133.0	8	15496.5	11
Haryana	37.5	7	1305.0	15	631.9	1	51117.5	1
Jharkhand	13.6	15	1304.9	14	-422.6	15	1825.8	15
Karnataka	47.8	4	894.3	6	142.1	7	25125.2	6
Kerala	40.2	5	1036.6	13	291.9	2	26647.0	4
Madhya Pradesh	23.3	13	945.3	9	243.4	5	18130.6	10
Orissa	28.3	11	955.6	11	-36.0	14	13275.4	13
Punjab	60.5	1	836.5	5	259.8	4	39675.0	2
Tamil Nadu	50.3	3	946.8	10	59.6	10	22009.1	8
Uttar Pradesh	37.5	8	806.9	1	165.1	6	23347.1	7
Uttarakhand	38.1	6	816.0	2	267.2	3	27384.9	3
West Bengal	36.9	9	1022.8	12	-29.5	13	18872.5	9
C.V.	36.16		16.51		185.15		53.51	
Corr.coeff. with yield	1.00		-0.31		0.42		0.68	

Source: Estimated from the cost of cultivation aggregated data, Ministry of Agriculture, Government of India.

Table 2 shows yield rate, cost efficiency and profitability in paddy during 2010-11 across states in India based on aggregated data. There is a great variation in yield rate of paddy across Indian States (from a minimum of 13.6 quintals per hectare in Jharkhand to 60.5 quintals per hectare in Punjab during 2010-11). But there is a good indication that such variation (cv) decreases from 43.3 per cent in 2004-05 to 36.2 per cent in 2010-11. It is found that there are also variation in unit cost (cost per unit of output), unit profit (=price –unit cost) and farm business income (income over paid out cost) across the states. It is true that minimisation of unit cost is very important for the farmers for augmentation of their economic efficiency and profitability and for the sake of sustainability of farming system. In India, on an average, unit cost of production in paddy increased from Rs. 587 in 2004-05 to Rs. 957 in 2010-11. We have now regressed (in log form) unit cost (UC) of production across states on the yield rate per hectare (yld), cost of chemical fertiliser in relation to total operational

cost (fert), rate of machine use in relation to labour use (mech), and a dummy variable (defined as D= 0 for the year 2004-05 and D= 1 for the year 2010-11). The results are summarised below:

$$\text{Ln (UC)} = 6.711 - 0.271 \text{ Ln (yld)} + 0.112 \text{ Ln (fert)} - 0.041 \text{ Ln (mech)} + 0.500 \text{ D}$$
$$\text{(t-value)} \quad (22.34) \quad (-3.11) \quad (2.24) \quad (-1.10) \quad (10.02)$$

$R^2 = 0.823$, Adj. $R^2 = 0.795$, F (4, 25) = 29.04

It is observed from the regression results that the variation in unit cost of paddy production across states is significantly explained by the variations in yield rate, rate of use of fertiliser, and farm machinery to the extent of 82 per cent. As yield rate and the extent of mechanisation increase, unit cost will decrease, but the higher rate of use of fertiliser may increase unit cost of production and thus reduce the profitability of farmers. The policy prescription that logically emerges is the need to minimise the use of chemical fertiliser (which represent high cost technology) and use low-cost plant nutrition like different kinds of organic manure in order to reduce unit cost without affecting yield rate. There is a scope for reduction of unit cost through farm mechanisation, i.e., increase in the use of machine power in relation to labour power in Indian agriculture.

The coefficient of dummy variable in the above regression results is found to be significant which implies the fact that unit cost of paddy production in India increases over time. The change in input cost structure during 2004-05 to 2010-11 in paddy is shown in Table 3**.**

TABLE 3. CHANGE IN INPUT USE IN PADDY PRODUCTION DURING 2004-05 TO 2010-11

(*input costs as per cent of total operational cost*)

States	2010-11	2004-05	2010-11	2004-05	2010-11	2004-05	2010-11	2004-05
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	17.0	10.5	56.9	49.0	1.9	5.1	9.4	13.4
Assam	6.3	1.8	60.3	61.0	22.8	26.3	1.9	1.5
Bihar	11.6	10.2	57.5	55.0	5.3	8.3	7.5	11.1
Chhattisgarh	20.0	6.8	45.3	48.1	9.1	14.8	8.5	12.1
Haryana	11.2	15.7	54.4	41.1	0.4	0.2	10.3	15.0
Jharkhand	6.9	0.5	60.5	57.0	18.3	27.0	4.3	4.9
Karnataka	16.1	10.6	51.3	42.0	8.1	9.3	12.2	12.1
Madhya Pradesh	11.2	8.2	49.1	41.0	13.2	17.1	7.7	7.4
Orissa	4.0	4.7	63.9	56.2	14.0	16.4	6.4	9.4
Punjab	19.1	21.8	43.8	28.6	0.5	0.5	11.9	14.4
Tamil Nadu	18.7	15.3	47.2	42.7	1.0	3.5	9.1	12.9
Uttar Pradesh	13.2	11.6	48.4	45.7	4.1	4.1	11.9	11.7
Uttarakhand	15.9	7.1	39.2	45.5	3.9	20.7	8.5	5.5
West Bengal	5.5	4.8	63.2	54.4	6.5	13.9	7.3	9.7
Mean	13.5	9.1	53.1	49.2	7.3	11.3	8.2	9.9
Corr. with machine cost	1.00	1.00	-0.65	-0.76	-0.67	-0.83	0.47	0.80

Source: Same as Table 2.

A significant portion of the operational cost in paddy is labour cost (43 per cent in Punjab to 63 per cent in Orissa among the major states). The percentage share of machine cost and human labour cost to total operational cost of paddy production increased significantly while such shares decreased in case of bullock labour and fertiliser use. It is interesting to note that the use of machine power is negatively associated with both human and bullock labour power but positively with the rate of fertiliser use in paddy across states but the degree of such association is decreasing over time. The states of West Bengal, Orissa, Assam, Jharkhand, Bihar and Madhya Pradesh are lagging behind in the use of machine power in paddy production compared to other states in India. The average productivity of labour in these states is also observed to be very low (Table 4).

TABLE 4. LABOUR ABSORPTION, LABOUR COST AND AVERAGE PRODUCTIVITY OF LABOUR IN PADDY, 2004-05 AND 2010-11

States	AP_{HL} (kg/lab hr.) 2010-11	Rank	Human labour (HL) use (hrs)/ha 2010-11	2004-05	Per cent change (2004-05 to 2010-11) Change in HL use	Change in wage	Change in output price
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh	7.2	4	735.6	990.8	-25.8	200.8	65.4
Assam	4.3	11	693.1	709.0	-2.2	77.8	71.2
Bihar	2.5	14	756.9	874.9	-13.5	90.5	92.3
Chhatisgarh	5.1	7	508.7	667.6	-23.8	121.2	64.6
Haryana	6.2	6	605.9	636.8	-4.9	97.8	139.7
Jharkhand	1.9	15	733.4	818.9	-10.4	80.8	82.9
Karnataka	4.8	8	998.6	1283.4	-22.2	127.5	77.1
Kerala	7.7	3	518.5	815.3	-36.4	91.5	95.0
Madhya Pradesh	4.3	10	539.0	540.0	-0.2	115.7	71.4
Orissa	2.7	13	1041.8	1088.4	-4.3	100.3	94.0
Punjab	15.5	1	391.0	451.3	-13.4	152.5	83.0
Tamil Nadu	6.5	5	771.4	842.1	-8.4	109.9	77.9
Uttar Pradesh	4.7	9	795.1	854.4	-6.9	82.9	79.4
Uttarakhand	7.8	2	485.8	690.8	-29.7	77.8	94.6
West Bengal	3.0	12	1222.6	1200.0	1.9	105.9	86.0

Source: Same as Table 2.

The rate of labour use per hectare in paddy cultivation has decreased in all states except in West Bengal during 2004-05 to 2010-11. In most of the states, increase in wage rate is significantly higher than the increase in output price during this period resulting into very low return in paddy production to the Indian farmers (an indication of unviable profit making farming in India).

The following regression exercise is used to assess the impact of mechanisation (mech = machine/labour), yield rate (yld) and price of output (price) on return to total investment (expenditure) in paddy (O/C2=value of output/ total cost of production).

$$\begin{array}{lllllll} \text{Ln (O/C2)} = & -2.985 & + 0.050 \text{ Ln (mech)} & + 0.393 \text{ Ln (price)} & + 0.164 \text{ Ln (yld)} & - 0.160 \text{ D} \\ \text{(t-value)} & (-3.76) & (1.81) & (3.34) & (3.03) & (-1.89) \end{array}$$

$R^2 = 0.724$, F (4, 25) = 16.40, Adj. $R^2 = 0.680$

The regression results show that price of output and yield rate positively contribute to the rate of return to the extent of about 39 per cent and 16 per cent respectively. Machine use in relation to labour use (mech) in paddy production significantly enhances the rate of output return to the extent of about 5 per cent.

Indian agriculture is approaching from family farming to an enterprise or commercial farming. There is an increase in the share of hired inputs to total (hired + owned) inputs used in paddy production in almost all states in India during 2004-05 to 2010-11 (Table 5). On an average, the share of hired labour is about 55 per cent. The share of hired human labour to total human labour in paddy production varies from a minimum of 26.2 per cent in Assam to a maximum of 86.7 per cent in Kerala in 2010-11. In case of machines used in paddy production the share of machines hired is very high of about 89 per cent. Lower resource base, smaller size of farms, higher level of initial investment to purchase machine, high maintenance cost of machine, lack of co-operative farming, lack of agricultural research, import dependence on agricultural machineries and equipments etc. may be the responsible factors for Indian farmers for using such high rate of rented machine. As a result, machine use on sharing basis may be the viable option to the Indian poor and marginal farmers to use or for the adoption of farm mechanisation. The variation in machine hired (C.V.=18.9 per cent) across states is found to be lower than the variation in hired labour used (C.V.=25.5 per cent) in paddy. It is interesting to note that such variations in hired inputs (machine and labour) used in paddy production across states decline over time that may be an indication of the reduction of regional inequality in input use in Indian agriculture.

TABLE 5. SHARE OF HIRED INPUT TO TOTAL INPUT USED IN PADDY, 2010-11 AND 2004-05

	2010-11		2010-11		2004-05	2004-05
	Per cent share of hired labour	Rank	Per cent share of machine hired	Rank	Per cent share of hired labour	Per cent share of machine hired
(1)	(2)	(3)	(3)	(4)	(5)	(6)
Andhra Pradesh	68.1	2	99.3	5	64.2	96.9
Assam	26.2	15	85.7	11	22.3	68.1
Bihar	58.0	7	99.3	4	62.2	98.8
Chhatisgarh	39.9	14	99.9	2	38.6	95.4
Haryana	55.9	8	74.9	13	47.4	37.7
Jharkhand	61.4	5	100.0	1	41.0	100.0
Karnataka	62.9	4	93.3	10	70.2	95.0
Kerala	86.7	1	99.6	3	86.9	98.9
Madhya Pradesh	51.2	10	98.1	7	31.8	99.6
Orissa	52.5	9	97.4	9	49.4	96.3
Punjab	58.4	6	58.5	14	42.2	36.1
Tamil Nadu	64.6	3	97.8	8	66.8	95.6
Uttar Pradesh	44.2	12	84.7	12	44.0	84.2
Uttarakhand	43.4	13	45.8	15	27.8	46.5
West Bengal	49.6	11	99.1	6	44.5	98.4
C.V.	25.5		18.9		35.7	28.6
Mean	54.9		88.9		49.3	83.2
sd	14.0		16.8		17.6	23.8

Source: Same as Table 2.

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