INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

(Organ of the Indian Society of Agricultural Economics)

Vol. 69	JULY-SEPTEMBER 2014	No. 3

CONFERENCE NUMBER

- * * * -

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Ind. Jn. of Agri. Econ.
Vol.69, No.3, July-Sept. 2014

SUBJECT II
LABOUR SCARCITY IN AGRICULTURE AND MECHANISATION

Farm Mechanisation, MGNREGS and Labour Supply Nexus: A State-Wise Panel Data Analysis on Paddy and Wheat Crop

A. Narayanamoorthy*, M. Bhattarai, R. Suresh* and P. Alli†**

ABSTRACT

An attempt has been made in this study to find out the relationship among the farm mechanisation, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), labour supply and other factors mainly using state-wise data pertaining to paddy and wheat crops covering the period from 2000-01 to 2010-11. To measure the regression of various growth factors including MGNREGS on the use of farm machineries, regressions is computed using panel data with fixed effects models. The descriptive analysis of the study shows that the machine labour cost in real value (which is used as a proxy variable to reflect the level of farm mechanisation) incurred for cultivating both paddy and wheat has increased considerably during post MGNREGS period in almost all the states selected for the analysis. The machine labour cost incurred for cultivating paddy has increased substantially in states like Andhra Pradesh, Tamil Nadu, Karnataka and Madhya Pradesh after the implementation of MGNREGS, while the same increase was found very high in Madhya Pradesh, Himachal Pradesh, Uttar Pradesh and Punjab in wheat cultivation. In most states where the machine labour cost has increased substantially, the use of human labour in man-hours has declined sharply in both paddy and wheat, confirming the fact that farm machineries are used to substitute the human labour especially after implementing MGNREGS. The regression results computed using panel data suggest that the factors determining the use of farm machineries is not the same between the two major crops selected for the study. Besides MGNREGS dummy, the factors such as coverage of irrigation, yield enhancing inputs cost, land-labour ratio and human labour use in man-hours have significantly influenced the use of machine labour in paddy cultivation. But, in the case of wheat crop, irrigation coverage and land-labour ratio has not significantly influenced the use of machineries. The MGNREGS dummy used to capture its impact on farm mechanisation has turned out to be positive and significant in both paddy and wheat cultivation suggesting that the level of farm mechanisation has increased after its implementation of national rural employment guarantee scheme.

Keywords: Farm mechanisation, Rural employment, Farm wages.

JEL: J3, E24, Q16

I
INTRODUCTION

The major objective of this study is to find out whether any nexus exists among the farm mechanisation, Mahatma Gandhi National Rural Employment Guarantee

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Scheme (MGNREGS), labour supply and other factors across the major states in India. More specifically, it tries to find out the relationship between farm mechanisation and MGNREGS, which has reportedly increased the farm wage rate by creating artificial demand for labour in rural areas (Gulati *et al.*, 2013, Narayanamoorthy and Bhattarai, 2013). It is well known that the advent of new agricultural technology during the mid-sixties has brought many changes in Indian agriculture. Besides changing the land use pattern, it has increased the adoption of modern inputs (HYV seeds, fertilisers, pesticides, etc.), changed the cropping pattern from low value to high value crops and also considerably improved the cropping intensity. As the modern agriculture is intensive that warrants the field operations to be completed in time, the use of machineries became necessary for farming. This is also confirmed by the use of tractors (an important constituent in farm machineries) that have increased from just three per 1000 hectares in 1962-65 to 167 per 1000 hectares in 2005-08 at the all India level (Bhalla and Singh, 2012). But, since India is a labour abundant country, it is often argued that the increased use of machineries in farm operations is not justifiable as it will reduce the employment opportunities in agriculture (for discussion on this see, Sidhu and Grewal, 1990). Farm machineries are used not necessarily to reduce the use of human labour but mostly to produce more output per unit of land, to complement other inputs use, achieve higher productivity and to reduce the post-harvest losses in agriculture. It is often misunderstood that the farm machineries generally reduce the employment in agriculture, which is not correct (Sidhu and Grewal, 1990). In fact, farm machineries are different in nature; some are labour augmenting, while others are labour displacing (see Binswanger, 1978).

Researchers across time and space have critically analysed the possible outcome of farm mechanisation using aggregated and disaggregated data. While mechanisation has been well received all over the world as one of the important elements of modernisation of agriculture, there exist certain varied compelling factors that accelerates the pace of farm mechanisation in the Indian context. It has been identified that cost-efficiency consideration, faster ploughing operations during the crop seasons, the increased adoption of high-yielding varieties, relative scarcity of labour during peak agricultural operations, sharp rise in wages, ready availability of cheap institutional credit and availability of off and on farm custom hire possibilities as the contributing factors for the increased farm mechanisation (Rao, 1972; Grewal and Kahlon, 1972; Binswanger, 1978, 1986; Jose, 1984; Bhalla, 1995; FAO, 2013). With respect to the impact of farm mechanisation on farm operations, it is the labour displacement effect of farm mechanisation that has come up vividly in most of the studies (Rudra, 1971; Rao, 1972, 1974; 1975; Parthasarathy and Abraham, 1975; Government of India, 1975; Mcinernery and Donaldson, 1975; Kahlon, 1976; Dasgupta, 1977; Binswanger, 1978; Vaidyanathan, 1978; Roy and Blasé, 1978; NCAER, 1980; Agarwal, 1981; Zarkovic, 1987; Bhalla,1991; Narayanamoorthy, 1992). Studies have also corroborated the positive effects of farm mechanisation on

income generation, cropping intensity, productivity of crops, land augmentation and total factor productivity (Brian, 1972; Government of India, 2006; Reid, 2011). However, the validity of the positive findings of mechanisation have been questioned by some scholars (Binswanger, 1978, Agarwal, 1983; Alagh, 2004). Quite a few studies have also found a close nexus between farm size and mechanisation in agriculture (Agarwal, 1981; Sidhu and Grewal, 1990).

In the recent years it is being argued that the implementation of MGNREGS has increased the labour shortage and farm wage rate in the major foodgrains producing states which have forced the farmers to resort to mechanized farming (Reddy, 2012). To our knowledge no systematic study is available that could cross-check the validity of the claim that MGNREGS induces farm mechanisation. Has the farm mechanisation accelerated at a greater pace after implementing MGNREGS? Farm mechanisation is determined by a host of factors like labour supply, wage rate, labour use by man-hours, bullock labour use, productivity and profitability of crops, source and coverage of irrigation, cropping intensity, land labour ratio, output price and pattern of cultivation. One must consider all these factors along with NREGS variable to find out the important determinants of farm mechanisation. Moreover, the existing studies have mostly used availability of tractors or other machineries to cropped area as the variable to capture the influence of farm mechanisation (see, Bhalla and Singh, 2012). But the availability of machineries does not always reflect its actual use in crops cultivation. The real farm mechanisation can be studied either by taking the cost incurred on machine labour or hours of use of machineries in crops cultivation. In spite of proliferation of studies on farm mechanisation, not many detailed studies are available in recent years covering all these issues raised above. Keeping this in view, an attempt is made in this study to find out the relationship among the farm mechanisation, MGNREGS as well as other factors using state-wise data relating to paddy and wheat crops with the following objectives: (1) To find out whether machine labour cost (used as a proxy variable to reflect the level of farm mechanisation) increased in the case of paddy and wheat crops across the major states after the implementation of MGNREGS, (2) To find out the relationship between rural labour supply and the farm mechanisation in paddy and wheat crops across the major states and (3) To measure the influence of various growth variables including MGNREGS on the use of farm machineries in paddy and wheat crops using regression analysis with panel data.

II

DATA AND METHODOLOGY

The study has utilised state-wise data of two major crops, namely, paddy and wheat covering the period from 2000-01 to 2010-11. With 11 important states for paddy crop and eight states for wheat crop, a panel data of 121 observations (11 years x 11 states) for paddy and 88 observations (11 years x 8 states) for wheat have been

considered altogether for the analysis. As the study aims more specifically to find out the nexus among the farm mechanisation, NREGS and other factors including labour supply, a total of 14 variables that one way or the other determine the use of farm machineries have been considered for the analysis. The variables considered for the analysis including its sources are presented in Table 1. Of the total variables considered, variables such as BLC, HLC, HLMH, MLC (which is used as proxy variable to farm mechanisation), output price realised, profit and YEIC have been compiled from the cost of cultivation survey data published by CACP, while other variables namely CI, GIA/GCA, LLR and WR have been collected mainly from different publications of the Ministry of Agriculture, Government of India. Machine labour cost is used as a proxy variable to reflect the use of farm mechanisation in this study. As one of the objectives of the study is to find out the real change in the use of machine labour cost after the implementation of MGNREGS, all costs and income related data have been converted into real value with CPIAL base year of 1986-87. In order to capture the effect of MGNREGS on farm mechanisation in the two selected crops, the data period has been divided into two as pre-MGNREGS (2000-01 to 2005-06) and post-MGNREGS period (2006-07 to 2010-11). Besides descriptive analysis, correlation and regression analysis have been carried out to trace the determinants of farm mechanisation including the effect of NREGS.

TABLE 1. DEFINITION OF VARIABLES USED IN THE STUDY AND THEIR EXPECTED RELATIONSHIP WITH MACHINE LABOUR COST

Variables (1)	Description of the variables (2)	Unit (3)	Source of data (4)	Expected relationship with MLC (5)
HLC	Human labour cost	(Rs./ha)	CACP	-
BLC	Bullock labour cost	(Rs./ha)	CACP	-
YEIC	Yield enhancing input cost	(Rs./ha)	CACP	+
Yield	Productivity	(Qtl/ha)	CACP	
HLMH	Human labour use	(Man-hours)	CACP	-
PR	Price realised	(Rs./Qtl)	CACP	+
$Profit_{t-1}$	Profit with one year lag	(Rs./ha)	CACP	+
Profit	Profit in current year	(Rs./ha)	CACP	+
WR	Male wage rate	(Rs/.day)	www.dacnet.nic.in	+
CI	Cropping intensity	(Per cent)	www.dacnet.nic.in	+
GIA/GCA	Irrigated area to cropped area	(Per cent)	www.dacnet.nic.in	+
LLR	Land labour ratio	(ha)	www.dacnet.nic.in	+
NREGS	Dummy variable	Before = 0; After = 1	----	+

Notes: CACP – Commission for Agricultural Costs and Prices; MLC – Machine labour cost.

For regression analysis, we have used fixed effects form of panel model to quantify the marginal impact of factor-inputs on spatial and temporal variation of machine labour cost in paddy and wheat. The fixed effects form of regression modeling allows separating intercept of each cross-section unit (state) of India by controlling the state-specific institutional and structural constraints affecting the use of farm machineries. More particularly, we have used fixed effects form of panel

model with robust form of error correction by using STATA software, with VCE option of fixed effect regression model. The VCE option provides the robust estimators and efficient parameter estimates by correcting the heterogeneity, scale, and size effects across the cross-section units (see, STATA version 12 manual; Greene, 2011). In the context of machine labour use, some variables inherently are time invariant in nature such as state specific agricultural machinery markets, state governments agricultural and agro-machinery financing policies, development of rural financing, etc. In such context, fixed effects form of panel model is preferred (for details on the use of fixed effects model see, Greene, 2011). The regression model estimated is shown below in equation (1):

$$MLC_{it} = a_{it} + b_1HLC_{it} + b_2BLC_{it}, + B_3YEIC_{it}, + b_4HLMH_{it}, + b_5PR_{it}, + b_6Profit_{it-1}, + b_7CI_{it}, + b_8GIA/GCA_{it}, + b_9LLR_{it}, + b_{10}NREGSD_{it} + eit \quad ....(1)$$

where; i = 1,...n states of India

t = year in number from 1 to 11(121 observations for paddy; 88 observations for wheat)

MLC_{it} = Machine labour cost in paddy/wheat in Rs./ha

HLC_{it} = Human labour cost in Rs./ha

BLC_{it} = Bullock labour cost in Rs./ha

$YEIC_{it}$ = Yield enhancing inputs cost in Rs./ha

$HLMH_{it}$ = Human labour in man-hours/ha

PR_{it} = Output price realised in Rs./qtl

$Profit_{it-1}$ = Profit with one year lag in Rs./ha

CI_{it} = Cropping intensity in percentage

GIA/GCA_{it} = Irrigated area to cropped area in percentage

LLR_{it} = Land labour ratio in ha

$NREGSD_{it}$ = Dummy variable (before implementation = 0; after implementation = 1)

III

RESULTS AND DISCUSSION

Farm Mechanisation Before and After NREGS

It is argued vehemently that after the implementation of the national rural employment scheme, the use of machineries in various crops cultivation has increased to tackle the increased wage rate and labour scarcity artificially created by this scheme (for details see, Narayanamoorthy and Bhattarai, 2013). Since there is a complete absence of information from the literature on this issue, we have made an attempt in this section to find out how far this argument is correct. As mentioned earlier, the actual cost incurred on machine labour is used as the proxy variable to reflect the intensity in the use of mechanisation in paddy and wheat cultivation.

Besides studying the level of increase in the real cost (at 1986-87 prices) of machine labour and its growth rate, we have tried to capture the changes in the share of machine labour cost in the gross cost of cultivation (Cost A2) during pre- and post-MGNREGS period.

Table 2 presents the details on machine labour cost by states before and after implementing NREGS for both paddy and wheat. Let us first study the machine labour cost incurred for paddy cultivation. It is clear that the real MLC in paddy cultivation has increased considerably after the introduction of MGNREGS in 10 out of 11 states considered for the analysis. In Punjab, which is all along a forefront state in using farm machineries, the real MLC has declined marginally from Rs. 929/ha to Rs. 892/ha between the two periods. As expected, the pattern of increase in MLC is not the same across the states. Except for Andhra Pradesh and Tamil Nadu, the absolute increase in real MLC between pre and post-MGNREGS was only in the range of Rs. 32-124/ha in all other states. But, the increase was substantial in Andhra Pradesh (Rs. 341/ha) and Tamil Nadu (Rs. 322/ha). This large increase in these two states could be due to increased labour scarcity after the introduction of MGNREGS which is also corroborated by earlier studies (see Gulati *et al.*, 2013). Although the MLC in real value has increased in almost all the states, its growth rate is not appreciable in most of the states after MGNREGS as compared to its previous period. However, the share of machine labour cost in the gross cost of cultivation (cost A2) has increased in all the states after the introduction of MGNREGS. All these seem to suggest an increase in the adoption of farm mechanisation in paddy cultivation after implementing MGNREGS.

Similar to paddy, the real machine labour cost in wheat crop too has increased in most states after implementing MGNREGS. Except for Bihar where the MLC has declined marginally, it has increased in the range of Rs. 63-175/ha in different states. As expected, the extent of increase in MLC is not the same among the eight states considered for the analysis in wheat crop as well. MLC has increased by Rs. 175/ha in Madhya Pradesh and Rs. 152/ha Himachal Pradesh, whereas it increased only in the range of Rs. 63-82/ha in Gujarat and Rajasthan. Punjab and Uttar Pradesh have also incurred more cost on machine labour in wheat cultivation after implementing MGNREGS, but the same was not true in the case of paddy crop. This implies that the level of mechanisation varies from crop to crop as reported earlier. The increased MLC during MGNREGS period is also reflected through its share in cost A2 which expanded considerably in all the states except for Bihar. Although the machine labour cost incurred for the cultivation of paddy and wheat has increased in almost all the states after implementing MGNREGS, one cannot say candidly that it is an MGNREGS induced farm mechanisation. The adoption of machineries in crop cultivation is determined by a number of factors where MGNREGS is one of among the variables. Therefore, one must carry out a comprehensive analysis by taking into account all the relevant variables to find out the influence of MGNREGS on farm mechanisation, which is done in the following section.

TABLE 2. STATE-WISE MACHINE LABOUR COST INCURRED FOR CULTIVATING PADDY AND WHEAT DURING PRE AND POST-NREGS PERIOD

(values in Rs./ha at 1986-87 prices)

		Paddy			Wheat		
States	Particulars	Pre-NREGS period	Post-NREGS period	All period	Pre-NREGS period	Post-NREGS period	All period
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra	MLC (Rs./ha)	550	891	705	----	----	----
Pradesh	Per cent MLC to A2 Cost	11.56	17.06	14.19	----	----	----
	CGR of MLC	4.24	7.50	6.46	----	----	----
Assam	MLC (Rs./ha)	55	123	86	----	----	----
	Per cent MLC to A2 Cost	3.00	6.51	4.63	----	----	----
	CGR of MLC	-2.49	33.30	10.96	----	----	----
Bihar	MLC (Rs./ha)	291	329	308	633	629	631
	Per cent MLC to A2 Cost	12.88	15.09	13.87	23.83	21.91	22.92
	CGR of MLC	11.05	-0.74	2.62	1.57	-0.50	-0.46
Gujarat	MLC (Rs./ha)	----	----	----	552	615	581
	Per cent MLC to A2 Cost	----	----	----	16.49	20.10	18.05
	CGR of MLC	----	----	----	2.76	-0.86	2.98
Haryana	MLC (Rs./ha)	697	732	713	1012	1084	1045
	Per cent MLC to A2 Cost	15.35	17.46	16.27	28.12	31.79	29.74
	CGR of MLC	8.12	-6.92	0.82	6.38	-1.46	1.59
Himachal	MLC (Rs./ha)	----	----	----	448	600	517
Pradesh	Per cent MLC to A2 Cost	----	----	----	28.65	33.70	31.11
	CGR of MLC	----	----	----	20.51	-7.68	7.18
Karnataka	MLC (Rs./ha)	642	755	694	----	----	----
	Per cent MLC to A2 Cost	11.48	16.72	13.58	----	----	----
	CGR of MLC	1.79	8.00	3.72	----	----	----
Madhya	MLC (Rs./ha)	118	242	174	426	601	506
Pradesh	Per cent MLC to A2 Cost	6.18	12.38	9.04	18.98	25.87	22.17
	CGR of MLC	24.67	2.68	20.30	7.99	4.63	6.26
Orissa	MLC (Rs./ha)	121	153	136	----	----	----
	Per cent MLC to A2 Cost	4.37	5.57	4.92	----	----	----
	CGR of MLC	12.42	0.44	6.70	----	----	----
Punjab	MLC (Rs./ha)	929	892	912	1064	1169	1112
	Per cent MLC to A2 Cost	19.35	19.46	19.40	26.95	30.81	28.67
	CGR of MLC	0.87	0.32	0.13	3.67	-0.60	1.73
Rajasthan	MLC (Rs./ha)	----	----	----	606	688	643
	Per cent MLC to A2 Cost	----	----	----	20.05	23.75	21.69
	CGR of MLC	----	----	----	2.90	-4.55	0.20
Tamil Nadu	MLC (Rs./ha)	872	1194	1018	----	----	----
	Per cent MLC to A2 Cost	14.95	21.21	17.74	----	----	----
	CGR of MLC	8.07	1.69	5.96	----	----	----
Uttar	MLC (Rs./ha)	404	456	427	795	916	850
Pradesh	Per cent MLC to A2 Cost	14.45	15.95	15.14	25.17	26.80	25.94
	CGR of MLC	4.53	6.76	3.63	4.44	-2.10	2.56
West Bengal	MLC (Rs./ha)	195	250	220	----	----	----
	Per cent MLC to A2 Cost	5.28	6.60	5.89	----	----	----
	CGR of MLC	4.16	9.57	7.26	----	----	----

Source: Computed using data from CACP (various years).

Notes: MLC-Machine labour cost; CGR-Compound growth rate in percent per annum.

Human Labour Use Before and After MGNREGS

Farm mechanisation and use of human labour have a close relationship. Increased use of farm machineries in agricultural operations tends to reduce the use of human labour in any crop, be it foodgrain crops or others. We have also seen above that the costs incurred on machine labour for cultivating paddy and wheat have increased in almost all the states after the introduction of national rural employment guarantee scheme. Going by this, the use of human labour for both paddy and wheat must have reduced in all the states considered for the analysis. In order to study this issue, we have computed human labour use by man hours before and after the introduction of MGNREGS for both paddy and wheat (see Table 3).

TABLE 3. STATE-WISE HUMAN LABOUR USE FOR PADDY AND WHEAT CULTIVATION, PRE- AND POST-MGNREGS PERIOD

(man-hours/ha)

States	Paddy			Wheat		
	Pre-NREGS period	Post-NREGS period	Per cent change	Pre-NREGS period	Post-NREGS period	Per cent change
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	975	809	-17.01	snca	snca	snca
Assam	732	696	-4.90	snca	snca	snca
Bihar	855	768	-10.12	474	416	-12.26
Gujarat	snca	snca	snca	610	430	-29.53
Haryana	614	612	-0.36	307	300	-2.39
Himachal Pradesh	snca	snca	snca	289	253	-12.44
Karnataka	1258	1087	-13.64	snca	snca	snca
Madhya Pradesh	626	556	-11.20	356	317	-10.95
Orissa	1085	1053	-2.87	snca	snca	snca
Punjab	456	417	-8.46	218	188	-13.85
Rajasthan	snca	snca	snca	526	476	-15.33
Tamil Nadu	939	809	-13.86	snca	snca	snca
Uttar Pradesh	861	835	-3.07	468	473	+1.08
West Bengal	1199	1230	+2.61	snca	snca	snca

Sources: Computed using data from CACP (various years).
Note: snca – state not considered for analysis.

As expected, the use of human labour has declined considerably in all other states after implementing MGNREGS except for one state each in paddy and wheat. Reduction in human labour use is found to be very high in those states where the cost incurred for machine labour is higher. For instance, the farmers from Andhra Pradesh and Tamil Nadu have incurred higher MLC for cultivating paddy crop after implementing MGNREGS, which has directly impacted on the use of human labour in these two states. Human labour use in man-hours has declined by about 17 per cent/ha in Andhra Pradesh (from 975 to 809 man-hours/ha), whereas the same has declined by about 14 per cent/ha in Tamil Nadu (939 to 809 man-hours/ha). Similarly, the use of human labour for cultivating wheat crop has declined considerably during post-MGNREGS period in states like Himachal Pradesh, Madhya Pradesh, Punjab and Rajasthan. All these states have also incurred much

higher cost on machine labour after implementing MGNREGS. The results on the whole suggest that the increased farm mechanisation has declined the human labour use in almost all the states cultivating paddy and wheat after the implementation of MGNREGS.

Determinants of Farm Mechanisation

The descriptive analysis carried out above shows an increased use of farm mechanisation after implementing MGNREGS. However, one cannot say that this increase in farm mechanisation is only due to MGNREGS as many supply and demand factors relating to agricultural sector play crucial role in determining it. Therefore, as reported in methodology section, in order to find out the influence of various factors including MGNREGS, we have computed correlation and regression (panel data with fixed effects model) by taking into account the important variables that are expected to have relationship with the adoption of farm mechanisation in paddy and wheat cultivation. As the correlation value explains the one to one relationship between MLC and other associated variables, let us first study correlation before getting into the analysis of regression results.

The correlation value between MLC and 13 other variables presented in Table 4 shows that the intensity of use of farm machineries vary considerably from one crop to another. Except two variables in both paddy and wheat, all other variables have shown significant relationship with MLC. Factors such as bullock labour cost, yield enhancing inputs cost, productivity, profit, male wage rate and irrigation coverage to cropped area are highly correlated with MLC in paddy crop, whereas in the case of wheat crop, the variables such as yield, cropping intensity and irrigation coverage are

TABLE 4. CORRELATION VALUES: MACHINE LABOUR COST WITH OTHER SELECTED VARIABLES

Variables (1)	Description of the variables (2)	Unit (3)	Paddy (No of observations 121) (40	Wheat (No. of observations 88) (5)
HLC	Human labour cost	(Rs./ha)	0.399^{a}	0.142^{d}
BLC	Bullock labour cost	(Rs./ha)	-0.675^{a}	-0.340^{a}
YEIC	Yield enhancing inputs cost	(Rs./ha)	0.816^{a}	0.431^{a}
Yield	Productivity	(qtl./ha)	0.760^{a}	0.785^{a}
HLMH	Human labour man hours	(hrs./ha)	-0.242^{a}	-0.406^{a}
PR	Price realised	(Rs./qtl.)	0.434^{a}	-0.203^{b}
$Profit_{t-1}$	Profit with one year lag	(Rs./ha)	0.658^{a}	0.491^{a}
Profit	Profit in current year	(Rs./ha)	0.647^{a}	0.489^{a}
WR	Male wage rate	(Rs./day)	0.523^{a}	0.057^{ns}
CI	Cropping intensity	(Per cent)	-0.023^{ns}	0.650^{a}
GIA/GCA	Irrigated area to cropped area	(Per cent)	0.546^{a}	0.881^{a}
LLR	Land labour ratio	(ha)	0.225^{ns}	0.008^{ns}
NREGS Dummy	Before = 0; After = 1	----	0.155^{c}	0.196^{c}

Sources: Computed using data from CACP (various years) and www.dacnet.nic.in.

Notes: a, b, c and d are significant at 1 per cent, 5 per cent, 10 per cent, 20 per cent level, respectively; ns-not significant.

closely associated with MLC. Cropping intensity (CI) was expected to have positive correlation with MLC in paddy crop, but it turned out to be negative with insignificant value. Similarly, for wheat crop, wage rate of male which is used to capture the overall wage rate of the state has showed insignificant correlation with MLC, which is not expected. Surprisingly, HLC is positively associated with MLC in paddy and wheat, instead of a negative relationship. With this understanding of correlation between MLC and other variables, let us now focus on the regression results.

As mentioned in the methodology section, we have estimated panel data regression with fixed-effects model to quantify the marginal impact of various factors on spatial and temporal variation of machine labour cost of paddy and wheat across the selected states. The fixed-effects form of regression modelling allows us for a separate intercept for each cross-section unit (state) by controlling the state-specific institutional and structural constraints affecting farm mechanisation, which is not possible through simple OLS (ordinary least squares) regression model. As demonstrated earlier, the factors that control the adoption of mechanisation in paddy cultivation may not be necessarily the same with wheat cultivation in any given region. In view of this, we have estimated regression separately for paddy and wheat. One of our objectives is to capture the influence of human labour use on MLC and therefore, two models of regression have been estimated: one with HLC and another with HLMH.

The regression results estimated using panel data with fixed effects model on the determinants of machine labour cost in paddy cultivation are presented in Table 5. The higher adjusted R^2 estimated for paddy crop indicates that the machine labour use in paddy is better explained by the independent variables used in the model. Of the nine variables used in the regression model (1), variables such as YEIC, GIA/GCA, LLR and MGNREGS dummy have positively and significantly influenced the machine labour cost in paddy cultivation, while CI has negatively and significantly influenced MLC. Increased cost on human labour was generally expected to reduce the cost of MLC, but HLC has negatively and significantly influence it. One of the major objectives of the study is to find out the influence of labour supply and MGNREGS on MLC. The land-labour ratio which is used to capture the impact of labour supply has positively and significantly influenced, suggesting that wherever the supply of labour to cropped area is less the farmers tend to adopt more machineries in paddy cultivation. The positive and significant coefficient of MGNREGS dummy shows that the use of machineries in paddy cultivation has increased significantly after its introduction. Among all the variables used in model (1), the percentage of irrigation to cropped area seems to be influencing the MLC more than any other variable which is evident from its higher elasticity (1.38) value. This is plausible because of the fact that irrigated areas generally practice intensive agriculture, where increased use of farm machineries cannot be avoided to tackle the labour scarcity.

TABLE 5. DETERMINANTS OF MACHINE LABOUR COST IN PADDY CULTIVATION – PANEL DATA REGRESSION RESULTS

Variable	Model (1)		Model (2)	
	Coefficient	Elasticity	Coefficient	Elasticity
(1)	(2)	(3)	(4)	(5)
Human labour cost (HLC) (Rs/ha)	0.06	0.25		
	(0.80)^{ns}	(0.80)^{ns}	---	---
Bullock labour cost (BLC) (Rs./ha)	-0.16	-0.11	-0.07	-0.05
	(-0.95)^{ns}	(-0.95)^{ns}	(-0.73)^{ns}	(-0.73)^{ns}
Yield enhancing inputs cost (YEIC) (Rs./ha)	0.14	0.41	0.19	0.53
	(2.19)^{c}	(2.19)^{c}	(3.50)^{a}	(3.50)^{a}
Human labour use (HLMH) (man-hours/ha)			-0.81	-1.40
	---	---	(-4.55)^{a}	(-4.55)^{a}
Output price (Rs./qtl)	0.05	0.02	0.03	0.01
	(0.51)^{ns}	(0.51)^{ns}	(0.75)^{ns}	(0.75)^{ns}
$Profit_{t-1}$ (Rs./ha)	0.01	0.07	0.012	0.08
	(1.27)^{ns}	(1.27)^{ns}	(1.30)^{ns}	(1.30)^{ns}
Cropping intensity (CI) (per cent)	-2.91	-0.87	-1.29	-0.39
	(-1.71)^{d}	(-1.71)^{d}	(-1.09)^{ns}	(-1.09)^{ns}
GIA to GCA (per cent)	13.21	1.38	7.51	0.79
	(1.95)^{c}	(1.95)^{c}	(1.59)^{d}	(1.59)^{d}
Land labour ratio (LLR) (ha)	177.88	0.75	122.30	0.51
	(1.66)^{d}	(1.66)^{d}	(1.62)^{d}	(1.62)^{d}
NREGS dummy (before = 0; After = 1)	144.09	0.13	102.32	0.09
	(1.66)^{d}	(1.66)^{d}	(1.44)^{d}	(1.44)^{d}
Constant	-508.19		397	
	(-1.31)^{ns}		(2-79)^{b}	
Adjusted R^2 (overall model)	0.49		0.41	
F statistics	42^{a}		44^{a}	
Number of observations	121		121	
Number of groups (states)	11		11	
Rho	0.96		0.97	

Sources: Computed using data from CACP (various years) and www.dacnet.nic.in

Notes: (1) Figures in parentheses are t-values; (2) a, b, c and d are significant at 1 per cent, 5 per cent, 10 per cent and 15 per cent level, respectively; ns-not significant; (3) The elasticity values are estimated at sample mean level of observation. (4) Rho = 0.96 in Model 1 means the fraction of the variance of intercept that is explained by u_i (state specific error term). The higher the value of Rho the more individual state effect (fixed effect) is important in explaining variation of the dependent variable.

In model (2) on paddy crop, HLMH is used (instead of HLC) along with other variables to capture the influence of human labour variable on machine labour cost. As expected, HLMH turned out to be negative and significant in influencing the use of machineries in paddy cultivation. It also turned out to be the most dominant variable in negatively influencing the farm mechanisation; its elasticity is estimated to be at -1.40. This negative coefficient of labour use in man-hours was expected because farm machineries are generally used as substitutes for human labour in crop cultivation. Similar to the results generated through model (1), YEIC, GIA/GCA, LLR and NREGS dummy have all positively and significantly impacted on the use of farm machineries. The regression results also provide answer to the issue of whether the introduction of MGNREGS has anything to do with farm mechanisation? The results of both models clearly suggest that the MGNREGS has significantly and positively impacted on the use of farm machineries in paddy cultivation.

The use of farm machineries generally varies from one crop to another because of certain intrinsic reasons as reported earlier. Therefore, as followed for paddy crop, an attempt has been made to study the determinants of farm mechanisation in wheat, which is an important foodgrain crop cultivated predominantly during *rabi* season. Two regression models (1) and (2) have been estimated for wheat using the same variables that were employed for paddy. The adjusted R^2 estimated through two models presented in Table 6 clearly shows that the variables included in the models are appropriate as they explain 76 to 82 per cent of variation in the adoption of farm machineries in wheat. One can observe that the variations in the results estimated between model (1) and (2) are not very substantial, except the level of significant values. The coefficients of YEIC, CI and NREGS dummy have all positively and significantly influenced MLC in both the models, while human labour variable (HLC or HLMH) has negatively and significantly influenced it. Among all the variables, CI turned out to be the strongest variable (elasticity is 1.70-1.74 in both models) in impacting the use of farm machineries in wheat crop, which is obvious as intensive agriculture requires increased use of farm machineries.

TABLE 6. DETERMINANTS OF MACHINE LABOUR COST IN WHEAT CULTIVATION – PANEL DATA REGRESSION RESULTS

Variable	Model (1)		Model (2)	
	Coefficient	Elasticity	Coefficient	Elasticity
(1)	(2)	(3)	(4)	(5)
Human labour cost (HLC) (Rs./ha)	-0.07	-0.09		
	(-3.48)[a]	(-3.48)[a]	---	---
Bullock labour cost (BLC) (Rs./ha)	-0.04	-0.01	-0.03	-0.01
	(-1.26)[ns]	(-1.26)[ns]	(-1.04)[ns]	(-1.04)[ns]
Yield enhancing inputs cost (YEIC) (Rs./ha)	0.26	0.54	0.28	0.56
	(3.91)[a]	(3.91)[a]	(4.21)[a]	(4.21)[a]
Human labour use (HLMH) (man-hours)			-0.24	-0.12
	---	---	(-2.18)[b]	(-2.18)[b]
Output price (Rs./qtl)	0.25	0.07	0.29	0.08
	(1.08)[ns]	(1.08)[ns]	(1.29)[ns]	(1.29)[ns]
$Profit_{t-1}$ (Rs./ha)	0.005	0.02	0.005	0.023
	(1.15)[ns]	(1.15)[ns]	(0.98)[ns]	(0.98)[ns]
Cropping intensity (CI) (per cent)	8.31	1.70	8.46	1.74
	(3.28)[a]	(3.28)[a]	(3.25)[a]	(3.25)[a]
GIA to GCA (per cent)	1.79	0.13	0.54	0.04
	(0.47)[ns]	(0.47)[ns]	(0.12)[ns]	(0.12)[ns]
Land labour ratio (LLR) (ha)	0.96	0.005	-0.16	-0.008
	(0.09)[ns]	(0.09)[ns]	(-0.01)[ns]	(-0.01)[ns]
NREGS dummy (before=0; after=1)	79.99	0.05	70.50	0.043
	(1.87)[c]	(1.87)[c]	(1.68)[c]	(1.68)[c]
Constant	-1050.54		-1000.41	
	(-3.03)[b]		(-2.79)[b]	
Adjusted R^2 (overall)	0.82		0.76	
Total number of observations	88		88	
Total number of groups (states)	8		8	
Rho	0.60		0.69	

Sources and Notes: Same as in Table 5.

On the influence of human labour variable on machine labour cost, it appears from the regression coefficients that human labour man-hours is more important than the human labour cost not only in the case of wheat but also in paddy cultivation. This is possibly because any increase in human man-hours would automatically reduce the adoption of farm mechanisation, which is also observed in most states that have been considered for the analysis. One important difference noted between the results of paddy and wheat is the irrigation coefficient that should be explained here. Irrigation has positively influenced the use of farm mechanisation in paddy cultivation, which is not true for wheat cultivation. The insignificant influence of irrigation variable does not mean that the increased coverage of irrigation is not important (see, Narayanamoorthy and Deshpande, 2003). The irrigation variable has not turned out to be significant because some of the states (Himachal Pradesh, Madhya Pradesh, Uttar Pradesh) considered for the analysis have incurred higher cost on machine labour but they have relatively less irrigation coverage. However, NREGS dummy has come out with positive and significant value in wheat crop as well, suggesting that the use of machineries has increased appreciably after the introduction of the rural employment scheme.

IV

CONCLUSION AND RECOMMENDATIONS

An attempt has been made in this study to find out the relationship among the farm mechanisation, MGNREGS, labour supply and other factors using state-wise data pertaining to paddy and wheat crops covering period from 2000-01 to 2010-11. To measure the influence of various growth factors including MGNREGS on the use of farm machineries, regression is computed using panel data with fixed effects model. The descriptive analysis of the study shows that the real (at 1986-87 prices) machine labour cost (which is used as a proxy variable to reflect the farm mechanisation) incurred for cultivating both paddy and wheat has increased considerably during post-MGNREGS period in almost all the states considered for the analysis. The machine labour cost incurred for cultivating paddy has increased substantially in states like Andhra Pradesh, Tamil Nadu, Karnataka and Madhya Pradesh after implementing MGNREGS, while the same increase was found very high in Madhya Pradesh, Himachal Pradesh, Uttar Pradesh and Punjab in wheat cultivation. In most states where the machine labour cost has increased substantially, the use of human labour in man-hours has declined sharply in both paddy and wheat, confirming the fact that farm machineries are used to substitute the human labour especially after implementing MGNREGS. The regression results computed using panel data suggest that the factors determining the use of farm machineries is not the same between the two major crops selected for the study. Besides MGNREGS dummy, the factors such as coverage of irrigation, yield enhancing inputs cost, land-labour ratio and human labour use in man-hours have significantly influenced the use

of machine labour in paddy cultivation. But, in the case of wheat crop, irrigation coverage and land-labour ratio has not significantly influenced the use of machineries. The MGNREGS dummy used to capture its impact on farm mechanisation has turned out to be positive and significant in both paddy and wheat cultivation, suggesting that the level of farm mechanisation has increased after the implementation of national rural employment guarantee scheme.

Although the study suggests that the use of machineries in agricultural operations appears to have increased after implementing MGNREGS, more studies covering crops such as pulses, oilseeds, sugarcane, cotton, etc., need to be carried out using more disaggregated data to validate the results of this study. Some argue that the increased farm mechanisation is a desperate attempt of farmers to tackle the labour scarcity that occurred after implementing MGNREGS. One must find out whether the increased farm mechanisation is a desperate attempt or is it a normal development dictated by the exogenous and endogenous factors. Adoption of modern technology in agriculture also takes place partly due to profit reason which has also been corroborated by plethora of studies. The Indian farmers are more enterprising now than ever before due to market related reasons, which is also corroborated by the fast change of cropping pattern from low value to high value crops (see, Bhalla and Singh, 2012). Therefore, more detailed studies with farm level data need to be carried out to find out whether farmers use machineries increasingly due to profit motive or due to MGNREGS induced labour scarcity. In any case, the present study shows that the increased use of machine labour has reduced the human labour (farm employment) in crop cultivation which will have various social ramifications. Therefore, as demanded by the farmers from different states, efforts may also be taken to link the MGNREGS work with agriculture to have win-win effect for both farmers and agricultural labourers.

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