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Pattern and implications of labour migration on technical efficiency of farm households: A study in Bundelkhand region of central India

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ABSTRACT

Labour migration and remittance influence resource use efficiency in agriculture. The present study evaluates the impact of labour migration on crop productivity and technical efficiency in the Bundelkhand region of central India. The study is based on a primary survey of 240 farm households, comprising 120 migrant and 120 non-migrant households during 2016-17.The average yield of selected crops was higher in non-migrant households than that of migrant households. However, there was no variation in the input use intensity between the two categories.Factors such as education, farming experience, and access to extension services significantly reduced technical inefficiency for migrant households.In addition to these factors, access to irrigation significantly reduced technical inefficiency for non-migrant households. Development of irrigation infrastructure and strengthening extension linkage can enhance crop productivity and check distress migration in the Bundelkhand region.

Key words: Bundelkhand, Crop productivity, Labour migration, Remittance, Technical efficiency

Migration, as a process, has an important role in determining the socio-economic and demographic features of a region. Diverse economic prospects across regions cause migration response among rural farming households and agricultural labourers. Migration is an important strategy for income diversification and risk aversion for farming households (Ellis 2000; Wouterse 2008). According to the new economics of labour migration, migrant remittances may enhance investments in agriculture.

Remittances from migration supplement income and expenditure of origin households and thus, alleviate poverty in rural areas (Taylor and Lopez-Feldman 2010; Amare *et al.* 2012; Nguyen and Mont 2012). Earlier studies report the constructive effect of migration on agricultural investment, technology spillover, and productivity (Singh *et al.* 2011; Deininger *et al.* 2012; Li *et al.* 2013; Loc 2015). At the same time, some studies suggest mixed effects of migration and remittance on agricultural productivity (Cohen 2004; Kirimi and Sindi 2006; Schmook and Radel 2008; Bolganschi 2011; Adaku 2013; Maharjan *et al.* 2013).

The same phenomena can be viewed from an entirely different view of resource use efficiency. Labour migration and remittances may influence resource use efficiency of rural agriculture.A dilemma related to rural migration and agricultural production is whether remittance augments production enough to compensate for the reduced availability of labour in any specific setting. However, there is a dearth of studies that empirically investigate the effect of rural labour out-migration on productivity and technical efficiency in Indian agriculture. Therefore, the present study examines the pattern and implications of labour out-migration on crop productivity and technical efficiency of the Bundelkhand region of central India.

MATERIALS AND METHODS

The present study is based on the primary survey conducted during 2016-17 in the Bundelkhand region which contributes to the highest rural to urban migration from central India (Census 2011). Bundelkhand is spread over southern Uttar Pradesh and northern Madhya Pradesh. The study is based on the survey of 240 farm households, comprising 120 migrant and 120 non-migrant households, selected through purposive sampling followed by a multi-stage random sampling technique. Two districts, viz. Jhansi (Uttar Pradesh) and Tikamgarh (Madhya Pradesh) were

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selected randomly, and two villages (Simradha and Behta in Jhansi district, and Jamuniya and Dabar in Tikamgarh district) were selected from each district. From each village, 30 migrant and 30 non-migrant agricultural households were identified and a total of 240 sample agricultural households were surveyed.

The ability of farms to use the input most efficiently and optimally in the production of the best level of output is termed as technical efficiency (Olayide and Heady 1982). The study employs stochastic production frontier with Cobb-Douglas functional form (Aigner *et al.*1977) to measure farm level technical efficiency scores.The stochastic production frontier for the crops was taken as:

$$InY_i = \alpha + \sum_{j=1}^{n} \beta_j InX_{ij} + v_i - u_j \quad (1)$$

where, n is the number of farms cultivating a particular crop; Y_i is the output of the i[th] farm; X_{ij} is an input corresponding to the i[th] farm and j[th] crop; v_i are normally and independently distributed random errors with zero mean and constant variance [N (0, σ_v^2)], u_j is the technical inefficiency effect, and β_i s are the parameters to be estimated. The variance parameters σ_u^2 and σ_v^2 were expressed in terms of parameterization (Battese and Corra 1977):

$$\sigma_u^2 + \sigma_v^2 = \sigma^2; \gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2} \quad (2)$$

and $\lambda = \frac{\sigma_u}{\sigma_v}$ (>0), the parameter γ can take values from 0 to 1.

The independent variables (X_{ij} s) included in the model were farm size (ha), labour days, cost of irrigation (₹/ha), seed (kg/ha), fertilizer (kg/ha), machinery input (hours/ha), and plant protection and miscellaneous costs (₹/ha) corresponding to j[th] crop and i[th] farm.

Generally, the stochastic production frontier is estimated in the first stage and then technical efficiency in the later stage as a function of various characteristics of the farms. To simplify this, we used a single-stage procedure following Mondal *et al.* (2012). Along with the parameters of the stochastic frontier production function, the technical inefficiency model was fitted simultaneously and estimated as follows

$$\textit{Technical Inefficiency}\ (\mathrm{TI}) = \mathrm{u}_i = \delta_0 + \sum_{j=1}^{n} \delta_j Z_{ij} \quad (3)$$

where Z_{ij} is the vector of farm and farmer-specific attributes. Farmer specific characteristics included in the model were age, gender, education, farming experience (years), farm size (ha), number of extension contacts made, access to institutional credit, access to irrigation, and use of modern technologies.

RESULTS AND DISCUSSION

Migration pattern and remittance

Rural out-migration from the Bundelkhand region was mostly informal, temporary, and seasonal. Lack of employment opportunities, recurring droughts, and lower wage rates acted as push factors for seasonal out-migration from the study area.The daily wage rate in the Bundelkhand region was in the range of ₹ 175 to ₹ 200, whereas in most of the preferred destinations, the wage rate was in the range of ₹ 250 to ₹ 300. A farm household member migrated mostly whenever there was no agricultural work in the village and returned during peak agricultural season. Migrant households had an average of two migrants from their families. About 47% of the migrant households had at least one earlier migrated family member. Remittance was an additional source of income for migrant agricultural households. Table 1 provides the details of remittance received by migrant households in the study area. Bundelkhand region faced recurrent droughts and water scarcity. To overcome these adversities, investment in groundwater irrigation was undertaken by farm households. The use of remittance for agriculture was high during normal agricultural years. The effect of migration on agricultural investments depends on local conditions (Taylor and Martin 2001). In drought years, remittance was used mainly for meeting household consumption and other expenditure.Once the consumption requirements and other expenditures are fully met, the household may invest remittances in agriculture to enhance productivity in cases of the extended length of the migration period (Cohen 2004). Seasonal migration adopted by rural households as a risk coping strategy is reported in earlier studies (Deshingkar and Start 2003; Jha *et al.* 2017; Singh 2019). Earlier studies also reported that in those areas where migration was a risk mitigation strategy, the use of remittance as an investment in agriculture was meager and land use pattern was not much different between migrant and non-migrant households (David 1995; Jokisch 2002).

Impact of migration on crop productivity and technical efficiency

A comprehensive account of variables included in the stochastic production frontier and technical inefficiency functions are presented in Table 2.Wheat, blackgram, and greengram were the major crops cultivated in the study area. The results indicated that the average yield of selected crops was higher in the non-migrant households than that

Table 1 Remittances received and its utilization by migrant households (n=120)

Particulars	Percent/₹
Migrant households receiving remittance (%)	54.6
Average monthly income from remittance (₹)	3342
Utilization of remittance by migrant households (%)	
Consumption	66.4
Education	34.7
Agriculture	23.5
Healthcare	11.7

Source: Authors' calculation based on the primary survey

Table 2 Description of variables used in the stochastic frontier function and technical inefficiency function

Variable	Migrant households			Non-migrant households		
	Wheat	Greengram	Blackgram	Wheat	Greengram	Blackgram
Output (q/ha)	16.6 (5.13)	3.64 (1.02)	4.09 (1)	17.53 (5.26)	3.77 (1.08)	4.14 (1.03)
Farm size (ha)	1.52 (1.15)	1.52 (1.15)	1.52 (1.15)	1.66 (0.74)	1.66 (0.74)	1.66 (0.74)
Labour (man-days/ha)	32 (5)	24 (2)	24 (2)	31 (4)	24 (2)	24 (2)
Cost of irrigation (₹/ha)	314.18 (264.11)	516.2 (126.5)	462.6 (138.1)	323.88 (151.1)	538.05 (131.6)	414.63 (142.16)
Seed (kg/ha)	94.31 (12.75)	23.8 (4.03)	23.73 (4.46)	89.74 (14)	23.36 (3.97)	22.63 (4.78)
Fertilizer (kg/ha)	94.28 (21.06)	26.36 (7.43)	23.65 (7.47)	89.49 (20.31)	25.63 (7.2)	24.17 (7.25)
Machinery input (hr/ha)	18.51 (6.74)	21.79 (6.25)	21.87 (7.15)	18.84 (6.78)	21.67 (6.51)	21.83 (6.38)
Plant protection & misc. cost (₹/ha)	930.59 (200.05)	568.6 (130.3)	548.13 (176.1)	888.45 (179.58)	576.85 (138.2)	503.65 (169.06)
Sample size	101	85	94	103	92	98
Age of the household head (years)		47.32 (9.06)			50.78 (8.68)	
Gender of household head -Male (%)		98			97	
Level of education of household head (years)		5.61 (3.77)			3.79 (3.01)	
Farming experience (years)		20.15 (7.56)			22.16 (7.54)	
Farm size (ha)		1.52 (0.74)			1.66 (1.15)	
Extension contacts (Number)		31			23	
Access to credit (%)		72			68	
Access to irrigation (%)		69			65	
Used modern technologies (%)		9			11	

Note: Figures in parenthesis are standard deviation. Source: Authors' own calculation based on the primary survey

of migrant households. However, there was no variation in the input use intensity between the two categories. Timely availability of labour for farm operations by non-migrant farmers throughout the cropping season could be the reason for the better performance of nonmigrant households. Bolganschi (2011) observed reduced agricultural production in migrant households as they used the remittance to move out of cultivation. Adaku (2013) also reported that households whose members opted for seasonal migration had significantly low farm production compared to non-migrant households in Ghana. According to Qin (2016), nonmigrating households had more intensified farming as they were more or less a homogenous group.

The results of the generalized likelihood test confirmed the presence of technical inefficiencies due to migration. Table 3 provides the estimates of the stochastic production frontier for the Cobb-Douglas form under truncated normal distribution of U_i. Variables such as farm size, cost of irrigation in wheat, plant protection in greengram and seed in blackgram had a positive influence on yield for migrant households. The results implied that raising the levels of these inputs have the potential for increasing productivity. Variables such as plant protection and miscellaneous cost in wheat and seed in green gram had a negative relationship with yield indicating over-use of these inputs in the production.

For non-migrant households, irrigation cost for wheat, seed in black gram, plant protection and other miscellaneous costs in green gram had a positive influence on productivity. The coefficients show a parallel trend to that of migrating

Table 3 Maximum likelihood estimates of parameters of the stochastic frontier model

	Migrant households			Non-migrant households		
	Wheat	Green gram	Black gram	Wheat	Green gram	Black gram
Farm size (ha)	0.20***	-0.06	-0.07	-0.09	-0.25***	-0.02
	(0.06)	(0.22)	(0.61)	(0.07)	(0.05)	(0.21)
Labour (man-days/ha)	-0.13	-0.82	-0.11	0.02	-0.31	-0.21
	(0.09)	(0.81)	(0.89)	(0.08)	(0.25)	(0.83)
Cost of irrigation (₹/ha)	0.05***	-0.02	-0.03	0.07***	-0.03***	0.01
	(0.01)	(0.21)	(0.77)	(0.01)	(0.01)	(0.05)
Seed (kg/ha)	-0.09	-0.19**	0.26**	0.08	-0.27**	0.27**
	(0.19)	(0.09)	(0.13)	(0.08)	(0.13)	(0.13)
Fertilizer (kg/ha)	0.01	-0.03	0.16	-0.04	0.11	0.18
	(0.1)	(0.24)	(0.54)	(0.09)	(0.08)	(0.37)
Machinery input (hr/ha)	0.01	0.1	0.35	0.02	0.17	0.22
	(0.07)	(0.21)	(0.42)	(0.06)	(0.16)	(0.38)
Plant protection & misc. cost (₹/ha)	-0.43***	0.54*	0.28	-0.07	0.18*	0.29
	(0.12)	(0.32)	(0.65)	(0.12)	(0.09)	(0.39)
Constant	6.38***	0.34	0.31**	2.95***	1.75*	0.14**
	(1.01)	(0.98)	(0.16)	(0.9)	(0.94)	(0.06)
Inefficiency model						
Age of the household head (years)	-0.01	-0.02	0.02	0.01	0.02	0.03
	(0.01)	(0.02)	(0.04)	(0.01)	(0.01)	(0.01)
Gender of household head (1=male; 0 otherwise)	0.68**	0.59	0.04	0.39	0.56	0.92
	(0.34)	(0.78)	(0.99)	(0.35)	(0.85)	(0.84)
Education of household head (years)	-0.05***	-0.01***	-0.01	-0.06***	-0.03***	-0.02***
	(0.01)	(0.01)	(0.07)	(0.02)	(0.01)	(0.01)
Farming experience (years)	-0.02***	0.01	-0.03	-0.02*	-0.04***	-0.02
	(0.01)	(0.03)	(0.04)	(0.01)	(0.01)	(0.02)
Farm size (ha)	0.13***	-0.03	-0.16	-0.16	-0.28	0.05
	(0.04)	(0.28)	(0.81)	(0.11)	(0.13)	(0.3)
Extension contacts (Number)	-0.39***	0.11	-0.03	-0.44**	-0.02	0.07
	(0.07)	(0.16)	(0.94)	(0.21)	(0.11)	(0.17)
Access to credit (1=yes; 0 otherwise)	0.22	0.124	0.1	0.03	0.27	-0.09
	(0.16)	(0.74)	(0.92)	(0.1)	(0.2)	(0.34)
Access to irrigation (1=yes; 0 otherwise)	-0.21	0.38	0.09	-0.46**	-0.44**	0.35
	(0.16)	(0.67)	(0.97)	(0.22)	(0.21)	(0.7)
Use of modern technologies (1=yes; 0 otherwise)	-0.22	-0.07	0.01	-0.45	-0.12	0.1
	(0.15)	(0.94)	(0.01)	(0.53)	(0.25)	(0.9)
Constant	-0.15	0.15	-0.21	0.17	-0.88	-0.99
	(0.55)	(0.93)	(0.91)	(0.58)	(0.74)	(0.99)
Variance parameter						
Sigma squared	0.06***	0.15***	0.08**	0.08***	0.18***	0.09**
	(0.01)	(0.05)	(0.04)	(0.03)	(0.05)	(0.04)
Gamma	0.26***	1.00***	0.92	0.44*	1.00***	0.86**
	(0.07)	(0.1)	(0.45)	(0.25)	(0.01)	(0.41)
Log likelihood function	2.12	5.58	21.59	2.28	-5.51	19.37
Mean technical efficiency	0.65	0.66	0.76	0.75	0.67	0.78

Note:*** p<0.01; ** p<0.05;* p<0.1., Coeff=coefficient, SE=Standard Error. *Source:* Authors' own calculation based on the primary survey

Table 4 Technical efficiency distribution of the migrant and non-migrant households

Frequency

Range of efficiency	Migrant households			Non-migrant households		
	Wheat	Greengram	Blackgram	Wheat	Greengram	Blackgram
0.01-0.20	6 (5.9)	4 (4.7)	3 (3.3)	3 (2.9)	5 (5.3)	8 (9.6)
0.21-0.40	8 (7.9)	8 (9.4)	5 (5.4)	4 (3.8)	7 (7.4)	9 (12.5)
0.41-0.60	23 (22.8)	13 (15.3)	12 (10.9)	15 (15.4)	12 (14.9)	8 (7.7)
0.61-0.80	47 (46.5)	45 (52.9)	46 (50)	52 (50)	50 (53.2)	42 (40.4)
0.81-1.00	17 (16.8)	15 (17.6)	28 (30.4)	29 (27.9)	18 (19.1)	31 (29.8)
Minimum	0.12	0.16	0.14	0.18	0.13	0.12
Maximum	0.96	0.97	0.99	0.98	0.98	0.99
Mean	0.65	0.66	0.76	0.74	0.67	0.77

Note: Figures in parenthesis are percentage share. *Source:* Authors' calculation based on the primary survey

households with similar implications in input use.

The technical inefficiency model specifies the relationship between farm-specific characteristics and inefficiency effects. The difference in performance could be due to the inefficiencies associated with farm management. For the migrant households cultivating wheat, the gender of the household head and farm size had a positive and significant relation with inefficiency. The effect of education was negative and statistically significant in general. The farming experience had a negative effect on technical inefficiency in the case of wheat for both migrant and non-migrant households. Access to irrigation had a significant negative effect on the inefficiency effects in wheat and greengram for non-migrant households. This implies that improvement in the availability of irrigation facilities has reduced the inefficiency. The coefficient of extension contacts was negative and statistically significant in wheat signifying that farmers who had access to extension service irrespective of their migration status were more efficient. These results accentuate the importance of extension services in enhancing technical efficiency which calls for strengthening of extension services.

Table 4 portrays the technical efficiency distribution of the migrating and non-migrating households. The results revealed that non-migrant farm households had higher technical efficiency than migrant households. Considering the selected crops, 63 to 80% of the migrant farming households and 70 to 78% of non-migrant households had technical efficiency indices of more than 0.60. This implies that with the efficient use of inputs and technology, the crop output can be increased by 20 to 39% in migrant farm households. Whereas for non-migrant households, the output can be increased by 21 to 30%. These findings are consistent with Iheke *et al*. (2013).

Conclusions

The use of remittance in agriculture was high during normal agricultural years. Investment of remittance by migrant farm households in agriculture depends upon their consumption needs and weather adversities. An analysis of the pattern of input-output usage found that the yield of selected crops was higher in the non-migrant households than the migrant households. However, there was not much variation in the level of input use between the two categories. The results also showed decreasing returns to scale for all the major crops implying that the quantities of some inputs exceeded the scale efficient point for the prevailing technology. The non-migrant households were more efficient than the migrant households as far as crop production is concerned. The difference in performance was due to the inefficiencies in farm management. Education and farming experience reduced technical inefficiencies. Access to irrigation significantly enhanced crop productivity in the region. Whereas, access to extension services has enhanced technical efficiency. Development of irrigation infrastructure and strengthening extension linkage can enhance crop productivity and check distress migration in the Bundelkhand region.

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