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Family Labour Out-Migration and Technical Efficiency: A Case of Rice Framers in Tanahun District, Nepal

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Abstract

This paper explores the relationship between rural out migration and technical efficiency in rice production applying it to the case of Nepal using detailed survey data obtained from 150 farming households over 3 villages throughout 2012/13 growing season. The study finds mean level of technical efficiency is 78, 68 and 66 percent, respectively, for households with no migrant family members, with international migrants and internal migrants. The efficiency differences are explained significantly by age and education of the household head, livestock holding, participation of family members in agricultural related organization and migration status. Both international and internal migration has negative relation with technical efficiency. Similarly, migration of male member has a negative relation and female member migration has no relation with technical efficiency. The study shows that out-migration does not drive agricultural production enhancements, hence, policies intended to minimize farm labour out-migration and improve agricultural efficiency is of paramount importance.

Key words: *Migration; technical efficiency; stochastic production frontier approach; Nepal*

Introduction

Out-migration of labour is an important livelihood strategy in rural area of many developing countries (Taylor, Rozelle, & De Brauw, 2003). A growing number of studies have assessed the impact of such migration on agriculture production (Gray, 2009; Jokisch, 2002; Mendola, 2008; Taylor et al., 2003; Wouterse & Taylor, 2008). An issue that has received much less attention in the literature is link between migration and technical efficiency, which is the focus of this study.

Previous studies have identified diverse impacts of out-migration on agriculture in origin areas. In general, studies can be divided into two categories between arguing that migration undermines agricultural production due to loss of productive labour and those arguing that it enhances agricultural improvements by providing capital inputs through remittance. For example, Taylor et al. (2003) found countervailing effects of migration and remittances that yields declined with the number of out-migrants but increased with remittances. According to Mendola (2008), international out-migration led to increased adoption of high-yielding crop varieties in Bangladesh, whereas internal out-migration led to decreased adoption. Gray

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(2009) found that international remittances result in increased maize production. According to Jokisch (2002) agricultural production of international migrant households is not significantly different from non-migrant households or households engaged in domestic circulation.

Studies analysing the effects of migration on farm level technical efficiency is very limited. Different migration status might affect farm level efficiency differently. Mochebelele and Winter-Nelson (2000) compare the technical efficiency of farms in Lesotho that supply migrants labour to South African mines with that do not. The study finds that technical efficiency of migrants' farm is higher than that of non-migrants suggesting that the households with more finance through remittance can be more responsive to farm management needs than households with more resident family members but less cash. Wouterse (2010) distinguish migration in Burkina Faso context into intercontinental and continental and assessed the effects of these two forms of migration on technical efficiencies of cereal production. The study found that continental migration has a positive relation and intercontinental migration no relation with technical efficiency.

This paper adds to the literature by offering new empirical evidence on the potential effect of migration on technical efficiency. To this end, this study takes into account two novel issues. First, Migration out of rural area can be divided into two categories: within country (internal) and outside the country (international). These two categories of migration may affect agricultural production and technical efficiency differently. International migration entails a relatively longer term loss of labour than internal migration whereas remittance from international migration might be higher than internal. Second, considering the different role of men and women farmers in agriculture, the effect of migration of male member of the household on agricultural production and technical efficiency might be different from migration of female members. This study advances previous quantitative studies by separately testing for the effects of internal and international migration as well as the effects of male and female out migration on the on technical efficiency of rice farmers in rural area of Nepal.

The study uses Nepal as a case study for two distinct reasons. Frist, in Nepal, agriculture remains a dominant sector, contributing about 35% of total gross domestic product and employing 70 percent of the population in the country (MoAD, 2012); and rice is the principal crop dominating the agricultural sector supplying about 40 percent of calories for the people (Gauchan & Pandey, 2011). However, rice production and productivity in the country is not encouraging and is unstable (Fig. 1). Second, while there is a critical debate on migration and agricultural based rural development (De Haas, 2010; Dethier & Effenberger, 2012; Stark, Taylor, & Yitzhaki, 1988), very few studies have investigated the impact of different migration status on farmer's production efficiency. In rural areas of Nepal, studies found the increasing abandonment of cultivable land, reduction in livestock holding and overall decrease in agricultural production as a result of rural out migration (Khanal & Watanabe, 2006). A correlational analysis of migration and development indicators found a high incidence of poverty in the regions associated with net out-migration in the country (Kumar, 2004).

Given this background, the objective of this study is to analyse the role of family member out-migration in explaining production efficiency and to identify other factors that determine technical efficiency of rice farmers in Nepal. This paper is organized as follows: section 2 describes the material and methods, section 3 presents results and discussion and section 5 presents concluding remarks.

Material and Methods

Methodological Framework

Farm technical efficiency is defined as the ability of a farmer to produce maximum output with given quantities of inputs and technology (output oriented) or the ability to use minimum input to produce a given quantity of output (input oriented). Stochastic Frontier Analysis (parametric method) (SFA) and Data Envelopment Analysis (non-parametric method) (DEA) are the most commonly used methods in analysing efficiency. A growing body of literature make side by side comparisons of the two methods (Odeck, 2007; Theodoridis & Anwar, 2011; Van Meensel, Lauwers, Van Huylenbroeck, & Van Passel, 2010; Wadud & White, 2000), however none of these studies make clear conclusions about which method is superior. SFA has the ability to separate the effect of noise from the effect of inefficiency whereas DEA cannot. SFA generates good results for single output and multiple inputs whereas DEA is useful to apply to farms with multiple inputs and multiple outputs. In a meta-analysis of technical efficiency in developing countries agriculture by Thiam, Bravo- Ureta and Rivas (2001) found that stochastic versus deterministic frontiers do not seem to significantly affect estimates of technical efficiency across studies. In this study, we use SFA as rice production is an example of single output and multiple inputs production and rice production in Nepal is subject to heterogeneous environmental factors like weather which are beyond the control of farmers. Moreover, considering the comparatively poor educated farmers, respondents might not precisely answer some of the questions which can affect efficiency measurement.

The SFA model was simultaneously introduced by Aigner, Lovell, and Schmidt (1977) and Meeusen and Van den Broeck (1977) and has been increasingly used to estimate technical efficiency. The technical efficiency of an individual unit is defined as the ratio of observed output to the corresponding frontier output, given the level of inputs used by the farm (Battese & Coelli, 1995). Many studies used a second stage regression method to determine the farm specific attributes in an attempt to explain the observed differences in efficiency among farms. However, Battese and Coelli (1995) incorporated farm specific attributes in the efficiency model directly. This model allows estimates of the farm specific sources and the factors explaining efficiency differentials among farms in a single procedure. This study employs this model. The general form of the model is:

$Y_i = x_i\beta + (V_i - U_i)$ $\quad i = 1,2.....N$

Where,

Y_i is the output of the farm i,

x_i is the vector of input quantities used by the farm i,

β is vector of unknown parameters to be estimated,

V_i are assumed to be identically and independently distributed N $(0, \sigma^2_v)$ two sided random errors, independent of the U_i, representing random shocks, such as exogenous factors, measurement errors, omitted explanatory variables, and statistical noise.

Ui are non-negative random variables, associated with inefficiency in production, which are assumed to be independently distributed as truncations at 0 of the N $(m_i, \sigma^2_{u)}$ distribution; where

$m_i = z_i\delta$

m_i is the inefficiency of farm i,

z_i is the vector of variables which may influence the inefficiency of a farm, and

δ is vector of parameters to be estimated.

The technical efficiency of production of farm i, given the level of inputs, is defined by:

$TE_i = \exp(-u_i)$

The technical efficiency of the farm is between 0 and 1 and is inversely related to the level of the technical inefficiency effect.

Study Area, Data and Model Variables

The study area for this research is the Tanahun district in the western mid hill region of Nepal which covers an area of 1568.4 sq. km^2. Majority of the population in the district depends on agriculture for their livelihood and rice is one the major crop grown. The rice production in the district is mainly under the rain fed system near the river basin and lower hills. For this study, primary data were collected from 150 rice growing households selected following simple random sampling procedure in three stages. First, three Village Development Committees (VDC)[2]namely; Ghasikuwa, JamuneBhanjyang and Kihun were randomly selected among 46 VDCs in the district. Second, five wards were randomly selected from each VDC. Finally, 10 rice growing households from each ward were randomly selected. Data were collected for the cropping year 2012-2013. A semi-structured questionnaire was used to interview the sampled farmers to collect information on input, output, migration status and other socioeconomic characteristics of farmers.

The variables included in this study have been commonly used in estimating technical efficiency in developing countries. Rice production expressed in kilogram was used as output variable (Rahman & Rahman, 2009; Skevas, Lansink, & Stefanou, 2012). Typical agricultural inputs like land area, labour and chemical fertilizers (Amara, Traoré, Landry, & Remain, 1999; Reddy & Bantilan, 2012; Rahman & Rahman, 2009; Skevas et al., 2012) were included in the production frontier. The explanatory variables selected for this study include age of the household head (Reddy & Bantilan, 2012; Khai & Yabe, 2011; Rahman & Rahman, 2009; Tan, Heerink, Kuyvenhoven, & Qu, 2010), education of household head (Reddy & Bantilan, 2012; Duvivier, 2013; Khai & Yabe, 2011; Rahman & Rahman, 2009; Tan et al., 2010), family size (Chen, Huffman, & Rozelle, 2009; Khai & Yabe, 2011; Rahman & Rahman, 2009), livestock holding (Rahman & Rahman, 2009), participation (Binam, Tonye, Nyambi, & Akoa, 2004; Solís, Bravo- Ureta, & Quiroga, 2007), and migration status (Mochebelele & Winter-Nelson, 2000; Wouterse, 2010).

Fig 1. Rice Area and Productivity in Nepal

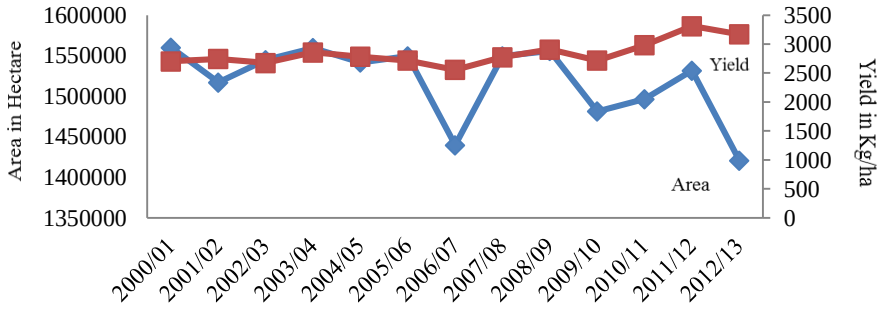

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Table 1. Descriptive Statistics of Selected Variables

Variables	Migration Status					T test	
	Non migrants	International migrants	Internal migrants	Overall migrants	Overall	a	b
Sample size (n)	55	56	39	95	150		
Area under rice (ha)	0.42	0.40	0.43	0.41	0.41	-0.283	-0.112
Rice Yield (Kg/ha)	3322.17	2612.93	2405.70	2539.15	2753.65	0.060	-2.039**
Chemical Fertilizer (Kg/ha)	115.95	106.45	100.53	104.12	109.49	-0.148	-0.979
Labour[1] (number of days/ha)	137.62	151.15	149.37	151.24	147.49	-0.356	0.479
Age of the household head (years)	45.91	47.71	51.89	49.43	48.14	-1.329	1.441
Education of the household head (years of schooling)	6.22	4.66	4.49	4.59	5.19	0.211	-2.343**
Family size (number)	4.67	4.48	4.62	4.54	4.59	-0.291	-0.373
Livestock holding (LSU)[2]	2.90	2.01	2.11	2.06	2.37	-0.432	-4.263***
Participation [3]	0.80	0.55	0.59	0.57	0.65	-0.347	-2.935***
Household income (Rupees)	166545	152232	156410	153947	158566	-0.318	-1.217

n= Sample size of respective category

[1]Labour includes both family labour and hired labour

[2]LSU is aggregates of different types of livestock in standard unit. 1 LSU = 1 buffalo = 1 cattle = 3 sheep or goats = 10 poultry (CBS, 2003)

[3]Participation is dummy variable and takes the value of '1' if any member of the household is a member of any agricultural related organization and '0' otherwise.

a International versus internal migrants

b Migrants versus non-migrants

*** Significant at 1% level

** Significant at 5% level

A summary of selected variables related to rice production, inputs, and household specific socio-demographic information is presented in Table 1. It shows that average area under rice cultivation in the study site is around 0.4 hectare and on average a household produces 1170 kg rice in a year using on average 44 kg chemical fertilizer and 60 man days of labour. On average, the age of the household head is 48 years old with 5 years of formal education. On average, a sampled household consists of 4.59 family members. Rice yield, education of the household head and livestock holding are found significantly higher in household with no migrant members than household with migrant members. The participation of family members in agricultural related organizations is also found higher in household with no migrants than with migrants. However, there is no significant difference among these variables when compared between household with international and internal migrants. Though not significant, remarkably, it is found that labour use is smaller among non-migrants households than migrants households. The reason behind this may be non-migrants households use hired labour more rationally than migrants households.

Results and Discussion

Technical Inefficiency Score

The average technical inefficiency of the rice farmers in the study site is 0.33 (Table 2), implying that their production is 67 percent of its potential. The mean TE of rice farms in this study is low but comparable to those from other studies in Asian countries. For instance, the mean TE of rice farmers is found to be 81 percent in Vietnam (Khai & Yabe, 2011),

ranging from 80 to 91percent in South-East China (Tan et al., 2010), 83 percent in India (Tadesse & Krishnamoorthy, 1997), 72 percent in Sri Lanka (Gedara, Wilson, Pascoe& Robinson, 2012) and between 74 and 67 percent in urban and rural areas in Nepal (Piya, Kiminami& Yagi, 2012). The average technical inefficiency of household with no migrants is significantly lower than both households with internal and international migrants implying that households with no migrants are more efficient than household having migrating members. This findings is not consistent with that of Mochebelele and Winter-Nelson (2000) which found that technical efficiency of migrants' farm is higher than that of non-migrants. Table 2 shows that the difference in TE between households with international and internal migrants is not significant.

Table 2. Technical Inefficiency Scores

Migration Status	Technical inefficiency mean	Standard deviation	T test
Non migrants	0.22	0.08	-0.890 a
International migrants	0.32	0.17	-4.69 b ***
Internal migrants	0.36	0.24	-3.936 c ***
Overall migrants	0.35	0.19	-4.086 d ***
Overall	0.33	0.21	

a International versus internal migrants

b Non migrants versus migrants

c Non migrants versus internal migrants

d Non migrants versus international migrants

Table 3. presents the comparative frequency distribution of technical inefficiencies of farms by migration status. The result shows that more than 88 percent of the households with no migrants has technical inefficiency less than 30 percent while in case of household with migrants family members, 51 percent has attained that level. Similarly, only 55 percent of household with international migrants and 40 percent of households with internal migrants has technical inefficiency less than 30 percent. The finding indicates that more than 50 percent of the farmers could increase rice production in the study area by 30 percent with the existing level of input and technology.

Table 3. Distribution of Technical Inefficiencies by Migration Status

inefficiency	Non- migrants	International migrants	Internal migrants	Overall migrants	Overall
>50	0	16.07	23.07	20.0	14.67
40-50	5.45	7.14	12.82	8.42	10.0
30-40	5.45	21.43	23.08	20.0	23.33
20-30	43.64	28.57	10.26	30.53	39.34
10-20	43.64	25.0	17.95	20.0	11.33
< 10	1.82	1.79	12.82	1.05	1.33
Total	100	100	100	100	100

Technical Inefficiency Determinants

Table 4 presents the results of stochastic frontier model with rice farms technical inefficiency determinants. The estimates of the variance parameters sigma squared and gamma were significantly different from zero indicating that inefficiency significantly

affected the level and variation of output of farm. All the coefficients, except those of family size and female migration are statistically significant (Table 4) revealing that technical inefficiency can be influenced by these determinants in the model.

Table 4: Results of Frontier Model with Rice Farms Technical Inefficiency Determinants

Production frontier	**Coefficient**	**Standard error**	**t-ratio**	**significance**
Constant	5.460	0.187	29.130	***
ln (land)	0.740	0.095	7.762	***
ln (labour)	0.053	0.083	0.638	
ln (chemical fertilizer)	0.047	0.027	1.707	**
Technical inefficiency determinants				
Constant	0.062	0.701	0.088	
Age	0.020	0.010	1.969	**
Education	-0.046	0.029	-1.578	*
Family size	-0.031	0.034	-0.912	
Livestock holding	-0.304	0.123	-2.468	***
Participation	-0.786	0.276	-2.842	***
Internal migration	0.139	0.294	1.898	**
International migration	0.121	0.094	1.491	*
Male migration	0.115	0.025	1.502	*
Female migration	0.024	0.032	0.791	
Sigma squared	0.250	0.082	3.032	***
Gamma	0.751	0.098	7.640	***
LR test of the one-sided error	105.344			

*** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level

The age of the household head has a positive effect on inefficiency which means the younger farmers are found to be more efficient. This finding is consistent with Khai and Yabe (2011), however, does not confirm the findings by Tan et al. (2010) and Piya et al. (2012) that older farmers are more experienced and contribute positively to the technical efficiency. The coefficient of education is negative which indicates that education is an important factor affecting technical efficiency. Farmers who have higher education produce rice more efficiently than those with lower education. This finding is consistent with earlier results by Khai and Yabe (2011) and Tan et al. (2010). The coefficient of livestock holding in the model for inefficiency effect is found to be negative. This indicates that households with greater livestock holding tend to have smaller inefficiency effects than farmers with smaller livestock holding implying that when farms had more number of livestock, they could improve rice production through adequate application of farm yard manure. This finding is not consistent with Wouterse (2010) that technical inefficiency increase with cattle holdings. Participation is a dummy variable that takes the value 1 if any member of the family were the member in any agricultural related organizations, and zero if not. The coefficient of this variable is negative indicating that the participation of farmers in organizations helps farmers to learn good crop management practices and cultivate rice better and more efficiently. This confirms the findings by Binam et al. (2004) in Cameroon, however, does not confirm the findings by Binam, Sylla, Diarra, and Nyambi (2003) and Chirwa (2007) that membership to a farmers' association affect negatively to the TE of maize farmers in Malawi.

The effect of all migration status; international, internal, male and female migration on technical inefficiency is found to be positive which indicates the households with any members of the family migrated outside the village tend to be less efficient in rice production. This confirms the finding of (Wouterse, 2010) that even though intercontinental migration provides households with the required liquidity, technical efficiency does not improve. The coefficient of female migration is not significant, implying that female member out-migration do not significantly affect technical efficiency. A possible explanation is that male members of the family are generally involved in labour intensive management practices like ploughing, land preparation and threshing. In the study area, ploughing land has been identified as the work of male since ancient time. Although migration is argued as a strategy to improve rural economy in the developing countries, it is found to affect negatively on the technical efficiency of rice farmers in the study area. Similarly, the impact of male out migration is found more severe than female out migration on the rice production in the area, which indicates that the loss of male threatens the capacity of households to respond to labour demands, leading to a decline in rice cultivation and production.

Concluding Remarks

There is an increase debate about the out-migration of labour and agricultural development in rural area; this paper concerns with this issue. It measures the technical efficiency of rice farmers using a one stage stochastic frontier approach. Factors that influence farmer's technical efficiency are determined. The relationship between technical efficiency and migration is investigated.

The results reveal that the rice farmers in the study area are not fully technically efficient. The mean efficiency obtained was 67 percent indicating that rice farmers in the study site can improve production by 33percent under the existing technology. This indicates that there is opportunity of efficiency improvement by addressing some important policy interventions. The positive effect of education on technical efficiency suggests that farmers should be encouraged and supported to improve their education level. Membership of family members in agricultural related organization is also found to be positively related to technical efficiency. From this we can draw a policy conclusion that farmers should be encouraged to join agricultural related institution or to form groups and organization that provide farmers the opportunity of sharing information on improved cultivation practices by interacting with other farmers. The positive relationship between livestock holding and technical efficiency implies that farmers should be motivated to involve in livestock rearing.

Results show the technical efficiency of households with no migrants was significantly higher compared to households with both international and internal migrants. Migration of family members outside village is found to be negatively related to technical efficiency, implying that the policies should be implemented that provides employment opportunities to the villagers within the village so that they can directly or indirectly involve in agriculture and contribute to the efficiency improvement. As demonstrated in this article, although out-migration provides household with remittance income, it does not improve the technical efficiency.

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