Rural Labor Outmigration and Gender Dimension in an Assessment of Farm Technical Efficiency: A Case Study in Selected Rice Villages in the Philippines

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ABSTRACT

Several studies have shown that labor outmigration is one of the livelihood strategies of poor farming households. However, no studies have shown its effect on rice crop production including a gender dimension on technical efficiency in rice farming. This paper attempts to improve the understanding of the relationship between male and female labor migration and farm technical efficiency in selected rice-based farming villages in the Philippines. Using cross-section data from 670 farm households in the Luzon area in the Philippines, results indicate that the type of migration, experience of the migrant, and frequency of home visits enhance farm technical efficiency; however, sex of the migrant increases inefficiencies. The average technical efficiency is 0.74. This implies that, in the short run, there is scope for increasing rice productivity by about 26 percent by conducting formal and informal trainings among the adult household members and providing them access to technical knowledge on the use of improved rice varieties and associated crop and resource management practices.

Keywords: Rural labor outmigration, rice farming households, rice productivity, technical efficiency, male and female migrants
JEL classification: C31, C67, F24, J16, O15

INTRODUCTION

Rice is the staple crop grown by millions of farmers in the Philippines. Rice production provides household food security, employment, and income in the rural areas where more than half of the total population lives. Under rainfed conditions, farmers can grow only one crop of rice during the year due to dependency on rainfall distribution. In rice areas with assured irrigation facilities, farmers grow two crops of rice and use short-duration, high-yielding rice varieties, and chemical fertilizer. In 2011, nearly 16.68 million metric tons of paddy were produced in the Philippines, which accounted for 21.86 percent of the gross value added in agriculture (BAS 2011). The average yield was 3.59 metric tons per hectare in 2009, covering about 4.5 million hectares of farmland (IRRI 2011). However, despite the importance of rice in sustaining livelihoods, rice farmers face several constraints to increasing rice productivity. These are small farm size; increasing costs of inputs such as fertilizer, fuel, and labor; and low paddy price in the harvest season. The majority of poor farmers who grow rice under rainfed conditions are severely affected by unpredictable rainfall, drought, and floods, which lead to crop loss, low production, and low profits. Submergence risk is not only faced by farmers in the Philippines but also by millions of resource-poor farmers in rainfed environments in Southeast Asia (Manzanilla et al. 2011). Farmers are often caught in a vicious cycle of poverty when they take out loans before the planting season and repay them after the harvest season. They borrow again in case of crop loss due to droughts and floods. To avoid this poverty trap, poor farming households resort to other sources of income. According to Ellis (1998), a variety of factors may explain income diversification. These are risk reduction strategies, responses to household shocks, and asset accumulation strategies that originate from movement into nonfarm activities and migration to cities. In the Philippines, outmigration of a family member for nonfarm work within and outside the country is increasingly becoming a strategy as a pathway out of poverty. Although there are many studies on the impact of migration as a livelihood strategy of poor households (Deshingkar and Start 2003) and studies on the patterns of and reasons for migrating within and outside a country (Afsar 2003; Deshingkar and Grimm 2005; Paris et al. 2005), there are no studies on the effects of labor outmigration on rice crop productivity including a gender dimension on technical efficiency in rice farming in the Philippines. The unresolved question concerning labor migration and rice production is whether remittance income enhances production enough to compensate for the reduced availability of labor in any specific setting. Who (whether male or female members) migrates and who is left behind in the village have implications on the management of rice farming and this is often overlooked in assessing farmers' technical efficiency.

Objectives and Hypothesis

This paper uses a detailed microeconomic data set to assess the impact of male and female labor outmigration on the rice farming enterprise in villages. Specifically, the study aims to (1) estimate the level of farm technical efficiency, (2) determine the socio-economic factors that affect their level of efficiency, and (3) recommend strategies (research and extension) and government policy options in response to the constraints and problems encountered by rice farming households, especially if female members are the ones left to manage farms due to male outmigration.

Although previous migration studies have considered factors such as human capital and household characteristics, this study has extended the analysis by including migration

patterns (frequency of visits of migrant, place of migration—domestic or international), and sex of migrant as factors that influence rice productivity and technical efficiency. The study hypothesized that migration affects the intra-household labor supply and income sources of the household, which in turn affects rice productivity and technical efficiency. With a diminishing supply of labor for male and shared farm tasks, women must either depend on hired labor or resort to limiting agricultural operations. For example, women left behind to manage farms may have problems hiring and/or supervising labor during the peak cropping season. This may have repercussions on the management of farming systems and may reduce rice production and result in more technical inefficiencies in farming. Additional income from remittances may also indirectly influence rice production. Indeed, cash availability enables farming households to purchase and apply the recommended material inputs at the right time as well as hire additional labor. A reduction in the labor supply can have negative effects if remittances are not reinvested in farm inputs. The impacts of both remittance income and labor migration have generated a large amount of literature. Among others, Murray (1981) and Stark (1980) argue that remittance flows can be critical for enhanced agricultural investment and farm management.

METHODOLOGY

The Data

This study was conducted in major rice-producing areas in Luzon, Philippines, in which the incidence of labor outmigration was observed to be higher than in other provinces, based on information provided by local government units (LGUs) and the Department of Agriculture at the provincial level. Data were collected from four provinces in Luzon island: Pangasinan and Bulacan were selected to represent rainfed production environments while Camarines Sur and Albay have more access to irrigation.

Rapid rural appraisals (RRA) were conducted in the sample villages to determine the incidence of labor outmigration. Sample households were randomly selected based on proportionate sampling according to the total number of households per village. For this study, a migrant is defined as a member of a farming household who has been away from his/her village for the purpose of employment for at least three consecutive months and who sends remittances to his/her family. The data from the sample of 670 farming households were collected from June to November 2005 through personal interviews using a pretested structured questionnaire. The questionnaire included detailed information on household characteristics, information on migration of household members, patterns, use of remittances, agricultural information, and sources of income (farm, off-farm, nonfarm, and remittances from migrants). Detailed output (yield) and input (amount and costs of inputs) data were obtained from the most important parcel the household controlled.

Model Specification and Estimation Procedure

The study uses a two-stage process in analyzing technical efficiency and its determinants. First, a stochastic production function analysis was conducted, then technical efficiency (TE) scores were regressed to determine the factors that influence TE. The function involves the estimation of a stochastic production frontier, in which the output of a farm is a function of a set of input variables (Aigner, Lovell,

and Schmidt 1977). The stochastic frontier production function (SFPF) (Coelli et al. 1998) and specification start with an SFPF given as:

$$Y_i = f(X_i)exp(\varepsilon_i) \quad (1)$$

where Y_i represents the output from farm i, X_i represents the input variables used on farm i, and f is the functional form to be specified. The error term is assumed to be composed of two parts, given as:

$$\varepsilon_i = v_i - u_i \quad (2)$$

where is the stochastic error term with symmetric distribution (two-sided noise component) and represents the one-sided error component. The first component (v_i) captures the random noise created by factors that are beyond the farmer's control and the measurement errors, while the second component (u_i) captures the absolute gap between the farmer's output and the potental frontier production function. The two-sided error component (v) is assumed to be independently and identically distributed with a mean of 0 and variance σ_v^2, while a half-normal distribution is assumed for the one-sided error component (u). In addition, it is assumed that the error components u_i and v_i are independent, and $u_i \geq 0$. The nonnegativity constraint on ui ensures that all farmers lie on or below the stochastic production frontier.

The individual technical efficiency score of each farm shows the ratio of the actual to potential production frontier or the relationship between observed production and some ideal or potential production (Greene 1997). The measurement of the farm-specific technical efficiency is based on deviations of observed output from the best production or efficient production frontier. If a farm's actual production point lies on the frontier, it is perfectly efficient, but, if it lies below the frontier, then it is technically inefficient. The index of technical efficiency is given as:

$$\frac{Y_i}{f(X_i)e^{v_i}} = exp(-u_i) \quad (3)$$

The SFPF was used to investigate the effect of migration variables on technical efficiency. The analysis of technical efficiency requires the specification of an appropriate functional form. We first tested between a Cobb-Douglas and a translog production function to determine which functional form fits the data better. Using the likelihood ratio (LR) test, the translog specification was found to be appropriate. We therefore considered a translog functional form, given as follows:

$$= \beta_0 + \sum_{j=1}^{n} \beta_j \ln X_{ij} + \frac{1}{2} \sum_{j=1}^{n} \sum_{s=1}^{n} \beta_{js} \ln X_{ij} \ln X_{is} + v_i \quad (4)$$

where Y_i is the yield obtained by farm i, β_0 is the constant term, β is a vector of unknown parameters, X_{ij} is the vector of inputs used on farm i, and j is used to refer to a specific input. The error components are as previously defined. The input variables considered in the translog production function are labor, seed, fertilizer, pesticide, and a dummy variable for the ecosystem of rice production. The output (Y) and input variables (X) are measured per hectare. Therefore, Equation (4) could be interpreted in terms of effects of production inputs on land productivity.

The determinants of technical efficiency are modeled in terms of socioeconomic and migration variables, which directly affect efficiency. The control variables include educational attainment and years in farming of the household head, dependency ratio, share of rice income in total household income, tenure status (1 = farmer is owner, 0 = otherwise), and

area of major rice parcel. Migration variables include proportion of the remittances used for farm inputs, sex of the migrant (1=male, 0=female), educational attainment of the migrant (for a household with more than one migrant household member, the educational attainment is the average educational attainment of all the migrants in the household), proportion of migrants to household size, frequency of visits of migrant to the village (1=yearly, 0=otherwise), type of migration (1=international, 0=otherwise), experience as a migrant worker (number of consecutive years the migrant has lived outside the village), and share of remittances in total household income.

The technical efficiency model can be expressed in the following equation:

$$u = \delta_0 + \sum_{k=1}^{p} \delta_k Z_k + \mu \qquad (5)$$

where δ_0 is the constant term and δ_1 to δ_p represent the inefficiency parameters to be estimated, Z_1 to Z_2 represent the explanatory variables associated with technical inefficiency, and μ is the error term, which is assumed to follow a truncated normal distribution. A positive value of a parameter in the model indicates a negative effect on efficiency and vice versa. The likelihood ratio test is significant, supporting evidence of the presence of inefficiency effects. The likelihood ratio test follows a chi-square distribution. The critical value of chi-square is 11.07 (df=5; p=.05). This result is also supported by the rejection of the null hypothesis (H_0: γ=0), indicated by the significance of γ. The models described above are estimated using maximum likelihood estimation (MLE). Statistical tests to examine the validity of the models were also conducted.

FINDINGS

Characteristics of Farming Households and Patterns of Migration

A majority (66%) of the household heads interviewed are owner-cultivators. More than half (55%) of the respondents have an area of 1 hectare and more for the most important parcel where input-output data were collected (Table 1). Migrants were classified by the frequency of visits to the village. More than half (51%) of the migrants visited their families every year while the others (49%) took more than a year to visit. A higher proportion (67%) of the households had international migrants and the rest (33%) migrated within the country. Among the households with migrants, 37 percent had male migrants only, 48 percent had female migrants only, and 15 percent had both male and female migrant members. The Philippines has a long tradition of international migration, for which the "overseas employment of Filipino workers" has been actively encouraged by the government. Since 2005, the annual deployment of temporary migrants or overseas foreign workers has reached the one-million mark. Of the temporary and permanent migrants, more than 65 percent are women (Gregorio and Opiniano 2011). In a migration study in the Philippines, Paris et al. (2010) found that a higher proportion of international male migrants are employed in the service sector (for example air transport, shipping, cargo) and factories. Men are employed in the Middle East, Korea, Taiwan, and other regions and countries. On the other hand, women overseas workers are employed as domestic helpers, caregivers, and factory workers in Italy, the Middle East, Hong Kong, and Singapore. Migrants prefer to work overseas because they receive higher remuneration and benefits than working within

Table 1. Characteristics of farming households and migration patterns

Characteristics	Number	%
Farmer characteristics		
Tenure status		
Owner-cultivator	440	66
Non-owner-cultivator	230	34
Area of important parcel for input/output		
< 1 hectare	143	45
≤ 1 hectare	178	55
Migration variables		
Migrant members		
Males only	120	37
Females only	154	48
Both males and females	47	15
Frequency of visits to the village		
More frequent (at least once a year)	165	51
Less frequent (less than once a year)	156	49
Type of migration		
Domestic	107	33
International	214	67

Source: Household survey (2005)

the country. More women than men migrate overseas than within the country (Paris et al. 2010). According to the Asian Migration Atlas (AMA 2009), women migrants accounted for more than 70 percent of newly hired overseas foreign workers from 2000 to 2005. The study of the UN International Research and Training Institute for the Advancement of Women (UN-INSTRAW 2008) showed that, of the USD 12.8 billion Filipino migrants sent back to the Philippines in 2005, USD 44 million was sent from Italy, making Italy the fourth-largest source of remittances. In general, regular remittances involve sending fixed amounts of money, averaging between USD 441 and USD 588 per month, which represents roughly half of the minimum salary of USD 882 per month earned by Filipino migrants. In Rome, 85.3 percent of the women and 64.7 percent of the men interviewed stated that they sent regular remittances to the Philippines each month. Filipino women in Italy send remittances back home more regularly than their male counterparts. Trager (1984), in her study on the outmigration of women in Dagupan, Philippines, concluded that the strategies of rural families for both survival and mobility play an important role in the migration of women, especially young single women. By sending daughters to the city and overseas, rural families can expect to receive monetary remittances and other assistance, which helps to maintain and support those family members remaining in the rural areas.

In general, migrant workers are educated, with an average of 12 years in school (Table 2). They have finished high school but tend to drop out of college due to a lack of financial support. For every sample household, about a quarter of the members migrate within or outside the country. The experience as a migrant worker refers to the number of accumulated years a migrant has been working and sending remittances. On average, a migrant has an experience of seven years. The share of remittances in household income comprises 64

Table 2. Descriptive statistics of quantitative variables

Variable	Mean	SD	Min	Max
Socio-demographic and economic variables				
Age of husband (years)	55.09	11.67	27.00	85.00
Age of wife (years)	52.01	11.31	19.00	83.00
Education of household head (years in school)	8.29	3.19	1.00	15.00
Years in farming of household head	25.01	15.93	0.00	65.00
Dependency ratio*	0.52	0.78	0.00	4.00
Share of rice in total household income (%)	35.00	0.44	0.00	100.00
Migration variables				
Proportion of remittances used for farm purposes	19.54	21.83	0.00	100.00
Education of the migrant (years in school)	11.82	2.10	6.00	16.00
Proportion of migrants per household	23.00	0.11	7.00	71.00
Experience as a migrant	6.96	6.98	1.00	44.00
Share of remittances in household income (%)	64.00	1.31	10.00	100.00
Output/input variables				
Yield (tons/ha)	3.80	1.31	0.43	9.60
Labor (person-days/ha)	84.61	16.94	43.26	148.00
Seeding rate (kg/ha)	112.37	37.54	20.00	300.00
Fertilizer (kg/ha)	270.52	144.93	0.00	620.17
Pesticides (liters/ha)	2.98	2.84	0.09	27.11
Farn area (ha)	1.17			

Source: Household survey (2005)

Note: * Dependency ratio refers to the number of children or elderly divided by the household size

percent, sent by international migrants. Of the total remittances received, farming households spend about 20 percent on farm inputs and the rest is spent on food and daily needs, as well as on children's college education. Similar findings can be found in Ang, Sugiyarto, and Jha (2009). International migrants send about USD 200 per month or more to their families back home. A study of Filipino migrants in Italy showed that it is the investment of remittances in agricultural production that has offered greater food security to remittance-receiving households. The remittances allow farmers to purchase the necessary inputs (seed, fertilizer, pesticide), rent machinery for land preparation, pay irrigation expenses, and hire or contract laborers or purchase livestock. This permits farmers to stock their rice requirements for a year, particularly farmers with rainfed plots, who harvest only once a year, thus contributing to food security (UN-INSTRAW 2008).

Input-output Variables

Households have an average yield of 3.80 tons per hectare. Labor inputs from land preparation to postharvest activities are 85 person-days per hectare, on average. Labor inputs are provided by family members, hired laborers, and other workers who provide labor through exchange arrangements. On average, the other material inputs used are seed (112 kilograms per hectare [kg/ha]); fertilizer (271 kg/ha), and pesticide (3 liters/ha). These amounts are also comparable with those used by farmers in other studies (David, Cordova, and Otsuka 1994; Hayami and Kikuchi 2000; Hossain, Gascon, and Marciano 2000).

Technical Inefficiency Estimates

Technical inefficiency estimates are shown in Table 3. It was hypothesized that the frequency of the migrant's visits home, place of destination

Table 3. Maximum likelihood estimates of the stochastic frontier production and the technical inefficiency models

Variable	Coefficient	Standard Error
Productivity		
Constant	8.032*	4.484
Ecosystem	–0.057*	0.029
Labor	–2.133	1.702
Seed	–0.902	0.664
Fertilizer	–0.477	0.428
Pesticide	0.458	0.317
Labor2	0.578	0.387
Seed2	0.295***	0.077
Fertilizer2	0.044***	0.013
Pesticide2	–0.005	0.030
Labor × seed	–0.091	0.150
Labor × fertilizer	0.061	0.083
Labor × pesticide	–0.074	0.069
Seed × fertilizer	0.026	0.037
Seed × pesticide	–0.048	0.040
Fertilizer × pesticide	0.022	0.023
Sigma	–3.277	0.153
Technical inefficiency		
Constant	–0.880**	0.303
Education of household head	–0.075**	0.025
Years in farming of household head	–0.001	0.005
Dependency ratio	–0.228*	0.098
Share of rice income in total household income	–0.248	0.168
Tenure status	0.161	0.151
Plot size	–0.019	0.149
Proportion of remittances used for farm purposes	–0.179	0.560
Education of the migrant	0.076	0.049
Proportion of migrants to household size	–0.336	0.522
Frequency of visits of migrant	–0.714***	0.213
Type of migration	–0.441*	0.212
Experience as a migrant	–0.034*	0.016
Share of remittances in household income	0.037	0.061
Sex of migrant	0.415*	0.222
Sigma	0.194	0.015

Note: Significance at the 1%, 5%, and 10% indicated by ***, **, and *, respectively.

of the migrant, experience, and sex would affect technical inefficiency. The frequency of the migrant's visits home and technical inefficiency have a negative association. Migrants who return home more often (yearly) to their villages help manage the farm (look for hired workers and supervise them), especially during peak cropping seasons (land preparation and harvesting), or work on their own farms, thus improving their farm efficiency.

Migrant's experience is negatively associated with technical inefficiency. It is a common practice among overseas foreign workers to use their earnings from the first contract to repay their debts incurred for relocation. Migrants with longer experience have established themselves in their workplace, have stable jobs, have paid debts incurred in the early years of relocation, and send remittances to their relatives back home on a regular basis. Thus, migrants with longer experience and stable jobs have more capacity to send regular remittances, which serve as insurance against risks incurred during droughts or floods.

The type of migration has a negative association with technical inefficiency. This finding indicates that households with international migrants tend to be more technically efficient. Farming households with international migrants who send larger remittances are able to adopt rice technologies, purchase the required inputs, and apply them at the right time, leading to better crop management and higher yield. The findings of a migration study (Mendola 2008) in Bangladesh showed that international migration has a robust positive effect on adopting a superior agricultural technology, whereas temporary and permanent domestic migrations do not encourage such a risky farming investment. These findings are consistent with Stark (1991) and Rozelle, Taylor, and de Brauw (1999), who argued that migration can complement productivity growth in the farm sector by relaxing credit or risk constraints faced by agricultural households through remittances, and this could contribute to technological change and rural development. In this Philippine case, farmers face severe constraints to rice productivity such as small farms, shortage of capital, and lack of insurance against drought and floods, therefore, remittances from international migrants provide an important source of insurance and investment that foster technical efficiency and agricultural development. According to Velosa (2011), by increasing the availability of capital and reducing the supply of labor, remittances, and migration can generate shifts from agriculture toward more capital-intensive sectors, and in this way promote a structural transformation that characterizes economic development. The shift in the relative endowment of capital and labor may also lead to the adoption of more mechanized farming practices.

Households with male migrants are more technically inefficient. This finding implies that farm households whose male members have left for nonfarm employment experience technical inefficiency. These findings are similar to those of Low (1986), who argued that farm households in southern Africa whose male members have left for mine employment experience lower productivity per acre and per worker because of changes in the quality and quantity of household labor. Mochebelele and Nelson (2000) contend that labor migration reduces farm output in Lesotho because of the low volume of remittances, the loss of male household labor, the high cost of hired labor, and constraints on the use of mining income. In the Philippines, most rice farming operations are done by the men. Although labor participation varies across regions, in the lowland rainfed areas, for instance, men contribute 65 percent to 80 percent of the total labor inputs in rice production (Paris 1987; Paris et al. 1992; Tisch

and Paris 1994; Luis 1995). Men are exclusively responsible for seedbed and land preparation, irrigating the fields, spraying chemicals, hauling, and threshing (mechanical). On the other hand, women provide labor (unpaid or hired) in crop establishment (transplanting, pulling of seedlings), hand weeding, harvesting, drying, winnowing, gleaning, and dehusking paddy for home consumption. Cooking and taking food to hired workers are mainly women's tasks. They also take paddy to the rice miller and purchase farm inputs, along with their marketing roles. Women are mainly responsible for budgeting their limited income. However, despite the participation of women as farmers, supervisors of hired laborers, and partners in decision-making related to the household and farm, they are often excluded in agricultural extension programs. The women left behind tend to assume the responsibilities of the male members but face several constraints such as a lack of technical knowledge, productive inputs, and timely information. Thus, when a male member leaves, farm technical efficiency is affected because of the decline in both the supply of family labor and the quality of the labor of family members left behind.

Besides this finding, there are some interesting results on the effects of control variables on inefficiency. Results show that the educational level of the household head, as expected, has a negative effect on technical inefficiency. This finding is consistent with the findings in other similar studies conducted by Ogundele and Okoruwa (2006), Bozoglu and Ceyhan (2007), Nonthakot and Villano (2008), Li et al. (2010), and Khai and Yabe (2011) in other countries (Nigeria, Turkey, Thailand, China, and Vietnam, respectively). This can be attributed to the fact that education improves understanding of and receptiveness to agricultural innovations. The result of this is effective use of inputs, which in turn increases the technical efficiency of the farming operation (Asogwa, Umeh, and Penda 2012). Dependency ratio, as expected, has a negative effect on technical inefficiency. These findings are consistent with the findings of Asogwa, Umeh, and Penda (2012), which indicate the positive effects of having a higher proportion of productive nondependents than nonproductive dependents on availability of labor and its productivity.

Technical Efficiency Score

The individual technical efficiency score of each farm shows the ratio of the actual to potential production frontier or the relationship between observed production and some ideal or potential production (Greene 1997). Technical efficiency scores range from 0 to 1. The technical efficiency scores of the models are shown in Table 4. Of the total sample farming households, 35 percent have technical efficiency scores between 0.80 and 0.90. The average technical efficiency is 0.74. This implies that, in the short run, there is scope for increasing rice productivity by 26 percent by adopting improved rice production techniques used by the best rice farmers. Examples of these are stress-tolerant varieties and associated crop and natural resource management techniques such as palay check, alternate wetting and drying (AWD) technology, and site-specific nutrient management (SSNM) (IRRI Rice Knowledge Bank 2009). Palay Check is a dynamic rice crop management system that presents the best key technologies and management practices as key checks, compares results of farmer practices with key checks, and facilitates learning through farmer groups to sustain improvements in production, profitability, and environmental safety. AWD is a technology for water saving in rice production. The SSNM approach emphasizes supplying rice with nutrients as and when needed. SSNM strives to enable farmers to dynamically adjust fertilizer use to optimally

Table 4. Technical efficiency scores of sample farming households

Technical Efficiency Score	Proportion
Less than 0.60	16
0.60 to 0.70	16
0.70 to 0.80	27
0.80 to 0.90	35
0.90 and above	6
Total	100
Mean	0.74
Standard deviation	0.14
Minimum	0.16
Maximum	0.95

fill the deficit between the nutrient needs of a high-yielding crop and the nutrient supply from naturally-occurring indigenous sources such as the soil, organic amendments, crop residue, manure, and irrigation water. The adoption of these specific technologies resulted in better yield, reduced cost of production with more efficient use of water, reduced labor costs, and higher profits (PhilRice 2007; IRRI 2001).

CONCLUSIONS

This paper examined the effects of rural male and female labor outmigration on the technical efficiency of selected rice farmers in villages located in four provinces of Luzon island in the Philippines. Results suggest that remittances from international migration, frequent farm visits of the migrant, and long-term experience as a migrant contribute to technical efficiency in rice farming.

Households with international migrants are more likely to adopt improved rice farming technologies to be technically efficient. International migrants send large and regular remittances to enable their families to purchase the recommended quantity and quality of farm inputs and apply these inputs at the right time, including hiring workers. Timely access to and use of inputs are crucial in crop and natural resource management practices.

Education of the farmer-cultivator (head of the household) is one factor that contributes to technical efficiency. Knowledge-intensive technologies that include best practices (such as suitable rice varieties for specific environments, recommended rates and timeliness in the application of inputs, and quality labor) require farmers' ability to absorb knowledge through various communication methods. More educated or well-informed farmers are more likely to comprehend crop management techniques that are crucial for increasing technical efficiency. Educated farmers are also more open to new ideas and innovations that can increase production. Thus, agricultural research and extension should continue to bring technological change to rural areas to make rice farming a profitable business venture.

An interesting finding of this study is that farm households whose male members have left for nonfarm employment experience technical inefficiency. Thus, those who are left behind to manage the farm, especially the women, should be target recipients of agricultural training and extension services so that they are better equipped with managerial capabilities in rice farming.

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