# Agricultural efficiency of rice farmers in Myanmar : a case study in selected areas

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# Agricultural Efficiency of Rice Farmers in Myanmar: A Case Study in Selected Areas

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**Abstract:** This paper try to analyze unique data set for rice producing agricultural households in some selected areas of Bago and Yangon divisions to examine the households' profit efficiency and the relationship between farm and household attributes and profit inefficiency using a Cobb-Douglas production frontier function. The frequency distribution reveals that the mean technical inefficiency is 0.1627 with a minimum of 3 percent and maximum of 73 percent which indicates that, on average, about 16% of potential maximum output is lost owing to technical inefficiency in both studied areas. While 85% of the sample farms exhibit profit inefficiency of 20% or less, about 40% of the sample farms is found to exhibit technical inefficiency of 20% or less, indicating that among the sample farms technical inefficiency is much lower than profit inefficiency.

**Keywords:** Myanmar, rice, efficiency, production frontier function

**JEL classification:** D2, Q12, R3

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# Agricultural Efficiency of Rice Farmers in Myanmar:

# A Case Study in Selected Areas

Contents




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## 1. Introduction

Myanmar government is recently trying to increase agricultural productivity and employment to achieve economic development for farmers and to alleviate poverty through various schemes such as micro-credit program, increased agricultural loan, establishing small cooperative groups, encouraging to use prescribed package technology, and etc. However, agricultural growth should be linked to farm profits. A considerable research for agricultural efficiency in the country is still very weak. Agricultural efficiency is gaining attention in the light of agricultural market liberalization and Myanmar currency appreciation. The experience of agricultural market reforms since the early years of 1990s shows how particularly important farm household efficiency is to the country's rural economy. The fundamental role of such reforms was to enable private markets to perform better by replacing the dominant public sector, encouraging the development of private sector, and letting price role in the allocation of factors of production, goods, and services. One of the key explanations for previous intensification of rice production in the country is to achieve food security in some rural and urban areas. But such policy might lead to failure in socioeconomic situations of farmers.

Given the market reforms, the reduction or removal of subsidies on agricultural inputs such as fertilizer, or various other inputs tends to increase the cost of those inputs to farmers. And new technology package brings additional cost of production for farmers. The agricultural output and productivity can be increased by encouraging using those recommended technology. The profit, however, for farmers are not considered. Policy makers think the profit will be increased if there will be an increased physical production. And little attention was paid on the relationships among market indicators, household characteristics, and production efficiency particularly during this unfolding process of agricultural and market reform. Those decision makers can better implement reform measures contributing to enhancing agricultural efficiency if we can try to convince them how production efficiency is affected by market indicators and household characteristics. If agricultural households are integrated with output and input markets under the market reform process, then profit maximization becomes an economic goal.

Accordingly, this paper try to analyze unique data set for rice producing agricultural households in some selected areas of Bago and Yangon to examine the households' profit efficiency and the relationship between farm and household attributes and profit inefficiency. Three assumptions are made in the analysis: (a) farmers' production is consistent with profit maximization; (b) profit efficiency differs across households through different aspects; and (c) profit efficiency is related to farmers' education, access to credit, experience, and etc. The objective of this paper is to improve policy formulation for rice farmers in Myanmar agriculture. While the government aims at alleviating poverty by increasing agricultural productivity, this paper shows an evident how achieving productivity can fail without considering market behavior, household characteristics and production efficiency. This specific objective will be achieved by fulfilling particular objectives: (1) evaluating rice farmers' marketing behavior and determinants that are related to it; (2) explaining the key factors in rice production; (3) quantifying the factors related to household productivity. This paper is organized into four sections. First, general trend of rice production in the country is discussed. Agricultural efficiency model and data sources are expressed in section two. Results are discussed in the third section. Conclusions and policy implications are included in the final section.

## 2. Rice production and present policies in Myanmar

Rice production has increased substantially throughout the years according to government published data (Table 1). Annual production increase was contributed by land area expansion and yield increase. Area expansion took place around the country where fallow lands exist. Starting from 1992, government introduced summer paddy production program. It increased crop production intensification for farmers. Farmers who relied on rainy season can now grow second rice with irrigation within a year. Department of Agricultural Research (DAR), which maintains contact with international research institutes, is producing new improved high yielding varieties. Those improved varieties are transferred to the seed division which is one of the sub-divisions of Myanmar Agriculture Service (MAS). Seed farms under the seed division are reproducing mass scale. There are thirty two seed farms around the country (Figure1). Although considerable efforts have been put into increasing yields in the country, adverse weather conditions in some years due to climate change, and low input use still keep average yields lower than other neighboring countries.

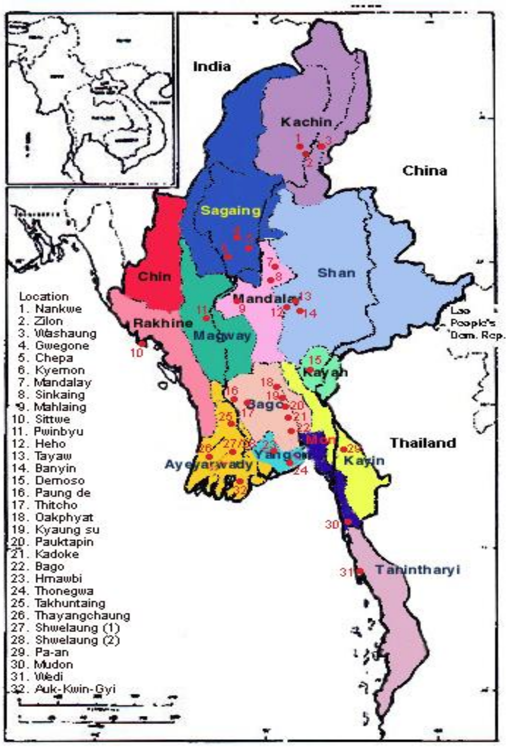
**Table(1): Paddy production**

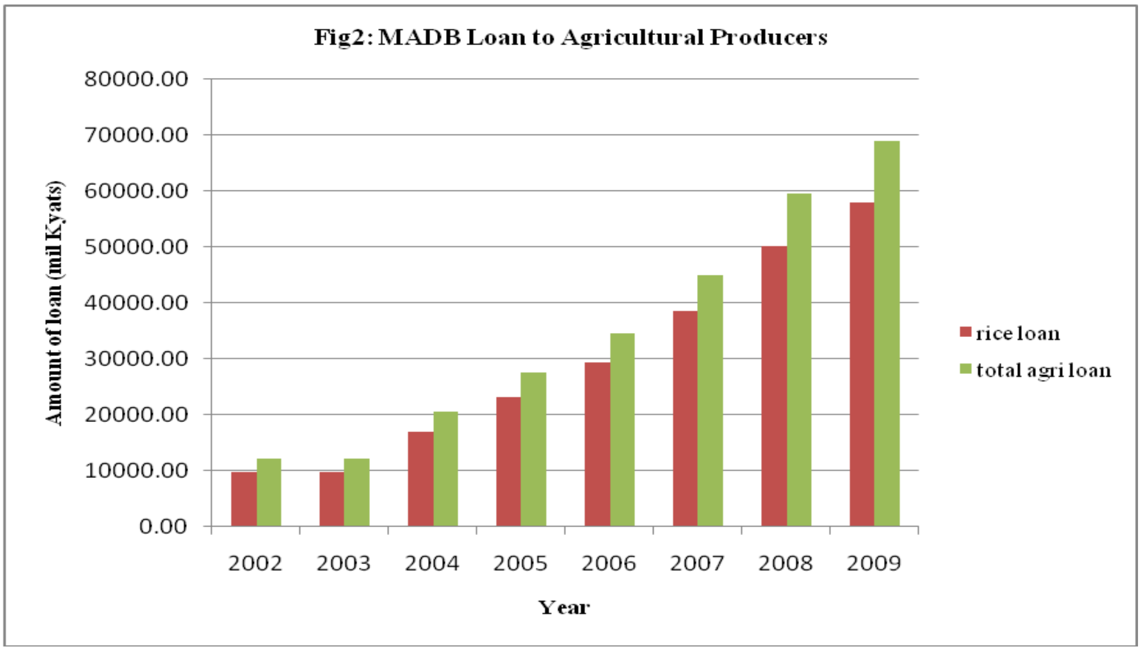
| Year | Sown Area (mil ha) | Harvested Area (mil ha) | Yield (ton/ha) | Production (mil ton) |
|---|---|---|---|---|
| 1989-1990 | 4.88 | 4.73 | 2.92 | 13.83 |
| 1990-1991 | 4.95 | 4.76 | 2.94 | 14.00 |
| 1991-1992 | 4.83 | 4.58 | 2.89 | 13.23 |
| 1992-1993 | 5.14 | 5.06 | 2.94 | 14.87 |
| 1993-1994 | 5.68 | 5.49 | 3.06 | 16.79 |
| 1994-1995 | 5.93 | 5.75 | 3.17 | 18.23 |
| 1995-1996 | 6.14 | 6.04 | 2.98 | 17.99 |
| 1996-1997 | 5.88 | 5.77 | 3.07 | 17.71 |
| 1997-1998 | 5.79 | 5.41 | 3.08 | 16.69 |
| 1998-1999 | 5.76 | 5.46 | 3.13 | 17.11 |
| 1999-2000 | 6.29 | 6.21 | 3.25 | 20.17 |
| 2000-2001 | 6.36 | 6.31 | 3.39 | 21.37 |
| 2001-2002 | 6.45 | 6.42 | 3.42 | 21.96 |
| 2002-2003 | 6.49 | 6.38 | 3.43 | 21.85 |
| 2003-2004 | 6.55 | 6.53 | 3.55 | 23.18 |
| 2004-2005 | 6.86 | 6.81 | 3.64 | 24.80 |
| 2005-2006 | 7.39 | 7.39 | 3.76 | 27.74 |
| 2006-2007 | 8.13 | 8.08 | 3.84 | 30.99 |
| 2007-2008 | | | | |

Source: MAS, MOAI

As rice is main staple food in Myanmar, the successive governments practiced consistently regulated prices by intervening in both input and output markets until 2003. After 2003 government announced they will liberalize both for domestic and export rice markets. Unfortunately, government revoked export liberalization after six months to be stable in domestic food market. This liberalization was named as second liberalization by Okamoto (2006). The rice sector was experienced a relatively free domestic trade regime starting from the mid of 2003. Rice export was again permitted to a few companies in 2007. Because of permission for rice export licenses are granted to few numbers of traders, price incentive for producers was unstable. Although regional market price shows increasing trend starting from 2001, the farm gate price for producers are still low due to low quality of paddy caused by inadequate, insufficient, and inefficient storage facilities. Those prices are determined by local traders or millers. There are many local traders and millers associations in every township. But there is no farmer association at all. Therefore, farmers can not complain about the price paid by millers or local traders. The recent appreciation of Myanmar Kyats, on the other hand, happen less profit and uncompetitive in the international market for the rice exporters.

Fig1: Location map of seed farms




Source: CSO, MAS, MADB

Myanmar Agriculture Development Bank (MADB) have borrowed increasing amount of loans to farmers year by year. The amount of loan borrowed by agricultural producers from MADB was about nearly seventy thousand million Kyats in 2009. Among the total amount of loan borrowed to farmers, nearly 84% was borrowed by paddy farmers. It was about sixty thousand million Kyats in amount. We can see that how government put rice production sector intensively. Each farmer can borrow twenty thousand Kyats per acre with two percent interest per month. Total area of rice sown acre was 20 million acres in 2009. Therefore, nearly 15% of total paddy land only are getting loan from MADB. The rest, 85%, are still inaccessible to the MADB loan. But there are many informal lenders in every place with higher interest rate. This informal financial market makes farmers increased cost to the production. Many farmers cannot escape from debt because of the lack of money which is needed during crop season. They have no other way to choose to get loan even if they do not want to borrow loan with higher interest rate.

Government is also trying to establish small and large local entrepreneurs or cooperative groups who can borrow money to agricultural producers. Because of this effort, many small cooperative groups have emerged to borrow loan and other various inputs for farmers. Though a considerable number of local groups are formed in the light of present policies, the question on whether it is an ad hoc basis or not is remains to answer.

According to MAS and CSO data, government subsidized inputs such as fertilizer and pesticides are becoming fewer by year. The previous government, however, imposed a fertilizer law in 2002 to encourage private sector involvement in large potential domestic market. The imposition of the law made many business tycoons to be appearing in the country' fertilizer market. They expanded their markets in every township and every village. Though the fertilizers produced domestically are experimentally tested by plant protection division of MAS, it is heard that there are still many inefficient and unregistered fertilizers are in the market. This may affect to the yield and production of farmers. On the other hand, because of the emergence of such fertilizer producing and importing companies, farmers have many choices to use in their production.

If we look at the private investment in agriculture, according to SLRD, it was increased nearly 22 percent agricultural implements such as ploughs, harrows and spades. Investment in water pump was increased from 46000 to 198000 in number in 1990 and 2009, respectively. It was increased nearly 4 times during 10 years period. But the most essential machine such as tractor were remain in almost same number during this period indicating that the country is still relying on bullock for plowing, harrowing, and for other uses like transportation of products from farm to house or farm to market. The whole agricultural investment picture indicates that the country is still need to strengthen the mechanization power in the fields.

## 3. Efficiency model

Farrell (1957) said that there are three components in the concept of efficiency: technical, allocative, and economic. As components of economic efficiency, technical and allocative efficiency can be derived from production function. Production efficiency represents the efficient resource input mix for any given output that minimizes the cost of producing that level of output or, equivalently, as the ability to produce a given level of output at lowest cost. Technical efficiency means the ability of a firm to maximize output for a given set of resource inputs, while allocative efficiency deals with the extent to which farmers make efficient decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost.

In fact, technology is not absolutely changing, but decision making is changing. Thus, changes in decision making come from a function of other factors such as knowledge, experience, education, socioeconomic characteristics, and etc. Though technical and allocative efficiency are required for economic efficiency, farms may show that technical and allocative efficiency without having economic efficiency. Production frontier functions can be used to measure agricultural production efficiency. However, it fails to capture inefficiencies associated with different factor endowments and different input and output prices across farms.

In literature, there are many alternative ways to measuring productive efficiency. Lau and Yotopoulos (1971) used a profit function in which specific farm prices and levels of fixed factors are incorporated in the analysis of economic efficiency. Their model explained input use and output supplied while input and output prices are exogenous to farm household decision making. In general, the resulting parameter estimates shows statistically consistent. Aigner, Knox Lovel, and Schmidt (1977) said that the profit function do not provide the numerical measure of efficiency. Ali and Flinn (1992) said that profit or economic inefficiency in this framework is defined as profit loss from not operating on the profit frontier, taking into consideration farm-specific prices and fixed factors. Kumbhakar, Ghosh and McGuckin (1991) used two-stage approach in which specification and estimation of the stochastic production function and subsequent prediction of the technical inefficiency coefficients. Battese and Coelli (1995) also applied same approach. Second stage explains the predicted technical inefficiency effects contradict the assumption of identically distributed inefficiency effects in the stochastic frontier function.

**4. Stochastic profit function**

The stochastic frontier approach unlike the other profit functions proposed by Aigner, Knox Lovel and Schmidt (1977) decomposes the error term into two-sided random error that captures the random effects outside the management of the farm, and the one-sided efficiency component. The normalized profit function can be expressed as follows:

$$profit = y_i(a^*,b) - \sum_i p_i a^* , \qquad a^* = f(p,b) , \qquad (1)$$

where $y_i$ is the production function; $a^*$ denotes vector of optimized variable inputs; $b$ is the vector of fixed factors; $p_i = w/p$ is the normalized price of input $i$; and $p$ and $w$ are the output and input prices, respectively. Then stochastic profit function $spf_j$ can be expressed as

$$spf_j = f(p_{ij}, b_{kj}).\exp e_j , \qquad (2)$$

where $spf_j$ is normalized profit of $j^{th}$ farm, and it can be calculated as gross revenue less variable cost divided with farm specific output price $P$; $p_{ij}$ is the normalized price of input $i$ for the $j^{th}$ farm, and can be computed as input price divided by farm specific output price $P$; $b_{kj}$ is the level of the $k^{th}$ fixed factor for the $j^{th}$ farm; and $e_j$ is an error term. $e_j = v_j - u_j$, consists of two error terms; $v_j$ is the symmetric error term or two-sided error term, and $u_j$ is the one-sided error term. The components of the composed error term are governed by different assumptions about their distribution. The random (symmetric) component $v_j$ is assumed to be identically and independently distributed as $N(0,\sigma_v^2)$ and is also independent of $u_j$. The random error reflects random variations in the economic atmosphere facing the production units such as weather, machine breakdown, variable input quality, and etc. The error term $u_j$ is used to represent inefficiency. It reflects profit shortfall from its maximum possible value given by the $spf_j$. Thus, if $u_j = 0$, the farm is getting potential maximum profit given the market indicators and the level of fixed factors. However, if $u_j \succ 0$, the farm is inefficient economically, and the profit is less than the potential maximum. Then, an estimated value of profit efficiency for each observation can be calculated as $\exp(-u_j)$.

According to Jondrow et al., the unobservable value of one-sided error term $u_j$ could be obtained from its conditional expectation given the observable value of $v_j - u_j$. The farm-specific inefficiency index $ii$ is given as

$$ii = \left(1 - \exp(u_j)\right) \qquad (3)$$

Then, profit loss can be calculated by multiplying farm-specific inefficiency index $(ii)$ with potential maximum profit $spf_j$ given farm-specific prices and fixed factors.

Farm and household attributes can then be specified as $ii = f(x) + z$, where $x$ is a vector of farm household attributes, and $z$ is the unexplained component of inefficiency such as weather, prices, and etc. that are peculiar to a particular farm.

## 5. Empirical Model

A Cobb-Douglas stochastic production frontier approach is used to estimate the production function and the determinants of technical efficiency among the rice farmers in the selected areas of Myanmar. One stage procedure is adopted by following Battese and Coelli (1995) given the potential estimation biases of the two-step procedure for estimating technical efficiency scores and analyzing their determinants. It remains one of the popular production functions in production frontier studies though this approach has its own limitations.

$$\ln \pi = \beta_0 + \sum_{i=1}^{m} \beta_1 \ln SA + \sum_{i=1}^{m} \beta_2 \ln L + \sum_{i=1}^{m} \beta_3 \ln K + \sum_{i=1}^{m} \beta_4 \ln F + v_j - u_j \qquad (4)$$

where $\pi$ is normalized profit computed as gross revenue less variable costs; $SA$ is the land input measured as hectares of rice grown per farm; $L$ is the total labor cost applied in rice cultivation; $K$ is the capital input computed as the sum of costs of animal and mechanical power; and $v$ and $u$ are the error terms. The estimate of $u_j$ could be obtained by replacing $e_j$ by its sample residual and the unknown parameters given in equation (4).

Inefficiency index $(ii)$ then can be calculated by inserting the sample residual for $u_j$ in the inefficiency index equation $ii = \left(1 - \exp(u_j)\right)$. The inefficiency index can be redefined as $\ln\left(ii/(1-ii)\right)$ to fit the relationship between profit inefficiency and household attributes. Then the empirical equation for the relationship between inefficiency and household attributes can be specified as

$$\ln\left(ii/(1-ii)\right) = \alpha_0 + \alpha_4 A + \alpha_2 Ex + \alpha_1 Ed + \alpha_3 OF + \alpha_4 SC + \varepsilon_j \qquad (5)$$

where $A$ represents age of the household head, $Ex$ denotes experiences, $Ed$ reflects level of education of household head, $OF$ stands for off-farm employment, $SC$ designates for income of second crop, respectively, and $\varepsilon_j$ serves as an error term.

## 6. Data and definitions of the variables

The data used in this empirical application is two random sample surveys conducted in May 2011 and June 2011 in two townships of Bago and Yangon. The first survey took place in Waw township of Bago district in Bago Division. The second survey was in Hmawbi township in northern district of Yangon division. A total of 110 households were collected. Information from these farm households were gathered using a structured questionnaire. Additional survey data were obtained from the local office of Myanmar Agriculture Service (MAS) of the Ministry of Agriculture and Irrigation. The data covers information about rice producing and marketing activities as well as household demographic characteristics. Information on rice farming activities include cost of nursing, land preparation, planting, fertilizer application, weeding, harvesting, and so on. Wages and capital assets were also collected.

Farmers in both regions are mainly cultivating paddy. The major second crop is a variety of pulses. Some farmers grow paddy in dry season where irrigation is available. Table (2) and (3) describes the selected characteristics of sample farms. Output is measured in metric ton of paddy rice per hectare. The mean rice yield over the sampled farms in Waw was 2.54 ton/ha with a range of about 1.55 tons per hectare to 4.13 tons per hectare. The yield gap between the average and the lowest farm yield was 0.99 ton per hectare, and that between the average and the highest was 1.59 tons per hectare suggesting that there is potential for improving average rice yields in the area. The mean rice yield over the sampled farms in Hmawbi was 3.38 ton/ha with a range of about 2.59 tons per hectare to 3.63 tons per hectare. The yield gap between the average and the lowest farm yield was 0.79 ton per hectare, and that between the average and the highest was 0.25 tons per hectare suggesting that there is less potential for improving average rice yields if we compare with Waw township.

The input of land is measured in terms of paddy grown area per farm in the cropping season when survey is done. Total land area is the number of total crops under cultivation in the same cropping season. The total labor expenditure per farm includes the calculated costs of family labor used in production at the wage rate paid to permanent hired labor. The money wage rate is computed by dividing the total labor expenditure for rice production per farm by the quantity of labor including both family and hired labor. Capital input can be obtained as the sum of costs of animal and mechanical power used in rice production. Fertilizer price is measured as total expenditure on fertilizer kilogram including transportation and application cost. Recent government policy has no subsidy schemes of price and input to farmers. So that production and distribution of inputs and outputs come from the forces of demand and supply. The farm level specific prices differ a little across the farms due to their product quality. Input prices are not different since most of the companies come and distribute fertilizer directly to farms in the survey area.

Farm and household characteristics variables that are used in the estimation of profit inefficiency index include the age, experience and educational level of household head, off-farm income, and income of secondary crop. Income of secondary crop is obtained as the proportion of a farm' land area used in second crop production multiplied with average yield and then subtracted to total variable cost used in the production of that crop. It is assumed that farmers who devote more of their time in second crop production has lower efficiency than would other producers who pay much effort and time on rice production.

Off-farm employment effect on economic efficiency is having two definitions; (1) taking part in the non-farm labor market may restrict specialization in production and decision making activities, thereby increasing inefficiency; (2) participating in off-farm work increase financial liquidity, and thus enable them to purchase necessary input for rice cultivation especially for resource poor farmers. The ability to or right to access formal credit makes farmers to prevail over financial constraints for the purchase of different inputs such as fertilizer or high yielding varieties that are accompanied with new technology package.

Table 2.Selected characteristics of sample farm in Waw township

| Farm and Household Characteristics | Minimum | Maximum | Mean |
|---|---|---|---|
| Age | 33 | 72 | 53 |
| Experience | 2 | 60 | 28.11 |
| Education | 0 | 4 | 1.52 |
| Off-farm work | 0 | 1 | 0.24 |
| Number of family | 1 | 9 | 5.57 |
| Plough | 0 | 4 | 1.61 |
| Harrow | 0 | 4 | 1.59 |
| Bullock | 0 | 12 | 4.48 |
| Cart | 0 | 2 | 0.81 |
| Tractor | 0 | 1 | 0.04 |
| Trailer | 0 | 1 | 0.11 |
| Power tiller | 0 | 2 | 0.30 |
| Inter-cultivator | 0 | 2 | 0.04 |
| Seeder | 0 | 0 | 0.00 |
| Sprayer | 0 | 4 | 1.00 |
| Water pump | 0 | 1 | 0.15 |
| Harvesting machine | 0 | 1 | 0.02 |
| Threshing machine | 0 | 1 | 0.04 |
| Ware house | 0 | 1 | 0.46 |
| Sown acreage | 5 | 80 | 13.69 |
| Yield (ton/ha) | 1.55 | 4.13 | 2.54 |
| Wage rate | 1200 | 3000 | 1661.11 |

Source: Owned survey

Therefore, formal credit, in a proper use in production, increases the net revenue that is obtained from fixed inputs, market conditions, and household characteristics. Informal credit, however, with higher interest rate reduce net revenue for farmers. Credit constraints, on the other hand, might decrease the economic efficiency of farmers especially during the time for planting and harvesting. These effects will be affected only for the farmers who are in need for credit.

Table 3.Selected characteristics of sample farm in Hmawbi township

| Farm and Household Characteristics | Minimum | Maximum | Mean |
|---|---|---|---|
| Age | 30 | 70 | 52.89 |
| Experience | 5 | 47 | 25.71 |
| Education | 1 | 4 | 1.88 |
| Off-farm work | 0 | 1 | 0.59 |
| Family number | 1 | 9 | 4.95 |
| Plough | 0 | 4 | 1.63 |
| Harrow | 0 | 4 | 1.64 |
| Bullock | 0 | 5 | 1.21 |
| Cart | 0 | 2 | 0.82 |
| Tractor | 0 | 1 | 0.05 |
| Trailer | 0 | 1 | 0.88 |
| Power tiller | 0 | 2 | 0.80 |
| Inter-cultivator | 0 | 1 | 0.84 |
| Seeder | 0 | 1 | 0.52 |
| Sprayer | 0 | 4 | 1.02 |
| Water pump | 0 | 1 | 0.29 |
| Harvesting machine | 0 | 1 | 0.05 |
| Threshing machine | 0 | 1 | 0.07 |
| Ware house | 0 | 1 | 0.48 |
| Sown acreage | 5 | 20 | 10.5 |
| Yield (ton/ha) | 2.59 | 3.63 | 3.38 |
| Wage rate | 1400 | 1600 | 1496.43 |

Source: Owned survey

For representing the characteristics of farm manager, age and education of household head are included in the analysis of the determinants of profit inefficiency. The simplifying assumption is that the farm manger who is also household head of that farm is a key decision maker for that farm whether he or she is. Another determinant factor for household characteristic is education of household head, and it is hypothesized to have positive effect on efficiency.

Education as a role of human capital mainly referred to as allocative ability stems from the fact that reallocation of resources in response to changes in economic environment requires (a) to recognize the changes are occurring (b) to gathering, retrieving, and examining critically on useful information on those changes, and (c) to bring effective decision from the information in hand, and (d) proceeding without hesitation. Allocative skill, therefore, as human capital in that sense, that it is acquired at a cost and tend to yield a valuable stream of services over future periods. That skill is gained in schooling, by getting information, and in experience from reallocating resources.

Age of the household head or farm manager is included to represent general decision-making ability. Schultz (1975) argued that education is likely to be more effective than the better location of farm exists. Farmers who have poor access to markets have less incentive in profit maximizing activities compared to those farmers who have better access to markets and their farms locate near cities. All of above-mentioned variables affect the efficiency of farm production.

## 7. Results

Maximum likelihood estimates for the parameters of the Cobb-Douglas production frontier function is given in Table 4. The ratio of the standard errors of $u$ and $v$, $\lambda$ is 2.0015 implying that the one-sided error term $u$ dominates the symmetric error $v$. This is indicating that variation in actual profit from maximum (frontier profit) possible profit between farms attributed mainly by the differences in farmers' practices rather than random variability. The average inefficiency indexes are 10.4286 and 22.1111 in Hmawbi and Waw townships, respectively. Inefficiency index suggests that, on average, about 10 percent of potential maximum profit is lost in Hmawbi, and about 22 percent is lost in Waw for the production of rice. This corresponds to a mean profit loss of 42573 Kyats per hectare in Hmawbi, and 79246 Kyats in Waw. This discrepancy between observed profit and the frontier profit is due to both technical and allocative inefficiency.

The frequency distribution of the farm specific profit inefficiency for both townships is reported in Table 5. The distribution shows that sample farm profit inefficiency varies widely. Although the minimum observed profit inefficiency is 0.03, and the maximum is 0.73, the most inefficient indexes lies between 6 to 20 % group of farmers in Waw township. The lowest inefficiency index in Hmawbi is 0.06, and the highest index is 0.19.

Table 4.Maximum likelihood estimates of the production frontier model

| Variables | | OLS | | Frontier | |
|---|---|---|---|---|---|
| *Stochastic production function* | parameter | coefficient | SE | coefficient | SE |
| constant | | 8.5897 | 3.3376 | 8.7737 | 3.1045 |
| land | $\beta_1$ | 0.0288 | 0.0396 | 0.0304 | 0.0346 |
| capital | $\beta_2$ | 0.3282** | 0.2221 | 0.2765** | 0.2074 |
| labor | $\beta_3$ | 0.2617** | 0.1585 | 0.2252** | 0.1494 |
| fertilizer | $\beta_4$ | -0.2155** | 0.0814 | -0.1271** | 0.0863 |
| Lambda | $\lambda$ | | | 2.0015 | 0.0665 |
| Sigma | $\sigma$ | | | 0.0772 | 0.0183 |
| | $\sigma_u^2$ | | | 0.2485 | 0.0453 |
| | $\sigma_v^2$ | | | 0.1242 | 0.0255 |
| Log likelihood | | | | 25.9078 | |
| *Inefficiency model* | | | | | |
| constant | | -0.6236 | 0.4297 | | |
| age | $\alpha_1$ | 0.0034 | 0.0936 | | |
| experience | $\alpha_2$ | 0.0083 | 0.0357 | | |
| education | $\alpha_3$ | -0.1982*** | 0.0311 | | |
| off-farm | $\alpha_4$ | 0.0067 | 0.0292 | | |
| secondary crop | $\alpha_5$ | 0.0278*** | 0.0267 | | |

***, **, * shows that statistically significant at 1%, 5% and 10% level, respectively

The frequency distribution reveals that the mean technical inefficiency is 0.1627 with a minimum of 3 percent and maximum of 73 percent which indicates that, on average, about 16 % of potential maximum output is lost owing to technical inefficiency in both townships. While 85% of the sample farms exhibit profit inefficiency of 20% or less, about 40% of the sample farms is found to exhibit technical inefficiency of 20% or less, indicating that among the sample farms technical inefficiency is much lower than profit inefficiency.

The estimated efficiency and inefficiency indexes of sample farms for different studies and different countries may vary based on database collection, referred period of survey time, farm structure, and etc. Thus, comparison between those estimates obtained in different analysis must be interpreted cautiously. A. Abdulai and W. Huffman (2000) used translog profit frontier function and obtained inefficiency index about 0.27 for northern Ghana; and Ali, Parikh, and Shah (1994) obtained a mean profit inefficiency index about 0.28 for China. But J. Wang, E.J. Wailes, and G.L. Cramer obtained a mean profit efficiency measure of 0.61, implying that inefficiency accounts for an average 38.9% loss of profits in China. E.W. Chirwa (2007) used a Cobb-Douglas frontier production function and obtained technical efficiency index of 46.23% implying that inefficiency among farms is about nearly 55% in southern Malawi for the study of maize. It is interesting to note that the mean inefficiency index obtained in this study is about 16 percent indicating that the value is much lower than those studies.

Table 5.Frequency distribution of farm-specific profit inefficiency in stochastic frontier function

| Inefficiency index (%) | Hmawbi | | Waw | |
|---|---|---|---|---|
| | Number of farmers | Percentage | Number of farmers | Percentage |
| 1--5 | 0 | 0.00 | 6 | 11.11 |
| 6--10 | 31 | 55.36 | 9 | 16.67 |
| 11--15 | 14 | 25.00 | 12 | 22.22 |
| 16--20 | 11 | 19.64 | 5 | 9.26 |
| 21--25 | 0 | 0.00 | 3 | 5.56 |
| 26--30 | 0 | 0.00 | 3 | 5.56 |
| 31--35 | 0 | 0.00 | 5 | 9.26 |
| 36--40 | 0 | 0.00 | 3 | 5.56 |
| 41--45 | 0 | 0.00 | 2 | 3.70 |
| 46--50 | 0 | 0.00 | 3 | 5.56 |
| 51--55 | 0 | 0.00 | 1 | 1.85 |
| 56--60 | 0 | 0.00 | 0 | 0.00 |
| 61--65 | 0 | 0.00 | 0 | 0.00 |
| 66--70 | 0 | 0.00 | 1 | 1.85 |
| 71--75 | 0 | 0.00 | 1 | 1.85 |

Source: Owned calculation minimum=3%,
and maximum=0.73

There are several reasons why profit inefficiency indexes are differed among sample farms in this study. Although prices among the sample farms are not so different in both townships since both are near to the cities, other factors such as soil condition, weather, extension service access, and so on affects the efficiency of those sampled farms. Those variables are not included in the study. Other non-physical input like market information service could not be also included since to get such kind of data is very difficult in those areas. Instead of those variables, age, experiences and schooling year of household head, off-farm employment, and income of the secondary crop which influence on the specialization in the production of rice are used in this analysis.

The parameter estimates of the relationship between profit inefficiency obtained from the stochastic frontier model and farm and household characteristics using an ordinary least square estimator are also shown in the Table 4. The technical inefficiency model shows that two of the five variables are statistically significant at the 1% level. The coefficient of the education as a kind of human capital is negative suggesting that the schooling year of the household head tends to have a highly significant impact on profit inefficiency. This finding is consistent with the estimate of Lockheed, Jamison, and Lau (1980). The negative sign indicates that more schooling year of household head reduces the inefficiency. The estimates of other findings such as Kumbhakar and Bhattarcharya (1992), and Abdulai and Huffman (2000) are also in line with this finding.

The coefficient for the income of the secondary crop shows positive and significant at 1% level indicating that farmers who specialize in the production of second crop tend to exhibit higher level of inefficiency in rice production. This is the real case happening in most parts of the country. Farmers in Myanmar are very much interested in the cultivation of various kinds of pluses since the price of pulses is quite higher than the price of rice. Even they suffer the cost in rice production due to government compulsory rice production program; they think that they might compensate for the loss with the income getting from second crop. Therefore, most of the farmers emphasize the second crop production especially pulses following a season after rice production.

Age and experiences of the household head shows no significant coefficient implying that those variables are not contributed to technical inefficient for the farmers in the studied areas. The dummy variable for off-farm employment also express positive and not significant statistically since most of the farmers in the areas are engaging only in agriculture. There are a few farmers who have higher schooling year and who have income from non-farm activities. Those farmers who have off-farm employment do not specialize in the production of rice.

The relatively high level of technical efficiency or low level of technical inefficiency in compared with other studies in other countries point that the need to pursue the recent technology with small scale intensive rice farming in the country. If the government tries to introduce new technology accompanied with additional cost of production, it will cause farmers decreasing their income.

## 8. Conclusions and policy implications

A Cobb-Douglas production frontier function is used in this study to examine the economic efficiency of rice production. The estimates of the function show mean level of profit efficiency is relatively high, but there is a significant variation between efficiency and inefficiency indexes among farms. The average inefficiency for both areas is about 16%; about 10% in Hmawbi and about 22% in Waw townships. Farmers who have higher income from secondary crop tend to lower profit efficiency. The higher educational level of farmers reduces the profit inefficiency. Farmers who have higher schooling year have more allocative ability in relation to perceiving and responding to the changes in the market prices and market behavior. Furthermore, the marginal value of an additional year of the household head' education in rice production is 23450 Kyats per farm in one rice production season. Mellor (1976) argued that investment education in rural areas should be considered as a central ingredient in a strategy designed to improve agricultural productivity when technology is dynamic. The finding in the study agrees with Mellor's argument.

Despite the long history of the country investment in the irrigation sector for improving the water ability for agriculture, and extension services and bringing new technology to the farmers' fields, smallholder farming of rice remains uneconomic and technically inefficient. Two main policy issues emerge from the results of this study. First, there is an improved and quality education investment in the rural areas. Though the government is saying they are trying in their utmost effort for education, public investment in rural areas should be considered carefully. Second, farmers prefer to produce a variety of pulses as a second crop after rice in a year indicates that the various policies such as production, marketing, and export policies for pulses are more favorable than the policies-related for rice.

Although this study does not include the relationship between inefficiency and access to credit, improving the efficiency of resources will require streamlining the acquisition of credit among small farmers. The government has recently decided to increase the amount of loan borrowed to farmers from 20000 Kyats to 40000 Kyats per acre. This is good news for the farmers themselves and to the persons-related in agriculture and rural development. But the number of loan available to the rice producers is limited and about 15% percent of the total rice cultivable land.

Overall, the rice producers in the studied area are highly responsive to market prices, labor prices and fertilizer prices since its results show statistically significant implying that market reform affects to the rice farming of those areas. There are, however, limitations in the study.

The results of this analysis may not necessarily be representative of the entire rice industry with its various land holding sizes, soil conditions, weather conditions, and so on.

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