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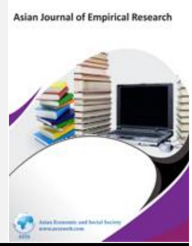

FARM EFFICIENCY AND SOCIOECONOMIC DETERMINANTS OF RAIN-FED RICE PRODUCTION IN MYANMAR: A NON-PARAMETRIC APPROACH

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ABSTRACT

The rice sector in Myanmar is predominantly for local consumption, maintaining national food security and uplifting the rural economy. The objective of the study is to estimate the value of economic efficiency and its determinant factors on paddy production by across farm sizes. A total sample of 400 rice farm households was randomly collected from main growing areas, in which farms were divided into three strata: small (<2.02 ha), medium farms (2.02-4.05) and large farms (>4.05 ha). Using Data Envelopment Approach, the empirical occurrence of efficiency analysis revealed that the average pure technical efficiency, allocative efficiency, economic efficiency, overall technical efficiency and scale efficiency of small farms were higher than other two farm size groups: medium and large farms size groups; therefore, small farms size groups were more economically benefits. Age of farmers, education level, extension visit, credit, seed replacements and frequency of fertilizer application were major factors affecting on efficiency scores. Policies leading to improving farmer knowledgeable level through provision of Workshops and training programs and helping to small farms by contribution input deliveries such good seeds, certified fertilizers are very important to enhance the achievement of total farms economic goals and increase farm efficiency in the area.

Keywords: Efficiency, Data envelopment approach, Myanmar

INTRODUCTION

Myanmar has traditionally been one of the rice exporting countries in Southeast Asia. Rice is a staple food crop as well as exportable item which has 7.06 million hectare in 2012 (MOAI, 2012) out of total agricultural land. Rice industry started to produce for local consumption and for exports

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under British colony (Win, 1995) and it ranked as on the largest rice exporting country (Young *et al.,* 1998). It is a national food crop and successfully grown under different policies since Pre-World War period. Recently, total factor productivity index for rice crop is declining from being largest one. After green revolution, there was no significant improvement in productivity so yield per unit areas was stunt and rice economy was generally low. High tax rates, the name in liberation for domestic and export rice markets induced the higher inflation problems in the country's economy. Raw materials used in agriculture are relatively high price and mostly are imported, for instance, fertilizer. Due to the effect of market reforms and government removal of subsidies for agricultural commodities in production, fertilizer price in private markets is steeply higher and increasing by year (Aung, 2011). Unstable price condition would increase higher production cost and reduce farm input delivery by producers; therefore, it may fall in paddy output and low in farm profits when comparing neighboring countries, for example, Vietnam which average yield was 5.1 t/ha in 2012 (FAOSTATA data). Moreover, Dapice *et al.* (2009) discovered that landlessness condition in Myanmar is increasing, especially in Nargis-affected areas, which is one of the major paddy growing areas. Therefore, landless and small farm conditions were made to be 74% of total food insecurity (Kyaw, 2009). Rice industry in Myanmar is declining, majority of farmers are poor, scare resources and increasing landless agricultural laborers on small farmers (Okamoto, 2004); therefore, assuming it could be one of the rice importers in next decades (Dapiec *et al.,* 2009).

Farm economic or profits are not mainly concern with physical production but also concerns with households' opinion on farming, household characteristics and production practices (Kiatpathomchai, 2008). Moreover, government contribution to farms input deliveries are very important to improve farm efficiency. Aung (2011) suggested that farm efficiency is still very weak and it needs to further study to measure the existing farm efficiency in Myanmar. In developing countries, an efficient use of farm resources is of vital important for agricultural sustainability under available technology (Kiatpathomchai, 2008). Therefore, improving profitability through more efficient utilization of available resources is a key to the survival of farmers. The objectives of this study are to calculate gross marginal value, to estimate the value of households' efficiency and to identify the determinants factors by across farm size groups.

METHODOLOGY

Gross marginal analysis was introduced to calculate the value of gross margin by each farm size group (Mankiw, 1998). For efficiency analysis, secondly, Farrell (1957) stated that there are two components; technical efficiency and allocative efficiency which are decomposed from economic efficiency. Technical efficiency is defined as the greatest possible production of goods and services from available resources. On the other hand, allocative efficiency can be defined as the ability of a firm to use inputs in optimal proportions given their respective prices and production technology. Economic efficiency or cost efficiency is a combination of technical and allocative efficiency and defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology or maximum output under given resources and available technology (Farell, 1957; Kopp & Diewert, 1982). The non-parametric approach is more suitable for analyzing production processes in developing countries where the availability of data is limited in production and lower understanding level in technology. Data Envelopment Analysis (DAE) was used to estimate technical, alloactive and economic efficiency (Charnes *et al.*, 1995; Collie, 1995; Battse and Coelli, 1988). It was originally proposed by Charnes *et al.* (1978), and a data envelopment analysis approach. The non-parametric approach or DEA analysis has no prior parametric restriction on the technology. It is one of the mathematical programming approaches measuring optimal solution relative to individual units (DMUs). DEA analysis is less sensitive to model misspecification presented by Lovell (1993), Ali and Seiford (1993), Charmes *et al.* (1995) and Seiford (1996).

Charnes *et al.* (1978) introduced CCR model to measure farm efficient level with constant return to scale (CRS) restriction; called overall technical efficiency. According to Banker, Charnes and Cooper (1984) showed that the BCC model is used to relax CRS, assuming VRS instead of CRS. However, Collie *et al.* (1998) concluded that if the firm is on optimal level of production, or more control over output variables than input variables: the constant return to scale (CRS) DEA model is appropriated. If the study area is affected by imperfect competition, constraints on finance, government regulation, it may cause the firm to be not optimal level of production. It could more control over input variables than output variables; therefore, DEA-VRS is more appropriated. If the values of technical efficiency under CRS and VRS are the same, it has no scale efficient in production function, or otherwise, the value of technical efficiency under VRS is greater than the value of scale efficiency, it has scale inefficiency (Coelli, (2008)). Under variable return to scale, it can categorize into increasing return to scale (IRS), decreasing return to scale (DRS) and constant return to scale (CRS). Variables return to scale (VRS) occurs when proportional units increase in farm inputs, more than or less than proportional unit increased in output. Based Farrell's (1957) seminar of input-oriented efficiency measure for each DMUs, empirical model that develop by Chares *et al.* (1978), and reviewed by By Chares *et al.* (1995) and guide by Collie (2008) to measure technical efficiency in the study areas is mathematically described as follow.

Mathematically.

DEA-CRS approach

$\min_{\Delta,\lambda}\Delta j$

s.t $\sum^{n}_{j=1} y_j\lambda_j - y_j \geq 0$: $\lambda_j \geq 0$ for all j

$x_{ij}\ \Delta_{ij} - \sum^{m}_{i=1} x_{ij}\, \lambda_{ij} \geq 0,$

$0 \leq \Delta \leq 1$

DEA-VRS approach

$\min_{\Delta,\lambda}\Delta j$

$s.t \sum^{n}_{j=1} y_j\lambda_j - y_j \geq 0 : \lambda_j \geq 0$ for all j

$x_{ij}\ \Delta_{ij} - \sum^{m}_{i=1} x_{ij}\,\lambda_{ij} \geq 0,$

$\sum^{n}_{j=1} \lambda_j = 1$

$0 \leq \Delta \leq 1$

Scale efficiency

$\min_{\Delta,\lambda}\Delta j$

$s.t \sum^{n}_{j=1} y_j\lambda_j - y_j \geq 0 : \lambda_j \geq 0$ for all j

$x_{ij}\ \Delta_{ij} - \sum^{m}_{i=1} x_{ij}\,\lambda_{ij} \geq 0,$

$\sum^{n}_{j=1} \lambda_j \leq 1$

$0 \leq \Delta \leq 1$

Δj is a scalar which indicates the technical efficiency scores of the j-th farm (Δj = 1 means the firm is on the frontier and is the best efficient farms under variable return to scale, otherwise, Δj=0 means the firm is below the frontier and is inefficient farms.)

In Coelli (2008), cost efficiency or economic efficiency is calculated from TE and AE. Mathematically,

$\min_{x_{ij}^*,\lambda j} w_{ij}x_{ij}{}^*$

$s.t \sum^{n}_{j=1} y_j\lambda_j - y_j \geq 0 : \lambda_j \geq 0$ for all j

$x_{ij}{}^* - \sum^{n}{}_{xij}\ \lambda_j \geq 0,$

$\sum^{n}_{j=1} \lambda_j = 1$

Therefore, the total cost efficiency (CE) or economic efficiency of the i-th DMUs would be calculated as

$CE = w_{ij}x_{ij}{}^* / w_{ij}x_{ij}$

Allocative efficiency of each DMU is also the ratio of CE to TE (AE=CE/TE). Coelli 2.1software was used to estimate TE, AE and EE in the study area. In the model, y denotes paddy output (kg/ha) while x_1, x_2, x_3, x_4, w_1, w_2, w_3, and w_4 denote seeds (kg/ha), fertilizer (kg/ha), farm labors (man-8hrs days/ha), farm tillers (unit-8hrs-days/ha), seed costs (USD/kg), fertilizer (USD/kg), farm labor costs (USD/man-8hrs-day and farm tiller costs (USD/unit).

Finally, factors affecting on efficiency were determined by using two-limit tobit regression function which is as followed (Maddala, 1999).

Efficiency = $\delta_0 + \delta_1$ (age) + δ_2(education) + δ_3(experience) + δ_4(extension)+ δ_5(credit) + δ_6(new improved seeds) + δ_7(frequency of fertilizer application)

Sources of data

Primary data was used to collect farm socio-economic characteristic using structural questionnaires in the rain-fed rice areas in crop year of 2011. A total sample of 400 respondents of ten villages from a major growing areas in Kayin State were gathered using random sampling technique, in which farms are divided into three strata: via; small (< 2.02 ha), medium farms (2.02-4.05) and large farms (>4.05 ha). Total sample sizes for small, medium and large farms were 194, 136 and 70 respondents, respectively.

RESULTS AND CONCLUSION

Descriptive statistics and gross marginal value for different farm size groups are summarized in Table 1. On farm performance, average value of paddy output for small, medium and large farms was 2,148.32 (kg/ha), 2,290.42 (kg/ha) and 2,100.45 (kg/ha) respectively. Total variables cost for small farms was USD 361.22/ha while medium and large farms has USD 391.89/ha and USD 385.28/ha. Given respective prices, total revenue for small, medium and large farms were USD 467.44/ha, USD 492.44/ha and USD 462.01/ha. Therefore, the value of gross margin for small farm was by about of USD 106.23/ha, medium farms at USD 100.55/ha and large farms at USD 76.82/ha. Herein, it stated that small farms attempted higher farm profit than other two farm sizes, medium and large farms. Across farm sizes, total labor costs were more sharing in total variables costs, therefore, paddy production in the study are labor intensive activities. In addition, paddy output was just beyond comparing neighboring countries, Thailand, and Vietnam (Daipce *et al.*, 2009), moreover, the average gross margin for each farms was relatively lower than those of gross margin value in Thailand (Kiatpathomchai, 2008) and Malaysia (Abdlatiff, 2008).

In Table 1, the results showed that farmers in the study areas were generally adult and small farmers were averagely 51.42 years old, whereas, medium and large farms were 50.27 years and 51 years old, respectively which were older than in Bangladesh (Zahidul Islam *et al.,* 2011). Average schooling years was 3.84 years in small farms, 4.08 years in medium farms and 4.50 years in large farms, so all farms in the study areas were low educated level which all were lower than in Bangladesh (Alam *et al.,* 2011). Farm experiences were averagely 21.85 years in small farms, 22.22 years in medium farms and 21.91 years in large farms which were higher than those of mean experiences of rice producers in Bangladesh (Khan *et al.,* 2010). In the study area, 60 DMUs or 30.93% of small farms, 27 DMUs or 19.85% of medium farms and 13 DMUS or 18.57% of large farms were visiting to extension agents while 31 DMUs or 15.98% of small farms, 21 DMUs or 15.44% of medium farms and 9 DMUs or 12.86% of large farms were assessing to farm loans from credit institutions. Fertilizer were used to practices in kinds of three pattern, basal application, before tillering and panicle initiation, however, 6 DMUs or 3.09% of small farms, 6 DMUs or 4.41% of medium farms and only 1 DMUs or 1.43% of large farms were practicing three times of fertilization application in paddy production.

Empirical results

The research finding in efficiency analysis revealed that the predicted value of pure technical efficiency (PTE) for small farms, medium and large farms were 0.836, 0.791, 0.767 while allocative (AE) and economic efficiency (EE) for small, medium and large farms were 0.715, 0.610, 0.647, 0.60, 0.484, and 0.503 respectively. The empirical results indicated that small farms size groups were higher efficiency scores than medium and large farms size groups. In addition, overall technical efficiency (OTE) for small farms, medium farms and large farms were 0.517, 0.512 and 0.465 while scale efficiency (SE) for small, medium and large farms were 0.62, 0.647, and 0.609, respectively. Under return to scale, the results suggested that majority of farms in each farm size group were experiencing under increasing return to scale (IRS) and they were operating above optimal scale; therefore, they can further reduce production costs by proportional reduction in inputs used while still attaining the same output level and the same environmental conditions. Frequency distribution of different efficiency scores are shown in Table 2.

Non-parametric statistical Mann-White U t test and Kruskal-Willis test were introduced to determine the statistical different between farm size groups on PTE, AE and EE. In Mann-White U test, the result showed that farm size groups were statistically significant in PTE and EE, however, there were significant in AE by medium and large farms size groups (Table 3). In Kruskal-Willis test, there were highly significant on PTE, AE and EE by farm size groups (Table 4). Therefore, the results indicated that there were vast different in farm efficiency by farms size groups in the study area.

Majority of farmers were operating under IRS, thus, if all farms has achieve fully efficiency, the potential efficiency improvement for each farm size groups was shown in Table 5. By using the potential efficiency improvement level, total production cost would save and increase saving by proportionally reduction in each input utilized in paddy production. The results stated that small farms, medium farms and large farms would save production cost by about of USD 56.41/ha, USD 78.73/ha and USD 103.21/ha at fully PTE. In addition, small, medium and large farms would also save production costs to USD 102.94/ha, USD 152.84/ha and USD 136/ha at fully AE and USD 160.18/ha, USD 138.34/ha and 191.48/ha at fully EE. Therefore, the value of gross margins or saving will increase, for example; small farms, medium farms and large farms would save total production cost up to USD 162.79/ha, USD 178.90/ha and USD 180.03/ha at fully PTE. The amount of increased in gross margin and each input save from the benefits of potential efficiency improvement are summarized in Table 6.

Variables input used in Tobit regression model are described in Table.7. The results revealed that determinants on PTE by farm size groups were age of farmers, education, experiences, extension visits, new improved seeds and frequency of fertilizer application (Table 8). In small farms sizes, education, extension and frequency of fertilizer application were positive while new improved seeds were negative effect on PTE. In medium farm sizes, education and times of fertilizer application were direct effect and new improved seeds were negative effect on PTE. In large farms sizes, age of farmers were negative effect and education, experiences, extension visits and frequency of fertilizer application were positive effect on PTE. Therefore, young, higher educated, more visiting to extension and more farm experiences farmers were higher technical efficiency. However, farmers who practiced new improved seeds and less fertilizer application in paddy production were higher technical inefficiency.

Determinants on AE were shown in Table 9 in which the results indicated that education and farm credits were determinants on AE. Across farm sizes, farmers education level were significant and positive effect, therefore, higher education level would improve AE value. However, farm credits were negative effect on AE by large farms sizes; therefore, farmers who access to farm credits would decrease AE value. Determinants on EE by farm sizes were summarized in Table 10 where farmers' age, education, credits, new improved seeds and times of fertilizer application were determinants on EE. In small farms, education level was positive effect while a new improved seed was negative effect on EE. In medium farms, a new improved seeds was negative effect and frequencies of fertilizer application were positive effect on EE. In large farms size, age of farmers and farm credit were negative effect and times of fertilizer application were positive effect. Therefore, young and higher educated farmers would increase economic efficiency, however, farmers who accessing to farms credits, using new improved seeds and less frequent in fertilizer application would decrease economic efficiency.

RECOMMENDATION

In the study area, the empirical results revealed that there were differences in efficiency levels between producers. Small scale farmers were more efficient; therefore, policies that help for small farm size by contribution input deliveries such as good seeds, certified fertilizer are very important to improve higher efficiency level in the study area. Public investment geared to improving farmer's knowledgeable levels and provision of workshops, training and extension programs are likely to lead higher level of efficiency. It should test soil quality and others agronomy factors before introducing new improved seeds and farm credit should also be in time. Government contribution, institutions and its activities are also needed to enhance economic goals.

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APPENDIX

Table 1: Descriptive statistics and gross marginal analysis

Items	Description	Small (n=194)		Medium (n=136)		Large (n=70)		t-ratio
		mean	SD	mean	SD	mean	SD	P=0.05
Output	kg/ha	2184.32	890.74	2290.42	888.177	2100.45	669.041	0.532
Variables								
land	ha	1.53	0.35	3.47	0.45	6.17	1.73	0.000***
Seeds	kg/ha	81.69	28.80	82.00	26.72	86.35	30.21	0.377
Chemical	Kg/ha	36.56	51.17	35.96	50.39	44.48	60.03	0.922

fertilizer								
FYM	Kg/ha	124.25	236.25	240.27	234.38	211.18	208.76	0.008**
Insecticide/pesticide	Kg/ha	0.02	.075	0.03	0.01	0.03	0.01	0.370
Farm Labors	man-8hrs-days/ha	56.66	12.41	62.54	12.76	60.31	10.88	0.423
Farm Tillers	units/ha	6.64	12.41	6.63	1.03	6.62	0.84	0.92
Prices								
Output price	USD/kg	0.21	0.02	0.22	0.03	0.22	0.03	0.125
Seed	USD/kg	0.25	0.03	0.24	0.03	0.24	0.03	0.928
Chemical fertilizer	USD/kg	0.58	10.04	0.58	0.04	0.58	0.04	0.437
FYM	USD/kg	0.03	0.01	0.03	0.01	0.03	0.01	0.307
Insecticide/pesticide	USD/kg	0.23	0.04	0.23	0.04	0.25	0.03	0.003**
Farm labor	USD/man-8hrs-days	4.62	0.28	4.61	0.31	4.69	0.32	0.911
Farm tiller	USD/unit-8hrs-days	5.81	0.39	6.02	0.31	6.03	0.33	0.043**
Other capital cost	USD/ha	16.31	34.60	16.99	33.95	11.43	32.32	0.600
TVC	USD/ha	361.22	86.22	391.89	84.83	385.28	90.97	0.593
1 unit cost	USD/kg	0.16		0.17		0.18		
TR	USD/ha	467.44	224.18	492.44	272.11	462.01	152.64	0.902
Gross margin	USD/ha	106.23	206.47	100.55	244.56	76.82	137.89	0.843
1 unit gross margin	USD/kg	.05		.04		.04		
Socio-demographic characteristics								
Farmers' age	years	51.42	9.26	50.27	11.14	50.91	12.26	0.610
Farmer' education	schooling years	3.84	1.29	4.08	1.54	4.50	2.63	0.368
Farm experiences	years	21.85	12.32	22.22	12.59	21.91	9.42	0.893
Extension visit	dummy	N		N		N		0.029**
yes		60.00		27.00		13.00		
no		134.00		10.00		57.00		
Farm credit	dummy	N		N		N		0.822
yes		31.00		21.00		9.00		
no		163.00		115.00		61.00		
New improved seed	dummy	N		N		N		0.550
yes		44.00		32.00		12.00		
no		150.00		104.00		58.00		
frequency of fertilizer application	dummy	N		N		N		0.513
yes		6.00		6.00		1.00		
no		188.00		130.00		69.00		

Source: Field analysis

Table 2: Different efficiency scores for different farm size

Efficiency scores	Different farm size								
	Small (n=194)			Medium (n=136)			Large (n=70)		
	mean	mini	SD	mean	mini	SD	mean	mini	SD
PTE	0.836	0.599	0.113	0.791	0.508	0.116	0.767	0.568	0.114
AE	0.715	0.228	0.162	0.610	0.601	0.138	0.647	0.376	0.142
EE	0.600	0.202	0.171	0.484	0.247	0.144	0.503	0.256	0.162
OTE	0.517	0.013	0.196	0.512	0.194	0.196	0.465	0.109	0.152
SE	0.620	0.016	0.214	0.647	0.092	0.214	0.609	0.133	0.173
DRS	2(1.03%)			1(0.74%)	0.103		-		
CRS	6(3.09%)			3(2.21%)			-		
IRS	186(95.88%)			132(97.06%)			70(100%)		

Source: Field analysis

Table 3: Mann-white U t-test

Types of efficiency	A standard Z-value	Asym; Sig; (2-tailed)
Pure technical efficiency		
Small and medium	-3.430	0.001***
Medium and large	-6.412	0.000***
Small and large	-6.446	0.000***
Allocative efficiency		
Small and medium	-1.629	0.103
Medium and large	-1.948	0.051*
Small and large	-0.584	0.559
Economic efficiency		
Small and medium	-4.289	0.000***
Medium and large	-3.480	0.001***
Small and large	-4.287	0.000***

Source: Field analysis

Table 4: Kruskal-wallis test

Types of efficiency	Farm size groups	Chi-square test	Asymp. Sig (2-tailed)
Pure technical efficiency	3	23.227	0.000***
Allocative efficiency	3	43.857	0.000***
Economic efficiency	3	46.590	0.000***

Source: Field analysis

Table 5: Summary of average potential efficiency improvement by farm size group

Production frontier	Potential improvement (%)		
	PTE	AE	EE
Farm size			
1.small	16.50	28.50	40.00
2.medium	21.00	39.00	51.60
3.large	23.30	35.50	49.70

Source: Field analysis

Table 6: Cost saves at fully efficiency scores by each farm size group

	Different farm size		
	small	medium	large
Output (kg/ha)	2,184.32	2,209.42	2,100.95
Actual observed TVC (USD/ha)	361.22	391.84	385.28
Actual observed gross margin (USD/ha)	106.23	100.55	76.82
Cost saving at fully PTE (USD/ha)	56.41	78.73	103.21
Cost saving at fully AE (USD/ha)	102.94	152.84	136.00
Cost saving at fully EE (USD/ha)	160.18	138.34	191.48
Gross margin increase at fully PTE (USD/ha)	163.14	179.28	180.03
Gross margin increase at fully AE (USD/ha)	209.17	253.39	212.83
Gross margin increase at fully EE (USD/ha)	266.41	238.39	268.31
2.Input save			
Seed (kg/ha)	13.47	17.21	20.12
Chemical fertilizer (kg/ha)	6.03	7.56	10.36
FYM (kg/ha)	20.98	50.41	49.21
Insecticide/pesticide (liter/ha)	0.01	0.01	0.01
Farm Labors (man-8hrs-days/ha)	9.34	13.13	14.05
Farm Tillers (unit-8hrs-days/ha)	1.09	1.39	1.54

Source: Field analysis

Table 7: Variables used tobit regression model

Explanatory variables	definition
Age	years
Education	schooling years
Experiences	years
Extension visits	dummy variables (1=assessing, 0=otherwise)
Assessing to farm credit	dummy variables (1=assessing, 0=otherwise)
New improved seeds	dummy variables (1=assessing, 0=otherwise)
Frequency of fertilizer application	dummy variables (1= fertilizer application in three times, 0 = less than three times)

Source: Field analysis

Table 8: Sources of determinants variables on pure technical efficiency (Tobit regression results)

Variables	Different farm size					
	Small (n=194)		Medium (n=136)		Large (n=70)	
	Coeff:	SE	Coeff:	S.E	Coeffi:	SE
Constants	0.8124***	0.0008	0.8063***	0.0542	0.7290***	0.0583
farmers' age	-0.0014	0.0064	-0.0011	0.0062	-0.0026**	0.0011
education	0.0260***	0.0006	0.0131**	0.0009	0.0145**	0.0050
experiences	0.0007	0.0172	0.0000	0.0234	0.0045**	0.0015
Extension visit	0.0342**	0.0218	0.0263	0.0269	0.0620*	0.0340
credits	-0.0198	0.0193	0.0057	0.0223	-0.0500	0.0396
New improved seeds	-0.0953***	0.0469	-0.0953***	0.0534	0.0212	0.0356
Frequency of fertilizer application	0.0989**	0.0551	0.1842***		0.2593**	0.1013
Standard error (σ)	0.1089	0.0060	0.1071	0.0068	0.0998	0.0088
Log-livelihood	109.6520		91.6320		53.7890	

Coeff: means coefficient

Source: Field analysis

Table 9: Sources of determinants variables on allocative efficiency (Tobit regression results)

Variables	Different farm size					
	Small (n=194)		Medium (n=136)		Large (n=70)	
	Coeff:	SE	Coeff:	SE	Coeffi:	SE
Constants	0.6681***	0.0184	0.6885***	0.0688	0.6342***	0.0736
farmers' age	-0.0004	0.0013	-0.0000	0.0013	-0.0008	0.0014
education	0.0183**	0.0093	-0.0143**	0.0078	0.0163**	0.0062
experiences	0.0008	0.0009	-0.0009	0.0011	0.0000	0.0019
Extension visit	-0.0300	0.0254	0.0267	0.0296	0.0300	0.0429
credits	-0.0455	0.0323	0.0210	0.0340	-0.1147**	0.0501
New improved seeds	-0.0000	0.0287	-0.0241	0.0283	-0.0597	0.0446
Times of fertilizer application	0.0302	0.0680	0.07118	0.0587	.1667	0.1282
Standard error (σ)	0.1625	0.0084	0.1365	0.0083	0.1263	0.0106
Log-livelihood	68.598		73.456		45.508	

Coeff: means coefficient

Source: Field analysis

Table 10: Sources of determinants variables on economic efficiency (Tobit regression results)

Variables	Different farm size					
	Small (n=194)		Medium (n=136)		Large (n=70)	
	Coeff:	SE	Coeff:	SE	Coeffi:	SE
Constants	0.5423***	0.0818	0.5563***	0.0687	0.4830***	0.0795
farmers' age	0-.0013	0.0013	-0.0006	0.0012	-0.0026*	0.0015
education	0.0328***	0.0093	-0.0066	0.0078	0.0207**	0.0067
experiences	0.0012	0.0009	0.0007	0.0011	0.0030	0.0020
Extension visit	-0.0075	0.0255	0.0441	0.0295	0.0613	0.0464
credits	-0.0507	0.0325	0.0358	0.0338	-0.1208**	0.0541
New improved seeds	-0.0688**	0.0288	-0.0761**	0.0282	-0.0305	0.0482
Frequency of fertilizer application	0.0849	0.0684	0.1318**	0.0586	0.3304**	0.1385
Standard error (σ)	0.1634	0.0084	0.1362	0.0083	0.1364	0.0115
Log-livelihood	66.673		73.364		40.117	

Coeff: means coefficient

Source: Field analysis