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Economic Efficiency of Key Mango Varieties between Cooperative and Non-Cooperative Farmers in the Mekong Delta, Vietnam

Truong Hong Vo Tuan Kiet[1*], Nguyen Thi Kim Thoa[1]
[1] Mekong Delta Development Research Institute, Can Tho University, Vietnam
*Corresponding author: thvtkiet@ctu.edu.vn

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Abstract

The study used Cobb-Douglas and translog form of stochastic frontier profit function to measure economic efficiency of mango farmers. The findings showed that economic efficiency of the cooperative farmer group was greater than that of the non-cooperative farmer group in all three seasons examined. Certain adjustments in the input factors could increase the profit of mango growers in the Mekong Delta. Moreover, the positive determinants of the profit efficiency of the cooperative farmer group were education, wrapping bag and plant density in season 1, wrapping bag in seasons 2 and 3, plant density in season 2, and education in season 3, while the negative factors were age, payment for the agro-input wholesaler, and farming experience in all three seasons, and credit access and market access in seasons 1 and 2. The positive determinants of EE in the non-cooperative farmer group were farming experience and market access in all three seasons, credit access in seasons 2 and 3, and plant density in seasons 1 and 3; the negative determinants of economic efficiency were age in all three seasons, education and payment for the agro-input wholesaler in seasons 1 and 3, wrapping bag and classifying sale in season 3.This may pave the way for relevant policymakers to look for policies that lead to improve income of small-scale farmers that either are or are not members of cooperatives with the ultimate goal of reaching a sustainable development strategy.
Keywords: *Key mango varieties, profit, cooperative, non-cooperative*

I. INTRODUCTION

Vietnam is a major exporter of agricultural products. The 2016-2020 period witnessed an impressive growth in agro-forestry and fishery export from 32.10 U.S billions to 41.25 U.S billions. In 2020, Vietnam ranked second place in term of agricultural export in Southeast Asia, and 15th place in the world [1]. Export of vegetables and fruit are gaining a prominent role in Vietnam's overall agricultural exports. Usually, fruit export percentage is approximately 70% of vegetables and fruit export. It is main motivation for exporting vegetables and fruit. Although dragon fruit currently has the largest influence on fresh fruit export value, mangoes have emerged as a high-potential commodity in boosting exports. Mango plantations are small, with an average cultivated area of 0.5-1 ha. This leads to a fragmented production system, which makes it difficult to disseminate information, coordinate technological improvements, produce markets to execute larger-scale orders, and generally achieve economy of scale, etc. Some of these challenges have been met by the organisation of producers into structures, such as cooperatives or cooperative groups [2].

Thus, the aim of this paper is to determine the determinants of the economic efficiency and economic inefficiency of mango growers in the cooperative and non-cooperative groups in order to boost their profit efficiency (EE). This paves the way for farmers to re-structure household resources effectively.

II. METHODOLOGY

2.1 Sampling Techniques

A multi-stage sampling technique was used to select the study area. First, the MD region was purposively selected because of its comparative advantage in mango production in Vietnam, as it accounts for 55% of the mango production volume and for 50% of the mango production area in Vietnam. Next, the Dong Thap, An Giang, Tien Giang, Hau Giang, Vinh Long, and Tra Vinh provinces were selected because, combined, they account for approximately 77% of the mango production volume and 71% of the mango production volume area in MD. Finally, a simple random sampling technique was used to select 644 sample observations of the cooperative farmer group (240, 204 and 200 observations for seasons 1, 2, and 3, respectively), and 832 sample observations of the non-cooperative farmer group (286, 246, and 300 observations for seasons 1, 2, and 3, respectively).

2.2 Empirical Model

A multiple regression model based on the stochastic frontier profit function which assumed the Cobb-Douglas functional form, was employed to determine the profit efficiency of mango producers in the study area. The frontier model, estimated according to [3], was therefore specified as follows:

$$ln\pi_i^* = \beta o + \beta 1 ln X^*1 + \beta 2 ln X^{*2} + \beta 3 ln X^*3 + \beta 4 ln X^*4 + \beta 5 ln X^*5 + \beta_k lnX_k^* + Vi - Ui$$

The translog production function was alternatively defined as follows:

$$ln\ \pi_i^* = \beta o + \beta 1 lnX^*1 + \beta 2 lnX^*2 + \beta 3 lnX^*3 + \beta 4 lnX^*4 + \beta 5 lnX^*5 + \beta_6 \ln(X_k^*) + 0.5\beta 7(ln\ X^*1)^2 + 0.5\beta 8 ln(lnX^*2)^2 + 0.5\beta 9 ln(ln\ X^*3)^2 + 0.5\beta 10 ln(ln\ X^*4)^2 + 0.5\beta 11 ln(lnX^*5)^2 + 0.5\ \beta_{12}(X_k^*)2 + \beta 13 lnX^*1 lnX^*2 + \beta 14 lnX^*1 lnX^*3 + \beta 15 lnX^*1 lnX^*4 + \beta 16 lnX^*1 lnX^*5 + \beta 17 lnX^*1 lnX^*_k\ \beta 18 lnX^*2 lnX^*3 + \beta 19 ln\ X^*2 lnX^*4 + \beta 20 lnX^*2 lnX^*5 + \beta 21 lnX^*2 lnX^*_k + \beta 22 ln\ X^*3 lnX^*4 + \beta 23 lnX^*3 lnX^*5 + \beta 24 lnX^*3 lnX^*_k + \beta 25 lnX^*4 lnX^*5 + \beta 26 lnX^*4 lnX^*k + \beta 27 lnX^*5 lnX^*_k + Vi - Ui$$

Where:

Ln = Natural logarithm,

π_i^*= Normalised profit computed for the i-th farmer,

X_1^*= Pesticide price (VND/L) normalised by the mango price,

X_2^*= Fungicide price (VND/L) normalised by the mango price,

X_3^*= Root fertiliser price (VND/kg) normalised by the mango price,

X_4^*= Leaf fertiliser price (VND/kg) (sprayed on mango leaves to induce flowering in mango trees) normalised by the mango price,

X_5^*= Hired labour price (VND/ man day) normalised by the mango price,

X_k= Area of cultivated land (cong = 1,000 m^2),

$\beta_0, \beta_{1\ldots5},$ and β_k are parameters to be estimated, and represent statistical disturbance terms, and u_i = profit inefficiency effects of the i-th farmer.

The determinants of the profit inefficiency of the mango farmers were modelled following specific farmer characteristics in the study area, according to [4]. The profit inefficiency was determined from the following equation:

$$\boldsymbol{u_i = \alpha_0 + \sum_{r=1}^{9} \alpha_r Z_r + \mathrm{k}}$$

Where:

$\boldsymbol{u_i}$ = Profit inefficiency of the i-th farmer,

α_0 and α_r = Parameters to be estimated,

Z_r = Variables explaining inefficiency effects,

r =1,2,3....,n,

k is a truncated random variable.

Z_1 = Farmer's age (years),
Z_2 = Educational level (years spent acquiring formal education)
Z_3 = Farming experience (years)
Z_4 = Credit access (access =1, no access = 0)
Z5 = Payment for agro-input wholesaler (ending of crop =1, immediate payment =0)
Z_6 = Wrapping bag (wrap = 1, no wrap =0) (applied mango wrap technique against incursion of pest, insect)
Z_7 = Market access (access = 1, no access = 0)
Z_8 = Classifying sale (classification =1, no classification = 0) (selling mango is classified including: first level with best price, second level with medium price, and third level with lowest price)
Z_9 = Plant density (plants/ha)

The estimates for all the profit functions and inefficiency model parameters were obtained by maximising the likelihood function on the FRONTIER 4.1 programme.

III. EMPIRICAL RESULTS

3.1 Estimation Procedure

To select the lead functional form for the data, we tested a hypothesis based on the generalised likelihood ratio (LR) test = - 2 {log [L (H0) – log [L (H1)]} formula was used for the LR test. The null hypothesis was that the Cobb-Douglas production function was the best fit for the data. According to our results, the null hypothesis was rejected in four cases, because the lambda values ($\boldsymbol{\lambda 1}$ = 58.36, $\boldsymbol{\lambda 2}$ = 43.66, $\boldsymbol{\lambda 3}$ = 127.70, and $\boldsymbol{\lambda 4}$ = 34.32) were greater than the critical value (32.67) at the 5% significance level, thereby suggesting that the translog form was the best functional form for the data (Table 2). In two cases when the lambda values ($\boldsymbol{\lambda 5}$ = 7.42, and $\boldsymbol{\lambda 6}$ = 2.18) were lower than the critical value (32.67) at the 5% significance level, the null hypothesis was not rejected, thereby demonstrating that Cobb-Douglas was the best functional form for the data (Table 1).

Table 1- Generalised likelihood ratio test for the stochastic profit model

Season	**Null Hypotheses**	**Log likelihood (H_0)**	**Log likelihood (H_1)**	**Test statistic (λ)**	**Degree of Freedom**	**Critical value (5%)**	**Decision**
Cooperative							
Season 1	Cobb-Douglas was the best fit	-482.88	-453.70	58.36	21	32.67	Rejected
Season 2	Cobb-Douglas was the best fit	-440.14	-418.31	43.66	21	32.67	Rejected
Season 3	Cobb-Douglas was the best fit	-473.50	-409.65	127.70	21	32.67	Rejected
Non-cooperative							

Season 1	Cobb-Douglas was the best fit	-609.43	-592.27	34.32	21	32.67	Rejected
Season 2	Cobb-Douglas was the best fit	-628.62	-624.91	7.42	21	32.67	Not rejected
Season 3	Cobb-Douglas was the best fit	-528.21	-527.12	2.18	21	32.67	Not rejected

** Critical values with asterisk were taken from Kodde and Palm (1986). For these variables the λ statistic was distributed following a mixed χ2 distribution.*

The expected parameters and the associated statistical test results obtained from the MLE analysis) of the translog and the Cobb-Douglas production function based on the stochastic frontier profit function for key mango farmers in the MD are presented in Table 3. The sigma squares (σ^2) of the cooperative farmer category were 36.65, 56.59, and 79.01 in seasons 1, 2, and 3, respectively. The sigma squares of the non-cooperative farmer category were 31.54, 84.80, and 175.87 in seasons 1, 2, and 3, respectively. All sigma squares were significantly different from zero, which suggested a good fit of the models and the correctness of the specified distributional assumptions.

Furthermore, the gamma parameters of the cooperative farmer group (γ_1=0.9999, γ_2=0.9999, and γ_3=0.9999) were quite high and significant at the 1% of probability level, thereby implying that 99.99% of the variation in seasons 1, 2, and 3 resulted from the profit efficiency of the sampled farmers rather than from random variability. Similarly, the gamma parameters of the non-cooperative farmer group (γ_1=0.9999, γ_2=0.9999, and γ_3=0.9994) were significant at the 1% level. This suggested that 99.99% of the variation in profit efficiency in seasons 1 and 2 was explained by the given variables; these variables explained 99.94% of the profit efficiency variation in season 3.

Table 2- Maximum likelihood estimates for the stochastic frontier analysis model regarding key mango varieties in the Mekong Delta

Variables	**Season 1**		**Season 2**		**Season 3**	
	Coop	***Non-Coop***	***Coop***	***Non-Coop***	***Coop***	***Non-Coop***
	Coef.	*Coef.*	*Coef.*	*Coef.*	*Coef.*	*Coef.*
Dependent Variable: [Y: Ln profit (VND)]						
Constant	-6.129***	11.169***	16.628***	9.693***	12.756***	8.159***
(X_1) Ln pesticide price (VND/L)	2.292***	-1.160*	3.953***	0.036	0.026	-0.060
(X_2) Ln fungicide price (VND/L)	1.456***	2.977***	8.114***	-0.076**	1.621***	-0.123

(X_3) Ln root fertiliser price (VND/kg)	-7.482***	1.133**	2.427***	0.450***	0.587***	0.253
(X_4) Ln leaf feriliser price (VND/kg)	2.689***	3.951***	1.586**	-0.159**	-0.418***	0.096
(X_5) Ln labour price (VND/day)	7.797***	-5.683***	-13.345***	-0.600***	-4.407***	-0.049
(X_6) Ln land area (cong = 1,000m²)	-1.644***	0.805*	-5.519***	1.013***	-1.564***	0.830***
½ *Ln (X1)²	-0.642***	-0.167***	0.256**		-0.187***	
½ *Ln (X2)²	0.694***	-0.662***	-2.726***		-0.820***	
½ *Ln (X3)²	-1.536***	-0.588***	0.531**		-0.316***	
½ *Ln (X4)²	-0.158***	-0.585***	-1.028***		-1.236***	
½ *Ln (X5)²	-0.839***	3.569***	5.701***		0.915***	
½ *Ln (X6)²	-0.048	-0.103***	0.207*		0.435***	
Ln (X1)*Ln(X2)	0.884***	0.182	2.902***		0.433***	
Ln (X1)*Ln(X3)	0.721***	-0.467***	2.127***		-0.129***	
Ln (X1)*Ln(X4)	0.753***	0.257***	-0.784***		0.351***	
Ln (X1)*Ln(X5)	-1.549***	0.277	-3.446***		-0.346***	
Ln (X1)*Ln(X6)	-0.098***	-0.310***	0.119		0.022***	
Ln (X2)*Ln(X3)	-0.182	-0.286***	1.818***		-0.518***	
Ln (X2)*Ln(X4)	-0.354**	0.843***	-1.224***		-0.158***	

Ln (X2)*Ln(X5)	-1.333***	-1.265***	-1.208***		0.101***	
Ln (X2)*Ln(X6)	0.092	-0.212**	-0.919***		-0.506***	
Ln (X3)*Ln(X4)	0.150	0.962***	1.582***		-0.605***	
Ln (X3)*Ln(X5)	2.914***	-0.361*	-3.735***		0.282***	
Ln (X3)*Ln(X6)	-0.630***	0.160	-0.963***		-0.085***	
Ln(X4) *Ln(X5)	-1.112***	-1.757***	1.458***		0.741***	
Ln(X4) *Ln(X6)	0.097	-0.464***	0.237***		-0.426***	
Ln(X5) *Ln(X6)	0.827***	0.826***	2.772***		1.399***	
Diagnostic Statistics						
Sigma square (σ^2)	36.65	31.54	56.59	84.80	79.01	175.87
Gamma (γ)	0.9999***	0.9999***	0.9999***	0.9999***	0.9999***	0.9994***
Log-likelihood function	-453.70	-592.27	-418.31	-628.62	-409.65	-528.21
Number of observations (N)	240	286	200	300	204	246

Source: Field Survey Data, 2018

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

The results of the analysis of the estimated model of the cooperative producer group demonstrated that, in season 1, the coefficients of the pesticide, fungicide, leaf fertiliser, and labour prices were positive and statistically significant at the 1% level, while the coefficients of the root fertiliser price and the land area were negative at the 1% significant level. The positive relationship of the pesticide, fungicide, leaf fertiliser and labour prices with profit suggested that a 1% increase in each of these prices would result in a 2.292%, 1.456%, 2.689%, and 7.797% profit increase , respectively, for mango farmers. The coefficient of the square term for fungicide price was positive and highly significant at the 1% level, thereby suggesting a direct relationship with profit. However, the coefficients of interaction between the pesticide price and the labour price, the pesticide price and the land area, the fungicide price and the leaf fertiliser price, the fungicide price and the labour price, the root fertiliser price and the land area, the leaf fertiliser price and the labour price were negative, thereby indicating that an increase in either of the aforementioned combinations would decrease the profit of mango farmers. Meanwhile, the analysis of the estimated model of the non-cooperative producer group revealed that the coefficients of the land area, the root fertiliser price, the fungicide price and the leaf fertiliser price were positive at the 10%, 5%, 1%, and 1% significance level, respectively. The pesticide price and labour price coefficients were negative at the 10%, 1% significance levels, respectively. The coefficients of the square term for the labour price and those of the interactions between the pesticide

price and the leaf fertiliser price, the fungicide price and leaf fertiliser price, the root fertiliser price and the leaf fertiliser price, the labour price and land area were significant at the conventional significance levels. This implied that these combinations would increase mango farmers' profit more.
In season 2, the labour price and the land area variables of the cooperative farmer category were negative and significant at the 1% level with coefficients of 13.345 and 5.519, respectively. Alternatively, a 1% rise in the labour price and land area would lead to 13.345% and 5.519% decline, respectively, in the profit incurred by mango production. Analogously, the coefficients of the square term of the fungicide price and the leaf fertiliser price were negative, showing increase of the variable in production was limited to output. Additionally, the coefficients of interaction between the pesticide price and the leaf fertiliser price, the pesticide price and the labour price, the fungicide price and the leaf fertiliser price, the fungicide price and the labour price, the fungicide price and the and area, the root fertiliser price and the labour price, the root fertiliser price and the land area were negative and significant at the 1% level, thereby implying that increases in these combinations would lead to a decrease in the output of mango growers. The coefficients of interaction between the pesticide price and the fungicide price, the pesticide price and the root fertiliser price, the fungicide price and the root fertiliser price, the leaf fertiliser (root) price and fertiliser price, the leaf fertiliser price and the labour price, the leaf fertiliser price and the land area, the labour price and the land area would increase the profit of mango farmers. In the non-cooperative farmer category, the root fertiliser price and the land area variables were positive and significant at the 1% level, with coefficients of 0.450 and 1.013, respectively. The coefficients of fungicide price, leaf fertiliser price, and labour price were negative and significant at the 5% and 1% levels, thereby implying that the more higher these prices, the lower the profit of the mango producer.
In season 3, the fungicide price and root fertiliser price input variables in the cooperative farmer category played important and positive roles in mango production, with high coefficients of 1.621 and 0.587, respectively, at the 1% significance level. The leaf fertiliser price, labour price, and land area variables were negative and significant at the 1% level with coefficients of 0.418, 4.407, and 1.564, respectively. In addition, the coefficients of the square term for the pesticide price, fungicide, root fertiliser, and leaf fertiliser prices exerted a negative influence on the profit of mango growers, whereas those of the labour price and the land area exerted a positive influence. Furthermore, the coefficients of interaction between the pesticide price and the fungicide price, the pesticide price and the leaf fertiliser price, the pesticide price and the labour price, the leaf fertiliser price and the labour price, the labour price and the land area were positive and significant at the 1% level. On the other hand, the coefficients of interaction between the pesticide price and the root fertiliser price, the pesticide price and the labour price, the fungicide price and the root fertiliser price, the fungicide price and the leaf fertiliser price, the fungicide price and the land area, the root fertiliser price and the leaf fertiliser price had a significant effect on the profit of mango farmers at the 1% significance level. In the non-cooperative grower category, land area was positive and significant at the 1% level, as a 1% increase in the land area would result in a 0.830% rise in the output of mango producers

3.2 Determinants of economic efficiency

The information presented in Table 3 represents factors that influenced the EE of mango farmers in the MD during the three examined seasons. The purpose of this analysis was to determine the relationship between economic inefficiency and household characteristics.

Table 3- Maximum likelihood estimates (MLE) of the determinants of the economic inefficiency score

Variables	**Season 1**		**Season 2**		**Season 3**	
	Coop	***Non-Coop***	***Coop***	***Non-Coop***	***Coop***	***Non-Coop***
	Coef.	*Coef.*	*Coef.*	*Coef.*	*Coef.*	*Coef.*
Economic Inefficiency Model						
Constant	-9.4086***	-5.2219**	-18.894***	-23.886***	-32.432***	-112.17**
(Z_1) Age	0.0501*	0.0997***	0.0680*	0.167	0.1492***	0.869**
(Z_2) Education	-0.4598***	0.2690**	0.0450	0.710	-0.8089***	1.810**
(Z_3) Farming experience	0.1751**	-0.1817**	0.1945**	-0.427***	0.2715***	-0.481**
(Z_4) Credit access	2.226**	0.666	2.078**	-6.880***	-0.824	-17.835*
(Z_5) Payment form for agro-input	1.956**	1.178*	3.592***	-1.178	7.543***	15.304**
(Z_6) Wrapping bag	-8.576***	-1.080	-7.930***	-4.158*	-4.314***	18.964**
(Z_7) Market access	5.785***	-2.575**	6.321***	-13.573***	0.394	-20.414***
(Z_8) Classifying sale	1.523*	1.251	1.298	8.275***	-0.209	24.876**
(Z_9) Plant density	-0.010***	-0.009***	-0.013***	0.002	0.003**	-0.031**

Source: Field Survey Data, 2018

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

***Note:** A negative sign in the parameters of the inefficiency function means that the associated variable had a positive effect on economic efficiency, and vice versa.*

In season 1, the parameter estimate pointed out that the age, payment form for agro-input and plant density variables were statistically significant. This meant that when the age, payment form for agro-input variables were negative, while the plant density had a significantly positive effect on the EE of farmers belong to both the cooperative and the non-cooperative group. The age variable results were consistent with those obtained from the studies of [5-8] who stated that older farmers had a negative effect on profit efficiency. However, these results were contrary to the findings of [9, 10]. Furthermore, education had a significantly negative impact on the non-cooperative farmer profile at the 5% level. The educational level had a negative impact on the profit of mango producers, thereby implying that a lack of education may not contribute to economic inefficiency. This result was similar to those obtained from [9]. However, in the cooperative farmer profile, this variable; this finding was similar to those of some previous studies [8, 10] in which a statistically significant correlation was obtained between education and EE. Moreover, the coefficient of farming experience had a significantly positive effect at the 5% level on the non-cooperative grower group. This meant that if the farming experience of the farmer increased by 10%, the mango profits could increase by 1.817% in season 1. The results of this study corroborate the results of other studies [7, 10], which have suggested a positive relationship between profit efficiency and farming experience.

In season 2, the coefficient of the wrapping bag had a significantly positive effect at the 1% level on the EE of the cooperative farmer group and a significantly negative effect at the 10% level on the EE of the non-cooperative farmer group. Meanwhile, the credit access variable had a negative effect on the EE of the cooperative farmer group. Similar findings were obtained by [8, 11]. However, the same variable had a positive effect on the EE of the non-cooperative farmer group. These results corroborate those of [7]. The coefficient of the classifying sale was negative and significant at the 1% level in the non-cooperative farmer group, thereby indicating that farmers who sold classified mangoes had lower profits than farmers who sold non-classified mangoes.

In season 3, the EE of the cooperative farmer group suffered significantly negative effect from the age, farming experience and payment form for agro-input variables, which had coefficients of 0.1492, 0.2715, and 7.543, respectively. On the other hand, the education and wrapping bag variables had a significant positive effect on the EE of the cooperative farmer group at the 1% level. The result of the education variable was consistent with those of other studies [8, 10]. Additionally, the wrapping bag was an important variable in terms of EE. It had a positive effect on the profit efficiency of the cooperative farmer group and a negative effect on that of the on non-cooperative farmer group. The positive sign of the wrapping bag variable indicated that if farmers use bags to wrap mangoes in production, their profit could increase. The main reason for this is that farmers focused on quality rather than quantity and they only wrapped high quality mango fruits, while also securing low wrapping bag costs, thereby achieving high selling prices.

3.3 Economic Efficiency Distribution

The result of season 1, indicated that the EE ranged from 0.0001 to 0.9990 with a mean of 0.3431 in the cooperative producer category and from 0.0000 to 0.9994 with a mean of 0.2949 in the non-cooperative producer category. These results suggest that the EE mean of the non-cooperative producer category was lower than that of the cooperative producer category. These results also suggest an economic efficiency gap of approximately 65.69% in the cooperative producer category and 70.51% in the non-cooperative producer category. This implied that the average farmer in the study area could increase their profit by 65.69% and 70.51%, respectively, by improving their economic efficiency. Additionally, our results showed that the average mango farmer of the cooperative and non-cooperative farmer groups required cost savings of 65.66% [(1 – 0.3431/0.9990)*100] and 70.49% [(1 – 0.2949/0.9994)*100], respectively, in order to attain the status of the most efficient mango producer. The cooperative and non-cooperative farmers with the lowest performance required cost savings of 99.99% [(1 – 0.0001/0.9990)*100] and 100.00% [(1 – 0.0000/0.9994)*100], respectively, to become the least efficient mango grower in the MD.

Table 4- Economic efficiency level distribution

Economic efficiency level	Season 1		Season 2		Season 3	
	Coop	***Non-Coop***	***Coop***	***Non-Coop***	***Coop***	***Non-Coop***
	%	**%**	**%**	**%**	**%**	**%**
<0.1	30.42	36.01	38.50	39.33	31.86	40.67
0.1-<0.2	17.08	15.03	12.50	14.33	14.22	10.05
0.2-<0.3	7.92	13.29	9.00	12.67	13.73	11.00
0.3-<0.4	9.17	8.04	5.00	9.00	11.27	5.26
0.4-<0.5	7.50	5.94	7.50	7.00	4.41	8.61
0.5-<0.6	5.83	3.85	8.00	3.67	4.90	6.22
0.6-<0.7	4.17	2.80	2.50	5.33	2.45	8.13

0.7-<0.8	2.92	2.10	1.00	2.33	2.45	6.70
0.8-<0.9	2.08	2.80	10.00	2.33	0.98	3.35
0.9-<1.0	12.92	10.14	6.00	4.00	13.73	0.00
1.0	0.00	0.00	0.00	0.00	0.00	0.00
Obsevations (N)	**240**	**286**	**200**	**300**	**204**	**246**
Minimum	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum	0.9990	0.9994	0.9663	0.9854	0.9990	0.8877
Mean	0.3431	0.2949	0.3079	0.2565	0.3249	0.2860
Std. deviation	0.3318	0.3158	0.3176	0.2699	0.3278	0.2705

Source: Field Survey Data, 2018

The most outstanding feature of season 2 was the EE of the cooperative farmer group that ranged between 0.0000 and 0.9663, with a mean economic efficiency of 0.3079, and that of the non-cooperative farmer group that ranged between 0.0000 and 0.9854 with a mean EE of 0.2565. These results demonstrate that the mean EE of the cooperative producer category was greater than that of non-cooperative producer category. The average EE indexes of 0.3079 and 0.2565 suggest that an average mango farmer of the cooperative and non-cooperative farmer groups, respectively, in the MD, had the capacity to increase their EE in terms of mango production by 69.21% and 74.35%, respectively, in order to reach the maximum possible level of EE. Thus, the sample frequency distribution indicated that there were efficiency gaps among mango farmers in terms of production, however there was room for improvement. The same frequently distribution suggested that the average mango farmer of the cooperative and non-cooperative farmer groups could experience cost savings of 68.14% [(1 – 0.3079/0.9663)*100] and 73.97% [(1 – 0.2565/0.9854)*100], respectively. Additionally, the least efficient farmers of the cooperative and non-cooperative farmer groups experience a boost of 100.00% [(1 – 0.0000/0.9663)*100] and 100.00% [(1 – 0.0000/0.9854)*100] respectively, in their EE.

In season 3, our results showed that the EE mean of the cooperative grower group (32.49%) was greater than that of the non-cooperative grower group (28.60%). These figures indicated that there were efficiency gaps among mango farmers in terms of production, however there was room for improvement. Additionally, our results revealed that the average mango farmer of the cooperative and non-cooperative farmer groups could experience cost savings of 67.48% [(1 – 0.3249/0.9990)*100] and 67.78% [(1 – 0.2860/0.8877)*100], respectively. On the other hand, the least efficient farmers of the cooperative and non-cooperative farmer groups could experience an increase in their EE by 100.00% [(1 – 0.000/0.9990)*100] and 100.00% [(1 – 0.0000/0.8877)*100], respectively.

IV. CONCLUSIONS

Result of study revealed that the mean EE of the cooperative farmer group was greater than that of the non-cooperative farmer group in all three seasons examined. Certain adjustments in the input factors could increase the profit of mango growers in the MD. Empirical findings indicated that the positive determinants of the profit efficiency of the cooperative farmer group were education, wrapping bag and plant density in season 1, wrapping bag in seasons 2 and 3, plant density in season 2, and education in season 3, while the negative factors were age, payment for the agro-input wholesaler, and farming experience in all three seasons, and credit access and market access in seasons 1 and 2. The positive determinants of EE in the non-cooperative farmer group were farming experience and market access in all three seasons, credit access in seasons 2 and 3, and plant density in seasons 1 and 3; the negative determinants of EE were age in all three seasons, education and payment for the agro-input wholesaler in seasons 1 and 3, wrapping bag and classifying sale in season 3.

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