Economic Efficiency Of Hoaloc-Mango Between Cooperative and Non-cooperative Farmer Groups In Vietnam

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Abstract - The study investigated the determinants of economic efficiency among Hoaloc-mango growers in Vietnam. The result revealed that the mean economic efficiency of the cooperative farmer group was greater than that of the non-cooperative farmer group in seasons 1, and 2, and less than in season 3. The positive determinants of the economic efficiency of the cooperative farmer group were age, and education in season 1, credit access in seasons 2, and wrapping bag and classifying sale in season 3, while the negative factors were farming experience, credit access, payment for the agro-input wholesaler, market access, classifying sale, plant density in season 1, age, education, credit access, wrapping bag, market access in season 2, and farming experience, credit access, and plant density in season 3. The positive factors of EE in the non-cooperative farmer group were credit access, and plant density in seasons 1, credit access, and market access in season 2, and farming experience, classifying sale, and plant density in season 3. On the other hand, the negative determinants of economic efficiency of non-cooperative farmer group were age, wrapping bag in season 1, education, farming experience, and classifying sale in season 2, and age, education, and payment for the agro-input wholesaler in season 3.
Key words - Economic efficiency, cooperative, non-cooperative

I. INTRODUCTION

Mango is not only a favorite food, but it also ranks high nutritious fruits. Mango is the most sought after seasonal tropical fruit but production in Vietnam remains small. With improved technologies in production and post-harvest operations, including the new techniques of producing off-season fruits, there is a great prospect for large-scale cultivation of mango in Vietnam, both in the southern Vietnam where it has traditionally been grown. A survey of 166 mango growing households conducted by [1] indicated an average growing area of 0.68ha per household. Mango farmers may be considered low income but do not constitute poor households according to national definitions. Mango cultivation does clearly, however, hold potential to help smallholders increase incomes and improve living standards.
Hoaloc-mango is one of the most well-known varieties of mango under cultivation in the southern Vietnam, especially is the Mekong River Delta for its aroma and sweetness. Mango transplantation and seedling selection, application of modern techniques are done with, aiming at raising the quality and productivity. Hoaloc - mango trees bring high economic efficiency, so the southern Vietnam provinces such as Tien Giang, Dong Thap, Hau Giang, Vinh Long, Hau Giang, Can Tho, Dong Nai,….the trees are planted. Mangoes prefer climates with much sunshine and little rain. However, flowering is rather erratic in the tropics due to variable temperature and rain falling at the wrong time, and high humidity. HoaLoc-mango is extremely sensitive with impacting weather condition, especially is in climate change context. The Mekong Delta (MD) region of Vietnam has been identified as one of the most vulnerable deltas to the impacts of climate change. Agriculture sector are increasingly affected by changes in freshwater supply due to salinity intrusion, flooding, increasing tropical cyclone intensity, and increasing temperatures. This influences directly on Hoaloc-mango farming of producers. Thus, on

November 17, 2017 Government of Vietnam (GOV) issued Resolution 120/NQ-CP on “*Sustainable development of MRD to adapt with climate change”,* which re-affirms that it is critical time for the MD to transform its socio-economic development towards more sustainable and resilient practice, along the lines of that proposed by the Mekong Delta Plan.

Hence, the objective of this study paid particular attention on effective disparities among HoaLoc-mango seasons of year, the economic relationships between inputs and output in mango production, determinants of economic efficiency in Hoaloc- mango production between non-cooperative and cooperative farmer groups. This is especially important in developing countries, where resources are meagre and opportunities for developing and adopting better technologies are dwindling. To identify determinants of economic efficiency in Hoaloc- mango production, it is good solution to adaptation capacity of Hoaloc-mango producers in climate change context impacting on agriculture sector in Vietnam

II. METHODOLOGY

2.1 Sampling Techniques

Firstly, 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. Secondly, the Dong Thap, Tien Giang, Hau Giang, and Vinh Long, provinces were selected because, combined, they account for approximately 61% of the mango production volume and 52% of the mango production volume area in MD [2]. Besides, Dong Nai province of southeastern region was also chosen. Finally, a simple random sampling technique was used to select 184 sample observations of the cooperative farmer group (53, 61 and 70 observations for seasons 1, 2, and 3, respectively), and 230 sample observations of the non-cooperative farmer group (67, 85, and 78 observations for seasons 1, 2, and 3, respectively).

2.2 Empirical Model

The paper applied to the stochastic frontier economic function which assumed the Cobb-Douglas functional form, was employed to determine the economic 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:

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

Where:

Ln = Natural logarithm,

π_i^*= Normalised economic 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),

β_0, $\beta_{1\ldots5}$, and β_k are parameters to be estimated, and represent statistical disturbance terms, and

u_i = economic inefficiency effects of the i-th farmer.

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

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

Where:

$\boldsymbol{u_i}$ = Economic 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 economic 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

In this study, we used data from, four main harvesting seasons in Vietnam, were April – June (natural season), February - April (early season), August - October (off-season), and November - February (late/festival season). The selection of the farming season is determined by the mango farmers. Farming usually takes place over two or three (maximum) seasons/year, as the period of time that has to pass from the flowering stage to the harvest of mangoes is four months.

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 three cases, because the lambda values ($\boldsymbol{\lambda 1}$ = 56.20, $\boldsymbol{\lambda 2}$ = 47.22, and $\boldsymbol{\lambda 6}$= 46.76) 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. In three cases when the lambda values ($\boldsymbol{\lambda 3}$ = 19.42, $\boldsymbol{\lambda 4}$ = 7.60, and $\boldsymbol{\lambda 5}$ = 8.58) were lower than the critical value (32.67) at the 5% significance level, the null hypthesis 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 economic 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	-99.71	-71.61	56.20	21	32.67	Rejected
Season 2	Cobb-Douglas was the best fit	-131.68	-108.07	47.22	21	32.67	Rejected
Season 3	Cobb-Douglas was the best fit	-141.34	-131.63	19.42	21	32.67	Not rejected
Non-cooperative							
Season 1	Cobb-Douglas was the best fit	-142.16	-138.36	7.60	21	32.67	Not rejected
Season 2	Cobb-Douglas was the best fit	-174.46	-170.17	8.58	21	32.67	Not rejected
Season 3	Cobb-Douglas was the best fit	-175.17	-151.79	46.76	21	32.67	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 Maximum likelihood estimates (MLE) analysis of the translog and the Cobb-Douglas production function based on the stochastic frontier economic function for Hoaloc - mango farmers are presented in Table 2. The sigma squares (σ^2) of the cooperative farmer category were 13.46, 21.27, and 40.79 in seasons 1, 2, and 3, respectively. The sigma squares of the non-cooperative farmer category were 23.44, 21.70, and 19.17 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.

Additionally, the gamma parameters of the cooperative farmer group (γ_1=0.9999, γ_2=0.9997, and γ_3=0.9999) were quite high and significant at the 1% of probability level, thereby implying that 99.9% of the variation in seasons 1, 2, and 3 stemmed from the economic efficiency of the sampled farmers rather than from random variability. Analogously, the gamma parameters of the non-cooperative farmer group (γ_1=0.9999, γ_2=0.9999, and γ_3=0.9999) were significant at the 1% level. This proposed that 99.99% of the variation in economic efficiency in seasons 1, 2 and 3 was explained by the given variables.

Table 2- MLE for Hoaloc-mango in Vietnam

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 economic (VND)]						
Constant	-61.891***	5.410***	-57.047***	9.470***	10.797***	56.028***
(X_1) Ln pesticide price (VND/L)	10.851***	0.088*	-1.321	0.364***	0.366***	10.783***
(X_2) Ln fungicide price (VND/L)	14.019***	-0.447***	-16.276***	0.537***	0.786***	10.195***
(X_3) Ln root fertiliser price (VND/kg)	-35.524***	-0.629***	-20.494***	0.619***	0.506***	20.337***
(X_4) Ln leaf feriliser price (VND/kg)	-6.168***	0.321***	-19.973***	-1.243***	0.372***	2.476**
(X_5) Ln labour price (VND/day)	39.755***	0.559***	72.441***	0.059***	-1.977***	-52.916***
(X_6) Ln land area (cong = 1,000m^2)	1.708*	0.768***	12.646**	-0.100***	0.264***	-0.220
½ *Ln $(X1)^2$	-0.270*		-1.792***			-4.015***
½ *Ln $(X2)^2$	-1.685***		-0.225			0.501
½ *Ln $(X3)^2$	-14.504***		-1.695			2.410***
½ *Ln $(X4)^2$	-11.051***		-2.353			4.597***
½ *Ln $(X5)^2$	-36.071***		-40.456***			28.808***
½ *Ln $(X6)^2$	5.138***		-1.501*			-0.804**
Ln (X1)*Ln(X2)	1.323***		0.651*			1.848***
Ln (X1)*Ln(X3)	9.296***		1.177			5.665***
Ln (X1)*Ln(X4)	-11.647***		-2.491***			-2.374***
Ln (X1)*Ln(X5)	2.672***		2.490***			-2.418***
Ln (X1)*Ln(X6)	1.233***		0.160			1.566**
Ln (X2)*Ln(X3)	9.328***		-5.628***			-0.254
Ln (X2)*Ln(X4)	-9.084***		-6.996***			0.077
Ln (X2)*Ln(X5)	2.320***		8.746***			-7.057***
Ln (X2)*Ln(X6)	2.364***		-0.679			2.338***
Ln (X3)*Ln(X4)	1.115***		-4.052***			1.754***
Ln (X3)*Ln(X5)	-3.013***		13.967***			-11.482***
Ln (X3)*Ln(X6)	0.083		2.415			-1.368***
Ln(X4) *Ln(X5)	26.095***		13.641***			-0.799
Ln(X4) *Ln(X6)	-6.891***		4.075***			-0.134
Ln(X5) *Ln(X6)	-4.754***		-5.760***			-2.618***
Diagnostic Statistics						
Sigma square (σ^2)	13.462	23.443	21.273	21.707	40.794	19.172
Gamma (γ)	0.9999***	0.9999***	0.9997***	0.9999***	0.9999***	0.9999***
Log-likelihood function	-71.618	-142.16	-108.07	-174.46	-141.13	-151.79
Number of observations (N)	53	67	61	85	70	78

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 farmer group showed that, in season 1, the coefficients of the pesticide, fungicide, and labour prices, were positive and statistically significant at the 1% level, while the coefficients of the root fertiliser, and leaf fertiliser prices were negative at the 1% significant level. The positive relationship of the pesticide, fungicide, and labour prices with economic suggested that a 1% increase in each of these prices would result in a 10.851%, 14.019%, and 39.755% economic increase, respectively, for Hoaloc-mango growers. The coefficient of the square term for land area was positive and highly significant at the 1% level, thereby suggesting land area was a direct relationship with economic. However, the coefficients of interaction between the pesticide price and the leaf fertiliser price, the fungicide price and the leaf fertiliser price, the root fertiliser price and the labour, the labour price and the land area 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 presented that the coefficients of the leaf fertiliser price, labour price, and land area were positive at the 1%, significance level. The fungicide, and root fertiliser prices coefficients were negative at the significance levels.

In season 2, the fungicide, leaf fertiliser, and root fertiliser prices variables of the cooperative producer category were negative and significant at the 1% level with coefficients of 16.276, 20.494 and 19.973, respectively. Alternatively, a 1% rise in the fungicide, leaf fertiliser, and root fertiliser prices would lead to 16.276%, 20.494% and 19.973% decline, respectively, in the economic incurred by HoaLoc-mango production. Similarly, the coefficients of the square term of the pesticide price and the labour price were negative at the 1% significance level, showing increase of the variable in production was limited to output. Moreover, the coefficients of interaction between the pesticide price and the leaf fertiliser price, the fungicide price and the root fertiliser price, the fungicide price and the leaf fertiliser price, the root fertiliser price and the leaf fertiliser price, the labour 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. By contrast, the coefficients of interaction between the pesticide price and the labour price, the fungicide price and the labour price, the root fertiliser price and the labour price, the leaf fertiliser price and labour price, the leaf fertiliser price and the land area would increase the profit of mango farmers at the 1% significance level. In the non-cooperative producer category, the pesticide, fungicide, root fertiliser, and labor prices variables were positive and significant at the 1% level, with coefficients of 0.364, 0.537, 0,619, and 0.059, respectively. The coefficients of the leaf fertiliser price and land area were negative and significant at the 1% levels, thereby implying that the more higher these prices, the lower the profitof HoaLoc- mango farmers.

In season 3, the pesticide, fungicide, root fertiliser, and leaf fertiliser prices input variables in the cooperative farmer group was positive with coefficients of 0.366, 0.786, 0.506 and 0.372, respectively, at the 1% significance level. The labour price variable was negative and significant at the 1% level with coefficients of 1.977. In the non-cooperative farmer group, the pesticide, fungicide, root fertiliser, and leaf fertiliser prices input variables in the non-cooperative farmer group played important and positive role in HoaLoc-mango production, with high coefficients of 10.783, 10.195, 20.337, and 2.476, respectively, at the 1%, and 5% significance level, as a 1% increase in the pesticide, fungicide, root fertiliser, and leaf fertiliser prices would lead to a 10.783%, 10.195%, 20.337%, and 2.476% rise in the output of HoaLoc-mango gardeners. In addition, the coefficients of the square term for the pesticide price, and the land area exerted a negative influence on the profit of HoaLoc-mango growers, whereas those of the root fertiliser, leaf fertiliser, and labour prices exerted a positive effect. More so, 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 land area, the root fertiliser price and the leaf fertiliser price were positive and significant at the 1% level. On the other hand, 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 labour price, the root fertiliser price and the labour price, the root fertiliser price and the land area, the labor price and the land area had a and negative significant effect on the proit of mango farmers at the 1% significance level.

3.2 Economic Inefficiency Function

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

Table 3- 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	-6.468***	-5.807***	-38.233**	-1.596*	-19.537*	-0.134
(Z_1) Age	-0.216***	0.129**	0.230*	-0.053	0.048	0.119***
(Z_2) Education	-1.976***	0.233	1.131***	0.286*	-0.516*	0.662***
(Z_3) Farming experience	0.815***	-0.040	-0.518***	0.073	0.320**	-0.315***
(Z_4) Credit access	4.042***	-1.265*	21.402***	-11.014***	7.691***	0.526
(Z_5) Payment form for agro- input	6.684***	0.999	-3.592**	3.171***	1.219	1.358*
(Z_6) Wrapping bag	0.717	1.270*	3.582*	-1.005	-3.585*	-0.162
(Z_7) Market access	4.882***	1.011	13.400***	-3.530***	-0.496	-0.024
(Z_8) Classifying sale	1.773**	-0.930	-5.081***	4.188***	-4.976**	-2.119**
(Z_9) Plant density	0.010**	-0.023***	0.010	0.004	0.030**	-0.033***

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 indicated that the age, education variables were statistically significant and positive. The finding of age variable was similar with the results of [5, 6], but it was against with those obtained from the studies of [7-13] and who stated that older farmers had a negative effect on economic efficiency. Furthermore, education had a significantly positive influence on the cooperative farmer profile at the 1% significance level, thereby implying that a lack of education may contribute to economic inefficiency. This result corroborate those of some previous studies [6, 7], [14, 15] in which a statistically significant correlation was obtained between education and EE. However, it differed from those obtained from [16, 17]. Meanwhile, the credit access variable had a negative effect on the EE of the cooperative farmer group. Similar findings were obtained by [7, 15]. However, this variable had a positive effect on the EE of the non-cooperative farmer group. These results corroborate that of [8].

In season 2, the coefficient of farming experience had a significantly positive effect at the 1% level on the cooperative grower group. This meant that if the farming experience of the farmer increased by 10%, the mango economics could increase by 0.518%. The results of this study were consistent with the results of other studies [6, 8], which have suggested a positive relationship between economic efficiency and farming experience. Besides, the credit access variable had a negative effect on the EE of the cooperative farmer group. The result of this study agreed with the results of [7, 15]. However, the same variable had a positive effect on the EE of the non-cooperative farmer group. These results corroborate those of [8].

In season 3, the EE of the non-cooperative farmer group suffered significantly negative effect from the payment form for agro-input wholesaler variable at the 10% significance level. On the other hand, the wrapping bag and classifying sale variables had a significant positive effect on the EE of the cooperative farmer group at the 10%, and 1% level, respectively. The wrapping bag was an important variable in terms of EE. The positive sign of the wrapping bag variable indicated that if farmers use bags to wrap mangoes in production, their economic 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. Furthermore, the coefficient of the classifying sale was positive and significant at the 5% level in both the cooperative and non-cooperative farmer groups, thereby indicating that farmers who sold classified mangoes had higher economics than farmers who sold non-classified mangoes.

3.3 Economic Efficiency Distribution

The result of season 1, indicated that the EE ranged from 0.0000 to 0.9997 with a mean of 0.5571 in the cooperative grower category and from 0.0001 to 0.9970 with a mean of 0.3161 in the non-cooperative grower category. These results suggest that the EE mean of the non-cooperative producer group was lower than that of the cooperative producer group. These results also suggest an economic efficiency gap of approximately 44.29% in the cooperative producer category and 68.39% in the non-cooperative producer category. This implied that the average farmer in the study area could increase their economic by 44.29% and 68.39%, 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 44.27% [(1 – 0.5571/0.9997)*100] and 68.29% [(1 – 0.3161/0.9970)*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 100.00% [(1 – 0.0000/0.9997)*100] and 100.00% [(1 – 0.0000/0.9970)*100], respectively, to become the least efficient mango grower in Vietnam.

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	26.42	37.31	37.70	51.76	37.14	42.31
0.1-<0.2	7.55	7.46	8.20	10.59	15.71	5.13
0.2-<0.3	1.89	16.42	3.28	10.59	8.57	5.13
0.3-<0.4	3.77	5.97	1.64	7.06	5.71	2.56
0.4-<0.5	1.89	5.97	0.00	1.18	8.57	2.56
0.5-<0.6	3.77	7.46	1.64	3.53	4.29	6.41
0.6-<0.7	7.55	1.49	1.64	2.35	2.86	2.56
0.7-<0.8	3.77	0.00	4.92	1.18	1.43	2.56
0.8-<0.9	11.32	4.48	36.07	3.53	2.86	1.28
0.9-<1.0	32.08	13.43	4.92	8.24	12.86	29.49
1.0	0.00	0.00	0.00	0.00	0.00	0.00
Observations (N)	53	67	61	85	70	78
Minimum	0.0000	0.0001	0.0000	0.0001	0.0001	0.0000
Maximum	0.9997	0.9970	0.9504	0.9991	0.9988	0.9995
Mean	0.5571	0.3161	0.4457	0.2437	0.3098	0.4214
Std. deviation	0.4062	0.3403	0.4063	0.3158	0.3332	0.4260

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 0.9504, with a mean economic efficiency of 0.4457, and that of the non-cooperative farmer group that ranged between 0.0001 and 0.9991 with a mean EE of 0.2437. 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 0.4457 and 0.2437 suggest that an average mango farmer of the cooperative and non-cooperative farmer groups, respectively, in Vietnam, had the capacity to increase their EE in terms of mango production by 55.43% and 75.63%, 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 53.10% [(1 – 0.4457/0.9504)*100] and 75.60% [(1 – 0.2437/0.9991)*100], respectively. In addition, the least efficient farmers of the cooperative and non-cooperative farmer groups experience a boost of 100.00% [(1 – 0.0000/0.9504)*100] and 99.99% [(1 – 0.0001/0.9991)*100] respectively, in their EE.

In season 3, our results showed that the EE mean of the cooperative grower group (30.98%) was less than that of the non-cooperative grower group (42.14%). 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 68.98% [(1 – 0.3098/0.9988)*100] and 57.83% [(1 – 0.4214/0.9995)*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 – 0.000/0.9988)*100] and 100.00% [(1 – 0.0000/0.9995)*100], respectively.

IV. CONCLUSIONS

The result pointed out that the mean EE of the cooperative farmer group was greater than that of the non-cooperative farmer group in seasons 1, and 2, and less than in season 3. Certain adjustments in the input factors could increase the profit of Hoaloc-mango farmers in Vietnam.

Overall, the positive determinants of the economic efficiency of the cooperative farmer group were age, and education in season 1, credit access in seasons 2, and wrapping bag and classifying sale in season 3, while the negative factors were farming experience, credit access, payment for the agro-input wholesaler, market access, classifying sale, plant density in season 1, age, education, credit access, wrapping bag, market access in season 2, and farming experience, credit access, and plant density in season 3. The positive determinants of EE in the non-cooperative farmer group were credit access, and plant density in seasons 1, credit access, and market access in season 2, and farming experience, classifying sale, and plant density in season 3. By contrast, the negative determinants of EE of non-cooperative farmer group were age, wrapping bag in season 1, education, farming experience, and classifying sale in season 2, and age, education, and payment for the agro-input wholesaler in season 3.

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