European Journal of Business and Management
ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online)
Vol.10, No.35, 2018

Impact of Farmers' Adoption of Good Agricultural Products on Total Factor Productivity Change: The Case of Grape and Apple Production in Vietnam

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Abstract
Development of agricultural production with Good Agricultural Practices (GAP) standards is an objective trend of sustainable agriculture. This research employed data envelopment analysis (DEA) and ordinary least square (OLS) Regression to quantify impact of farmers' adoption of GAP on the Total Factor Productivity Change (TFPCH) in investment in grape and apple production in Ninh Thuan of Vietnam. The results show that farmers' adoption of GAP positively influenced on increase on total factor productivity. Therefore, it is necessary to find-out solutions to speed up farmers' investment in development of agriculture with GAP standards.
Keywords: GAP, TFPCH, impact, farmer household, Vietnam

1. Introduction

Good agricultural practices (GAP) associated with satisfying customers' product standards are very nessesary for Vietnam to penetrate global agricutural market and bring more benefits to farmers. Agricultural production with GAP standards ensures safety for comsumers, producers and also protects rural environment.

Ninh Thuan is one of the farming provinces in Vietnam in grape and apple products. Farmer households in Ninh Thuan started adoption of GAP standards in production of these products since 2013. In addition to initial achievements of expanded cultivation area and increased goodwill of these products, there are still difficulties and limitations in increase of production scale and market development.

The study aims to investigate impact of GAP adoption on TFPCH in farmer households' investment in agricultural production by using two main methods of DEA and OLS, in order to provide farmers and state managers with objective view of real benefits of GAP adoption.

2. Literature Review

According to Holleran et al. (1999), incentives based on that production units invest in measures to control food safety have originated from both in-side producers and out-side customers and governmental regulations. Sharing this point of view. Reardon and Farina (2001) stated a food producer can have advantage over its competitors through applying techniques to enhance food safety. Studies of Wannamolee (2008), Mushobozi (2010), Jiao et al. (2010), Henson & Northen (1998) show that partners with-in agricultural supply chain including producers, distributors as well as consumers play very important roles in encouraging application of food safety standards in which GAP is generally basic one.

Hobbs (2003) argued that benefits of GAP can divide in two aspects. The first one is to reduce farmers' production costs by effective use of labors, reasonable selection of inputs and application of good methods. In a case-study of Kenya, GAP help reduce significantly costs of vegetable production. This production method contributes to improve production effectiveness in terms of economic, social and environmental aspects. GAP help farmers control production costs by applying appropriate farming techniques. The second one is to contribute to increase selling prices of agricultural products. GAP is to help enhance product quality, thus, GAP's products can penetrate markets with higher standards. However, when supply of GAP products increased, risk of reduced prices is unavoidable.

In order to ensure strictly standards of GAP, it is necessary to have significantly invest in technical training on production, processing, selections of inputs (seed/seedlings, fertilizers, etc.) as well as in getting regularly certification of quality audits (Graffham et al., 2007; Okello & Swinton, 2007). These impact on production efficiency in the case that outputs achieved is not proportionally. As the result, this make difficulty for small farmers and facilitate sized enterprises in agricultural production with GAP standards, as examples in Kenya (Asfaw, 2007; Graffham, 2006; Graffham et al., 2007) and Uganda (Kleih et al., 2007). However, higher effectiveness of investment in agriculture with GAP have stimulated small farmers to adopt GAP. To be able to protect themselves from competition with enterprises, many small farmers have co-operated each other to set up an organization of agricultural production with GAP standards and have succeeded, as in Zimbabwe (Henson et

al., 2005) and in Madagascar (Minton et al., 2007), or made linkages between small farmers and enterprises as in several projects of EurepGAP in Zambia (Graffham & MacGregor, 2007).

Using the index of Total Factor Productivity Change (TFPCH) as index of Malmquist in Data Envelopment Analysis (DEA) to measure efficiency of development investment have been carried out by many authors, especially in agricultural investment, such as Mao and Koo, 1997; Lin, 1992; Fan and Pardey, 1997; Jin et al., 2002; Chen el al., 2008, Fan & Zhan, 2002. These studies used different input and output indexes to measure TFPCH index, for example, Lin (1992) used 4 normal inputs and 6 supplement variables, Fan and Pardey (1997) used 5 normal input variables and 2 supplement variables, main input factors used by these authors were based on Cobb-Douglas production function.

Researches of Fan & Pardey (1997) have stated that change in production techniques lead to significant change in the Total Factor Productivity. Fan et al. (2004) in his study also showed that increase of R & D in agriculture, rural education and infrastructure by supports from Government would contribute to increase of Total Factor Productivity of agriculture. Thus, it is said that farmers' adoption in development of agriculture with GAP would make changes in production techniques, infrastructure, knowledge of production, etc. These would significantly impact on TFPCH.

2. Research Methodology

2.1. Research Site

Ninh Thuan is a province of coastal south-central area of Vietnam. There are some favourable conditions for development of agricuture following GAP standards especially grape and apple plantation, such as appropiate climate for cultivating grape and apple; most farmers with long-time experiences of these fruit plantations. At the year of 2016 Ninh Thuan ranked the third province in number of farmer groups that have invested in developing grape and apple productions following VietGAP standards, with grape area of 280 ha and apple area of 47.2 ha. However, there are several diffiçuties in sustainable agriculture development here namely poor livelihoods, low education levels and limited capital sources of farmers, having located far from economic centers and big cities. Having solved these barries would make theoretical and practical constributions to GAP agriculture in developing countries generally and in Vietnam particularly.

2.2. Data Collection

Data in this research was gathered through surveying 200 farmer households in Ninh Thuan province wih using structured questionaires.

Primary data was collected using ramdom and leveling methods in Ninh Thuan with sample sise of 200 farmer households in which 100 households cultivating with VietGAP standards who represented for 88 GAP linkage groups of farmers and 100 farmer households with-out VietGAP agricultural prodution. Leveling was based on terms of locations and linkage groups. There are total 88 GAP linkage groups of farmers in Ninh Thuan province (Vietgap.com.vn) with total 1.272 farmer housekols, in which 27 groups at Phan Rang - Thap Cham city, 26 groups in Ninh Hai district, 20 groups in Ninh Phuoc district, 10 groups in Ninh Son district and 5 groups in Thuan Nam district. The research based on sizes of linkage groups of farmers to select farmer groups for survey, after that, seleted randomly households in the surveyed groups of farmers.

2.3. Processing Techniques

According to DEA, the ML (Malmquist) formula to calculate TFPCH can be decomposed into two components: technical change and efficiency change (Grosskopf et al., 1994). The efficiency change can further be decomposed into pure efficiency change and scale efficiency change. The "technical change" component measures the shift in the frontier over time and can be interpreted as providing evidence of innovation for the province considered. The "pure efficiency change" component measures the extent to which observed production is moving toward (or away from) the frontier, which is constructed by the best practice provinces based on the variable returns to scales (VRS) technology. The pure efficiency change component, therefore, captures the performance relative to the best practice in the sample and can be interpreted as the catching-up effect. The "scale efficiency" in a given period captures the deviations between the VRS technology and the CRS technology at observed input levels. So the TFPCH formula can be written as below:

$$TFPCH = (TECH) \times (EFFI) = (TECH) \times (PUREFF) \times (SCAL)$$

where $TECH = \left[\frac{d_c^t\left(x^{t+1}, y^{t+1}\right)}{d_c^{t+1}\left(x^{t+1}, y^{t+1}\right)} \times \frac{d_c^t\left(x^t, y^t\right)}{d_c^{t+1}\left(x^t, y^t\right)} \right]^{1/2}$,

$$EFFI = \frac{d_c^{t+1}\left(x^{t+1}, y^{t+1}\right)}{d_c^{t}\left(x^{t}, y^{t}\right)},$$

$$PUREFF = \frac{d_v^{t+1}\left(x^{t+1}, y^{t+1}\right)}{d_v^{t}\left(x^{t}, y^{t}\right)}, \text{ and}$$

$$SCAL = \frac{\dfrac{d_c^{t+1}\left(x^{t+1}, y^{t+1}\right)}{d_v^{t+1}\left(x^{t+1}, y^{t+1}\right)}}{\dfrac{d_c^{t}\left(x^{t}, y^{t}\right)}{d_v^{t}\left(x^{t}, y^{t}\right)}}.$$

This research employs the method of Data Envelopment Analysis (DEA) for criteria of maximizing Variable Returns to Scales (VRS) to measure Total Factor Productivity Change (TFPCH). According to Cobb-Douglass production function, outputs depend on four factors of capital, labour, natural resources and technology. The research uses four input factors namely annual production costs/1,000m^2/year, initial investment costs/1,000m^2, number of labour and cultivating area, and three outputs namely average yield/1,000m^2/year, average profit/1,000m^2/year & average revenue/1,000m^2/year to measure total efficiency.

The research uses Ordinary Least Square (OLS) regression to quantify impact of GAP participation/adoption on total efficiency of farmer households' investment in agricultural development, as model: TE = f(GAP, Ivo, Acr, L, Pro, Exp, Know, Infras).

First, identify input variables including investment capital, production costs, cultivating area and number of labour basing on Cobb-Douglass production function, results from calculating total factor productivity changes show that input factors often negatively impact on total efficiency.

Second, average profit is an output variable that have direct impact on investment efficiency, results from calculating total factor productivity changes show that output variables often positively impact on total efficiency.

Third, GAP: according to Hobbs (2003), adoption of GAP have positively impacted on investment efficiency due to efficient use of labour, appropriate selection of inputs and application of good management. Moreover, technical change through GAP have also influenced significantly on TFPCH (Fan & Pardey, 1997; Fan et al., 2004).

Fourth, control variable: Efficiency of investment in agricultural development with GAP depends on infrastructure (World Bank, 2007; Mai & Dang, 2013), characteristics of farmer household namely farmer's knowledge of GAP and production experience (Janvry and Sadoulet, 2000; World Bank, 2007; Mai & Dang, 2013); the qualitative study has also the same results that main part of surveyed households agreed that efficiency of investment in grape and apple cultivation have been clearly impacted by weather, especially in grape cultivation.

3. Results and Discussions

3.1. Descriptive Statistics of Variables

Results from DEA as following:

Table 1: Total Efficiency TE as results of DEA

Variables	Group of households with-out GAP adoption			Group of households with GAP adoption		
	Mean	Max	Min	Mean	Max	Min
TFPCH	0.8576	1.2037	0.6472	0.9771	1.4493	0.7449
EFFI	0.926	1.1206	0.7425	0.9791	1.2553	0.7799
TECH	0.9234	1.1206	0.8204	0.9959	1.3333	0.8563

Table 1 shows that there is no increase in the total factor productivity at the after- GAP adoption compared with before-GAP adoption for both groups of households. In detail, analysis of VRS with a data envelopment shows that change in TFPCH of 0.9771 for group of farmer households adopting GAP demonstrated that TFP at after-GAP adoption reduced 2.29% in comparison with before-GAP adoption, however, still less than the reduction of 14.24% in TFP for group of farmer households without GAP adoption.

Table 2: Differences of 2 household groups in TFPCH by Malmquist index in 2016

No.	Indicator	Difference	
		Xi (GAP=1) - Xi (GAP=0)	Sig.
1	TFPCH	0.1195	.000

Comparison between the two groups shows that group with GAP adoption has higher TFPCH than group

without GAP adoption with significant level 99% in analysis of VRS using a data envelopment of 11.95%. This indicates that GAP adoption have positive impact on improvement of TFP of famers investing in grape and apple cultivation in Ninh Thuan province.

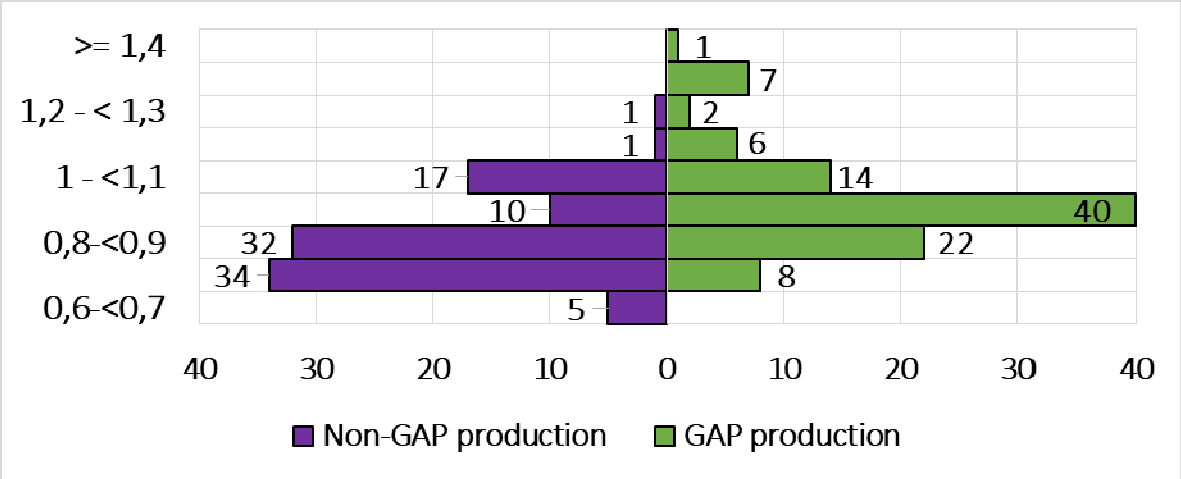

Figure 1: Changes in TFP of household groups with and without GAP adoption in 2016

The above map gives the same conclusion on differences between the two groups. The group with GAP adoption has more change in TFP at high TFPCH level and less change in TFP at low TFPCH level.

3.2. Verification of Conformity of the Model

Explanations of the model is verified in the Table 3 below:

Table 3: Verification of Explanations of the Model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.819[a]	.671	.658	.088348122491973

a. Predictors: (Constant), GAP, LnExp, Infras, LnL, LnAcr, Know, LnPro, LnIvo

Result of verification of conformity of the model showed adjusted R2 =0,658. This means 65.8% of change in investment capital is explained by independent variables.

Table 4: Verification of Conformity of the Model

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.047	8	.381	48.790	.000[b]
	Residual	1.491	191	.008		
	Total	4.537	199			

a. Dependent Variable: TFPCH

b. Predictors: (Constant), GAP, LnExp, Infras, LnL, LnAcr, Know, LnPro, LnIvo

Verification Tests of Model Coefficients Omnibus in table 2 result Sig. = 0.000 <0.01. So can reject the null hypothesis $\beta 1 = \beta 2 = ... = \beta 8$. Thus, the 99% significance level can conclude regression model was fit.

3.3. Impact of determinants on decision to invest in developing agricultural production of farmers GAP

The model regression is run and gives the results presented in Table 5 below:

Table 5: The Models' Regression Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.577	.320		4.922	.000		
	Infras	-.023	.008	-.119	-2.691	.008	.886	1.129
	Know	-.016	.007	-.130	-2.127	.035	.462	2.166
	LnExp	.040	.012	.154	3.416	.001	.843	1.186
	LnL	-.255	.021	-.553	-12.203	.000	.838	1.193
	LnAcr	-.092	.012	-.351	-7.614	.000	.811	1.233
	LnPro	.300	.038	.519	7.993	.000	.409	2.447
	LnIvo	-.341	.073	-.312	-4.641	.000	.379	2.635
	GAP	.193	.026	.641	7.453	.000	.233	4.296

a. Dependent Variable: TFPCH

The regresion result showed 5 variables impact negatively on TFPCH with significance 95%, in which number of household labour have strongest impact, total area of cultivation and lately investment capital. This indicated that increase in input resources have strong impacts on investment efficiency. Besides, average profit and experience of household head impact positively on investment efficiency with significance 99%.

Especially, adoption of (or participation in) GAP has positively on efficiency of farmer households' investment in agricultural development. If other factors are constant, farmer households' adoption of (or participation in) GAP will increase TFPCH 0.641 with significance 99%. This result support to points of view of Hobbs (2003), Fan and Pardey (1997) and Fan et al. (2004).

4. Conclusion

Development of agricultural production with GAP is an objective trend of sustainable agriculture. The study basing on data of 200 farmer households cultivating grape and apple stated that adoption of GAP has positively impacted on TFPCH, and this result supports to points of view of Hobbs (2003), Fan and Pardey (1997) and Fan et al. (2004). However, increase in TFP (compared with TFP before adoption of GAP) is still under potential. The reason for this may be application of GAP have not get results as expected. Thus, it is necessary to find out appropriate solutions to speed up agricultural production with GAP in terms of both quantity and quality.

In our point of view, it is necessary to implement following solutions as below:

(i) Planning and organizing areas of safety agricultural production that are appropriate to each local province. This will create conditions and orientations for famer household to invest in agricultural production with different GAP standards driven by market demands.

(ii) Enhancing knowledge and skills of GAP production for famer households. This help them understand efficiency of adoption of GAP and know how to invest in agricultural production with GAP standards.

(iii) Developing markets for agricultural products certified GAP standards. This is the crucial condition to ensure sustainability of adoption of investing in GAP of famer households.

(iv) Implementing linkages between 4 shareholders of farmers, firm state managers and scientists. In development of GAP agriculture, small famers could not do themselves separately. Positive participation of related shareholders is very important for development of GAP agriculture.

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