Research article

Determinants of Good Agricultural Practices (GAP) Adoption in the Chili Production System in Northeastern Thailand: A Case of Participatory Approach

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Abstract A participatory research approach has been conceptually proposed as an effective method for introducting knowledge-intensive technologies. This approach was adopted for the promotion of Good Agricultural Practice (GAP) in the chili production system in Thailand. However, some farmers still use conventional practices that often result in an overuse of chemicals. This study projected the impact of participation and improved knowledge of farmers, which can encourage the program adoption. Other conventional factors such as farming characteristics were also considered. Research was carried out involving 179 chili farmers both participants and non-participants in the GAP program located in the Northeastern part of Thailand. A treatment effect model was used in the identification of factors affecting the program adoption. Results showed a significant effect on program participation and farmer's knowledge that was the precursor of adoption. Farmers' experience in chili production significantly affected adoption. Age was a negative determinant of adoption. The conclusion can be drawn that adoption of knowledge-intensive technologies such as GAP needs an effective approach such as the participatory research program, which can improve farmers' knowledge and encourage them to adopt innovative technologies. This approach allows farmers to learn from the experience of other farmers.

Keywords chili production, knowledge intensive technologies, treatment effect model

INTRODUCTION

The participatory research approach program has been developed to overcome the hierarchical structure of the training and visit system (Krasuaythong, 2008). Hussain, et al. (1993) had confirmed that the adoption did not live up to its expectations seven years after the introduction of the extension program using the training and visit approach. Therefore, the participatory research approach was adopted as an effective way to transfer innovation, particularly for knowledge-intensive technologies (Feder, et al., 2003). It also has been adopted as the introduction of good agricultural practices (GAP) for Thai farmers. The objective of the GAP program is to reduce the use of pesticides, and increase the production and marketing standards of agricultural commodities. It has been firstly applied in rice, vegetable, and fruit production systems; especially in the areas where most farmers grow in commercial enterprises with high level usage of pesticides.

Chili is among the vegetable commodities, playing a major role as an important ingredient in Thai cooking. Also, it is a high value crop providing a major source of income for small scale farmers in Thailand. However, chili farmers in Thailand have overused pesticides both pre and post-harvest, to control pests and diseases (Pak-Uthai, 2010). This still occurs even though several organizations have been introducing practices that rely less on the use of pesticides and were more benign for the environment and human health. Adoption of GAP seems to be at a very low scale.

Recently, chili exported from Thailand was banned from European countries, because it was found to be contaminated with banned pesticides (Ariesen, 2011).

Adoption of innovation was a complex issue. Many factors were identified as determinants of adoption of innovation. Among those factors, the farmers' knowledge was important to the adoption of new technologies, particularly knowledge-intensive technologies (Krasuaythong, 2008). The result of Krasuaythong (2008) was consistent with the suggestion of several studies, which stated that producers with more knowledge will increase the probability of technology adoption (Praneetvatakul et al., 2007; Waibel and Zilberman, 2007). However, this was not clear for the case of GAP adoption in chili production. The objective of this paper, therefore, was to determine the factors that affect the adoption of GAP. The results of this research thus can guide policy makers in developing strategies suitable to achieve a more rapid and efficient introduction of such practices.

DATA COLLECTION

The Thailand Research Fund (TRF) is a non-government organization that provided the budget for Khon Kaen University to develop the GAP program in chili production system to farmers in the Chaiyaphum province of Northern Thailand. This paper is a part of that research. Purposive sampling was used for the selection of the study area. A multistate sampling technique was used for data collection. The first stage consisted of the selection of four districts. In the second stage, simple random sampling was used for the selection of a sub-district and, subsequently, a village. Stratified random sampling was involved in the final stage. Farmers were divided into two stratums, namely those participating in the GAP program, and those who were not participating in the program. Each farmer was interviewed to determine the socio-economic characteristics of their household by using a structured questionnaire. A total of 200 farmers were interviewed, but only 179 questionnaires were completed.

SPECIFICATION OF THE EMPIRICAL MODEL

A matrix $\mathbf{z}$ demonstrated the factors affecting the farmers' decision to participate in the program, and $\mathbf{p}$ was a vector of two parameters for participation and non-participation. The expected utility of farmers was measured through their decision making, and was formulated as a dummy variable P. It was identified as 1 if farmers participated in the program and 0 otherwise. The probability of farmers' decision for participation in the program was derived as Eq. (1).

$$\begin{aligned} Prob(y_{i=1}/z) &= Prob(U_1 - U_0 > e_1 - e_0) \\ &= F(\mathbf{p_i} \times \mathbf{z}) \end{aligned} \tag{1}$$

Green (1997) stated that $F(\mathbf{p}_i \times \mathbf{z})$ was the cumulative distribution function for a random disturbance term, or the error term (e_i). The distribution of this term proposed the functional form of $F(\mathbf{p}_i \times \mathbf{z})$, which can be of logistic distribution or a normal distribution. In this study, a probit model was adopted, because this assumption was more efficient for the treatment effect model (Hechkman, 1979). Notation Φ is normally distributed with a mean and zero unit of variance, and $(\mathbf{p}_i \times \mathbf{z})$ was called as the probit score.

$$Prob(y_{i=1}/z) = \Phi(\mathbf{p}'_\mathbf{i} \times \mathbf{z}) \tag{2}$$

Estimation of Eq. (2), a nonlinear maximum likelihood was used and the functional form was derived as Eq. (3).

$$\ln L = \sum_{y_i=0} \ln 1 - \Phi(\mathbf{p}'_i \times \mathbf{z}) + \sum_{y_i=1} \ln\Phi(\mathbf{p}'_i \times \mathbf{z}) \tag{3}$$

However, in practice; farmers who decided to participate in the GAP program are not randomly selected. It implies that factors affecting the farmers' decision to participate in the GAP program also determine the adoption of GAP, which means that the direction of causality obtained by simple regression can be biased. To cope with these biases, the treatment effect model developed by Heckman (1979) was used. This model assumes that the unobserved variables (ε) of the utility function parameter of adoption are correlated with the unobserved variables affecting the farmer's decision to participate in the program (e), but not with the factors (X) determining the value of parameters (Heckman, 1979). Therefore the conditional expected value of the utility function observed when individual farmers decide to adopt GAP can be represented as Eq. (4).

$$E(ADOPT \mid participation = 1, X, z) = P \times \gamma + X \times \boldsymbol{\beta} + \rho \times \sigma_{parameter} \cdot [\, -\Phi(\mathbf{z} \times \mathbf{p}) / (1 - \Phi(\mathbf{z} \times \mathbf{p}))\,] \quad (4)$$

$\sigma_{parameter}$ is the standard deviation of the utility function, and ρ is the correlation between the unobservable independent variables (ε, e) . $\mathbf{z}$ is the vector determining the farmer's decision to participate in the program, $\mathbf{p}$ is an unknown parameter, and $\Phi(.)$ is normally distributed with a zero mean and unit variance. The final term in the brackets is the inverse mill ratio (IMR) that represents a correlation between ε and e . The Hypothesis for testing this correlation was carried out using chi-square. If there was no correlation between those terms, the formulation was reduced to a multiple linear regression model.

DESCRIPTION VARIABLES

The adoption variable was a dependent variable, and identified by the cumulative practices which the farmers adopted. The GAP introduced by the researcher was a set of practices. It contained 17 practices in total. During the survey, chili farmers were asked whether they have knowledge, and in-depth understanding about these practices or not. Also, they were asked to identify many practices they adopted, non-adopted, and dis-adopted. The independent variable used in the treatment effect model contained five variables including participation, knowledge, asset, land-labor, and meeting (Table 1).

The *participation* variable was expressed as a dummy variable, and was used as a proxy of a major source of knowledge for farmers who participated in the GAP program. It was expected to have a positive and direct effect on practice scores. The *meeting variable* was the number of meetings with neighbors. The knowledge scores, measured from a number of in-depth practices, determined the farmers' understanding. This factor encouraged farmers to adopt new technologies.

Table 1 Description of dependent and independent variables

Variables	Variable type	Expected sign	Description
Dependent variable Adoption	Continuous		Practice score that is the cumulative total of GAP practices applied in chili production system.
Independent variable			
Participation	Dummy	+	1=if farmers participated in GAP program; 0=otherwise.
Knowledge	Continuous	+	Farmers' knowledge scores.
Meeting	Continuous	+	Number of farmers meeting with neighbors and discussing chili production practices.
Asset	Continuous	+	Value of farmers' asset.
Land-labor	Continuous	-	The ratio of household labor working full time on chili production to total land area (manday/rai*).
Age	Continuous	-	Farmers' age (years).

Note: 1 ha = 6.25 rai

The variable *asset* expressed the wealth of the farmers, and was expected to increase with the number of practices adopted by farmers. *Age* was expected to have a negative effect on adoption. In this paper, the *land-labor* variable was the land to labor ratio. It was used as a farm resource, as endowments use neither farm household labor nor land size. Gebresekassie and Sanders (2006) pointed out that farmers with a larger farm size tend to be more likely to adopt new technologies, but Feder et al. (2003) argued that small scale farmers were more likely to adopt labor intensive technologies. In this study, the set of practices promoted by the GAP program were suggested as labor-intensive technologies (Pak-Uthai, 2010).

RESULTS

Table 2 shows results obtained from the descriptive statistics of variables used in the model. Statistical analysis using the t-test showed significant differences between participants and non-participants, except *asset, meeting* and *age*. A correlation matrix was carried out between knowledge and program participation. This may bring to light the problem of multi-co-linearity.

Table 2 Descriptive statistics of variables used in the model

Variable	Mean		All samples
	Participants	Non-participants	
Practices	12.12***	3.99	8.11
Participation [1]	49.72%	50.28%	100.00
Knowledge	14.61***	5.81	10.23
Meeting	8.14^{ns}	5.97	7.06
Asset (Thai Baht; 30 Thai Baht =$1)	14,026.50	57,747.98	,674.17
Land-labor	5.29***	7.92	6.59
Age	50.00^{ns}	48.89	49.46
N	90	89	179

Note: [1/] *Percentage of total farmers*
[2/] **Significant at the level 0.1 **Significant at the level 0.05; ***Significant at the level 0.04*

Table 3 Correlation matrix of independent variables

Variable	Part	knowledge	meeting	asset	land-labor	Age
Participation	1					
Knowledge	0.56	1				
Meeting	0.09	0.14	1			
Asset	-0.32	-0.15	-0.01	1		
Land-labor	-0.23	-0.05	0.0009	0.17	1	
Age	0.08	-0.11	-0.06	0.05	0.09	1

Table 4 Determinants of GAP adoption estimated by treatment effect model

Variables	Coefficient	Standard error	Z	P-value
Constant	0.72388	1.35430	0.53	0.593
Participation	14.35064	1.05897	13.55	0
Knowledge	0.22935	0.05896	3.89	0
Asset	-0.01795	0.01390	-1.29	0.196
Meeting	0.00001	0.00000	4.34	0
Land to labor ratio	-0.27156	0.41812	-0.65	0.516
Age	-0.04460	0.02114	-2.11	0.035
Wald chi^2			978.40***	
Log likelihood			-526.963	
Test of selection bias (IMR)			Chi^2 = 14.56***	

Note: [1/] **Significant at the level 0.1 **Significant at the level 0.05; ***Significant at the level 0.04*

Table 3 shows a non-correlation between knowledge and program participation. Results obtained from the treatment effect model showed that the estimated model had selection biased problems, because the null hypothesis was rejected (IMR≠0). Therefore, they were appropriate for identification of factors determining adoption of GAP (Table 4).

The *participation* and *knowledge* variables have had a significant effect on the number of practices (measured by practice scores) with a high level of significance. However, the magnitude of *participation* was greater than that of the *knowledge* variable. This suggests that participation in the GAP program that applied the concept of a participatory research approach was more pronounced in adoption of knowledge intensive-technologies such as GAP. During participation, farmers can gather information and exchange their experience with other farmers. This can affect the farmers' decision making about whether to adopt GAP practices. The *meeting* variable that used as a proxy of social network increase the number of GAP practices adopted by farmers, as farmers can learn from the experience of others (Foster and Rosenzweg, 1995). Therefore, farmers who were non-participants were able to adopt some practices gained from those neighbors who participated in GAP program. Richer farmers were more likely to adopt an increased number of practices, because they were more inclined to experiment with new technologies (Krasuaythong, 2008). This was supported by the study of Jayasinghe-Mudalige and Weersink (2004). They pointed out that rich farmers tend to adopt as many environmental management practices as possible. However, this study showed it significantly affected GAP adoption. The younger farmers tended to adopt more practice in the set of GAP. They opened their minds to innovation and tried to gather more information as well as improving their knowledge.

Results of this paper support findings in several publications, which stated that program participation has a direct effect on adoption of GAP (Krasuaythong, 2008). Moreover, the process of knowledge gathering was a major factor affecting adoption of technologies that related to natural resource management (Waibel and Zilberman, 2007). However, adoption of knowledge-intensive technologies depended upon other factors as well. Farmers' risk attitude and their behavior were also suggested from the study of Krasuaythong (2008).

CONCLUSION

This study aimed at identifying factor affecting adoption of GAP. The treatment effect model was applied. The results finding in this were similar to many publications. Farmers' characteristics such as age and wealth play a major role in determining the adoption of technologies. An important finding drawn from this paper was that using the participatory research approach can be an effective tool to enhance farmers' knowledge and increase the rate of adoption. In this case, it was measured by the number of practices being adopted from the set of GAP. However, practices may have different levels of complexity. This may suggest one reason for non-adoption or ceasing a practice. Additionally, other factors such as farmers' risk attitude and behavior should be involved in the adoption model as they may affect adoption of innovation. This paper does not discuss these issues, and is therefore recommended for further study.

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