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# An Adoption of Compound Biological Products on Highland Cultivation in The Northern, Thailand

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***Abstract*— The study is aimed at estimating and explaining the parameters of the adoption process of compound biological products on highland cultivation in the northern, Thailand. In this study, a conceptual framework was developed for the decision to adopt or not to adopt and econometric analyses of the diffusion process are presented using logit model. Empirical data were collected from 97 farmers via questionnaires. The results of a logit model showed that age of household head, household income, households' debt and households' access to public extension services were significantly associated with decisions to adopt the compound biological products using for highland cultivation.**

***Keywords*— Adoption; Compound Biological Product; Highland Cultivation; Northern; Thailand**

## I. INTRODUCTION

In the past, the highlands agriculture of northern Thailand are mostly chemicals farming that cause of various effects not only farmers but the environment also, such as illnesses, land degradation, the toxic residues in agricultural products and cost increasing from high price of chemicals using. Thus, the agriculture sector in northern Thailand is the most important sector in terms of sustaining growth and reducing poverty. However, a lack of adequate nutrient supply, the depletion of organic matter in soils, and soil erosion are major obstacles to sustainable improvements in agricultural production.

From the above reasons, the government has been encouraging farmers to change from chemical to organic farming. The campaign encourages organic farming can be done by providing training to educate farmers in the area. Therefore, the present study was carried out to investigate factors that influence the adoption of the adoption process of compound biological products on highland cultivation in the northern, Thailand.

## II. METHODOLOGY

### *A. Conceptual Framework*

Adoption models are generally based on the theory that farmers make decisions in order to maximize their expected profits or utility. On the other hand, farmers' utility is dependent on optimizing productivity and minimizing the costs of cultivation to attain maximum profits. Feder et al. [1] stated that farmers adopt or practice new technologies when they expect a more profitable outcome than that gained from existing technology. Optimizing utility may also include considerations such as health benefits, environmental concerns, food security and risk [2].

Several studies have suggested that the determinants of the adoption of organic production systems should be explained. Various research approaches have been used for this purpose: Adoption of Organic Farming Techniques: Evidence from a Semi-Arid Region of Ethiopia, using the multinomial logit model [3]; Determinants of adoption decisions: The case of organic farming (OF) in Bangladesh using the logit regression model [4]; The adoption of organic rice farming in northeastern Thailand using the Cox model [5]; Factors influencing the adoption of organic farming by the farmers using the correlation [6]; Adoption and extent of organic vegetable farming in Mahasarakham province, Thailand using the Logistic Regression [7].

### *B. Empirical model*

Empirical model specification: The data in which the empirical model is based were drawn from a sample size of 97 farmers on highland in Chiang Mai province, Thailand, using a stratified random sampling technique. Structured questionnaire was used to solicit information from the respondents. The dependent variable was dichotomized with a value of 1 if a farmer was an adopter of compound biological products cultivation and 0 if otherwise. The explanatory variables were the farm size, household income,

age of household head, education level, number of family member, households' debt and households' access to public extension services. The definitions and measurement of variables as well as sample characteristics are presented in Table 1. The probability of compound biological products cultivation (ADT) is specified as a function of economic and social factors. It is represented as follows:

$$ADT = \alpha + \beta_1 FAR + \beta_2 INC + \beta_3 AGE + \beta_4 EDU + \beta_5 FAM + \beta_6 DEBT + \beta_7 ACC + \varepsilon \quad (1)$$

The categorization of firms into "adopters" and "non-adopters" is based on the dichotomous outcome of the adoption decision, which characterizes the dependent variable (ADT). Thus, a firm is defined as an "adopter" where ADT = 1 or as a "non-adopter" where ADT = 0 [8]. For this purpose probit and logit analysis are well established approach. In many of the adoption behaviour, the dependent variable is constrained to lie between 0 and 1 and the models used were exponential functions while univariate and multivariate logit and probit models including their modified forms have been used extensively to study the adoption behaviour of farmers and consumers. Shekya and Flinn [9] have recommended probit model for functional forms with limited dependent variables that are continuous between 0 and 1 and logit models for discrete dependent variables. In this study, the responses recorded are discrete (mutually exclusive and exhaustive) and therefore, a univariate logit model was developed to analysed the adoption behaviour of farmers to compound biological products cultivation. The logit model, which is based on cumulative logistic probability functions, is computational easier to use than other types of model and it also has the advantage to predict the probability of farmers adopting the compound biological products agricultural production practices.

TABLE 1
DESCRIPTION OF THE MODEL VARIABLES.

| Variable | Type | Measurement |
|---|---|---|
| Dependent | | |
| Adoption (ADT) | Dummy | 1 if farmer was an adopter of compound biological products on cultivation, otherwise 0 |
| Explanatory variables | | |
| Farm size (FAR) | Continuous | Amount of land under cultivation (rai)* |
| Household income (INC) | Continuous | Amount of money earned by the family members in a month (Thai Baht) |
| Age of household head (AGE) | Continuous | Age of the household head (years) |
| Education of household head (EDU) | Continuous | Formal education of the household head (years of Schooling) |
| Family size (FAM) | Continuous | Number of family members (persons) |
| Households' debt (DEBT) | Dummy | Households' debt 1 if family has debt and 0,otherwise |
| Households' access to public extension services (ACC) | Dummy | households' access to public extension services 1 if at least 1 family member has access to public extension services, otherwise 0 |

Remark: *A rai, commonly used in Thailand that is a unit of area equal to 1,600 square metres or 0.395 acre.

The attributes in equation (1) was specified in the empirical model to include the following variables: farm size, household income, age of household head, education of household head, family size, households' debt, households' access to public extension services and ε, the random disturbance.

The hypothesis of the study was to determine the relationship between the compound biological products cultivation adoption and independent variables in the model as follow: farm size, household income, education of household head, households' and access to public extension services is expected positively related to adoption. While, factors including age of household head, family size and households' debt is expected negative sign. Data for the study was collected in northern Thailand during crop year 2013/14. The Royal project extension in Chiang Mai is situated in the area.

## III. RESULTS AND DISCUSSION

### A. Descriptive statistics

The characteristics of respondent farmers are listed in Table 2. The average age of the household head was 41.21 years, average education of the household head was very low (5.7 years of schooling).The average farm size was 9.94 rai or 4 acre. There was an average of 5.38 members in each household. The average household income per month was around 17,772 Baht (Thai currency; 1USD = 31 Baht as of January 2014), with 48% of the household being debt and 36% of households had access to public extension services.

TABLE II
DESCRIPTIVE STATISTICS OF EXPLANATORY VARIABLES BY ADOPTER AND NON-ADOPTER

| Variable (Units) | Mean | | |
|---|---|---|---|
| | All farmers | Adopters | Non-Adopters |
| Farm size (rai) | 9.94 | 9.89 | 10.01 |
| Age of household head (years) | 41.21 | 37.61 | 46.81 |
| Education of household head (years) | 5.70 | 6.10 | 5.07 |
| Household income per month (Thai Baht) | 17,772 | 23,725 | 8,528 |
| Family size (persons) | 5.38 | 5.81 | 4.71 |
| Household's debt (dummy: 0/1) | 0.48 | 0.40 | 0.60 |
| households' access to public extension services (dummy: 0/1) | 0.36 | 0.42 | 0.26 |

### B. Logit model analysis

An important purpose of this study was to explore the important factors that influence farmers' decisions to adopt of compound biological products cultivation. To this end, we performed logit regression analysis (Table 3). The obtained log likelihood ratio is -34.052 and the chi-square statistic for the goodness of fit of the model is 34.05199, significant at the 1% level. The McFadden $R^2$ value of the model is 0.2621. Thus, the overall model is significant and the explanatory variables used in the model are collectively able to explain the farmers' decisions regarding the adoption of compound biological products cultivation.

TABLE III
LOGIT MODEL ESTIMATES OF COEFFICIENTS ASSOCIATED WITH ADOPTION OF COMPOUND BIOLOGICAL PRODUCTS CULTIVATION

| Variables | Coefficient | Std. Error | Z | Sig. |
|---|---|---|---|---|
| Intercept | 2.4189 | 1.4598 | 1.657 | 0.0975 |
| Farm size (FAR) | $0.8003x10^{-2}$ | $0.2679x10^{-1}$ | 0.299 | 0.7653 |
| Age of household head (AGE) | $-0.7207x10^{-1}$ | $0.2602x10^{-1}$ | -2.770 | 0.0056** |
| Education of household head (EDU) | $-0.5250x10^{-1}$ | $0.6981x10^{-1}$ | 0.752 | 0.4520 |
| Household income (INC) | $0.7033x10^{-4}$ | $0.3181x10^{-4}$ | 2.210 | 0.0271 * |
| Family size (FAM) | 0.1173 | 0.1243 | 0.944 | 0.3453 |
| Households' debt (DEBT) | -1.4030 | 0.5850 | -2.398 | 0.0165* |
| Households' access to public extension services (ACC) | 1.3075 | 0.6132 | 2.132 | 0.0330* |
| Dependent Variable: Farmer's adoption of compound biological products cultivation (ADT ) | | | | |
| Chi-squared | 34.0519 | | | |
| Log likelihood function | -47.9179 | | | |
| Restricted log likelihood | -64.9439 | | | |
| McFadden $R^2$ | 0.2621 | | | |

Note. **Significant at 1% level; *Significant at 5% level

Logit regression analysis shows that most of the coefficients are not consistent with hypothesized relationships and their tests of significance help to indicate their importance in explaining adoption decisions of the farmers. The parameter estimates for the model was evaluated at 5% level of significance. Logit estimates for the survey location revealed that apart from farm size, education of household head and family size which were found not statistically significant in explaining adoption of compound biological products cultivation; age of household head, household income, households' debt and households' access to public extension services were statistically significant at 5% level.

The positive sign and significance of the farmer's adoption, household income was an important factor in terms of adoption decisions. This finding reflects the fact that farmers with higher income were more likely to adopt risky technology compared with those with a low income [10].

Meanwhile, households' debt was negative and significant, we found evidence that household has debt limited the adoption of compound biological products cultivation. This suggests that poverty significantly limits technology adoption. Wealth affects adoption decisions since wealthier farmers have greater access to resources and may be better able to take risks [3].

Next to the compound biological products cultivation adoption, the households' access to public extension services variable implies that extension is an important factor that will promote farmers adoption of the compound biological products cultivation in the study area [5].

The characteristics of the household head, we found a negative and significant impact of age on the likelihood of adopting the compound biological products cultivation. This could suggest that younger farmers are more likely to try innovations and, in addition, they might also have a lower risk aversion and longer planning horizon to justify investments in technologies whose benefits are realized over time [3].

## IV. CONCLUSIONS

The results of the present study demonstrate that farmers' adopting to compound biological products cultivation is a very important that lead to improved income, improved supply of safe food, and reduced environmental pollution. These beliefs are based on the logic that expensive agro-chemicals are not used in organic farming; consequently, the cost of production is relatively low and the price premium attained by organic produce leads to increased profit. Thus, it is essential to make farmers aware of the benefits of organic farming via intensive education campaigns.

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