# Agrochemicals Use Reduction Compensation of Chiang Dao Farmers in Chiang Mai Province

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## ABSTRACT

Chiang Dao district in Chiang Mai province is located nearby two food safety districts however Chiang Dao is not a member of Chiang Mai food safety network. Therefore, this paper applies a choice experiments to estimate the willingness to accept of farmers for reducing the use of agrochemical inputs in their fields. The four attributes are identified including use of chemical fertilizer, chemical herbicide, chemical insecticide, and compensation. The empirical results found that less than 1500 baht / rai / year of compensation may encourage farmers to reduce agrochemicals use in their farms. These amounts of compensation are not only encouraging farmers to reduce agrochemicals use but also causing the positive effects to farmers and consumers health as well as environments.

**Keywords:** Agrochemical Inputs; Compensation; Organic Farming

Received 25 May 2020 Revised 21 July 2020 Accepted 29 July 2020

## INTRODUCTION

Thailand's agricultural sector has changed from household consumption to commercial production therefore, the demand for agricultural chemicals increases to be able to produce large quantities of agricultural products for supporting the market demand. In term of comparing the cost of agricultural chemicals and revenues, it may be worth the cost of accounting. However, farmers do not take the health risks cost, they may receive agricultural chemicals into the body as well, into the farming account.

The statistic from the universal healthcare scheme explored that only first 10 months of 2019 fiscal year, there were 3,067 agrochemicals use patients, the deaths were 407 people and their treatment costs was 14.64 Million baht. Moreover, health zone 1 covers Chiang Mai, Lamphun, Lampang, Mae Hong Son, Chiang Rai, Phrae, Nan and Phayao provinces found the highest patients were 506 people (Hfocus, 2019).

The farming pattern in Chiang Mai province is an agricultural - based agriculture that uses agrochemicals. The statistics of Chiang Mai province presented the pesticide poisoning is ranked 1$^{st}$ of the country in 2012 (347 person) (BOED, 2012). It indicates that Chiang Mai had the highest patient rate from pesticide poisoning in the north region

The first Thailand agricultural organic strategic plan appeared in 2008 – 2011. In 2012, the National Organic Agriculture Committee was established to set up policies and strategies of Thailand's organic agriculture. There are four main strategies consisting of 1) to focus on knowledge and innovation management and create the database for organic agriculture; 2) to development the production of organic agriculture and to develop supply chain network; 3) to access strong markets and upgrade the standards of Thailand's organic agriculture products; and 4) to develop the sector of organic agriculture by cooperating with all the actors concerning Thailand's organic agricultural (Hnin, 201). According to the strategies, there were approximate 2.55 million farmers had been trained to use of organic fertilizers instead of chemical fertilizers however the import of chemical fertilizers still increased continually from 5.172 to 5.579 and 5.583 million tons in 2010, 2011 and 2012, respectively (Green Net, 2019). Considering to the import value of agricultural chemicals, the value equaled 20,618 million baht in 2016 and equaled 27,922 million baht in 2017 (OAE, 2019). Consequently, this issue should concern in case of Thailand organic agriculture sustainability. Contributing to the literature, the organic farming development policy should target to three main instruments including (1) legal or regulation instruments, (2) financial instruments, and (3) communicative instruments (Stolze and Lampkin, 2009, p. 241 - 243). And, the suitable organic policy for the specific area should be concern (Sukallaya and Gopal, 2011, p. 625). In developing countries, a barrier to develop the organic farming was the infrastructure problem (Veisi et al., 2013, p. 234). Moreover, the economic and environmental justification could be strongly considered for promoting the adoption of organic farming in developing countries (Pompratansombat et al., 2011, p.4).

The Thai government, in 2017, also launched a direct subsidy project (organic land acreage, input subsidy and free government certification) to expand one million rai of organic rice farming within 3 years. Nevertheless, by the end of 2017, there were only 200,000 rai of organic rice farming which the goal was 300,000 rai (Green Net, 2019). Moreover, Thai organic products were in high demand in the global market, such as United States and

the European Union, but the supply was relatively small. The major organic agricultural export products of Thailand were rice, black tiger prawn, beef, milk and fish (PRD, 2014).

As we have known, agricultural production is the main source of income of Thailand. Farming pattern, at present, has changed from traditional to conventional farming by using many agrochemicals in their farms. Agrochemical is not only increase productivity but also cause farmers' health effects and environmental problems. In term of economic aspect, agrochemicals use which caused the environmental problems and farmers' health effects could not measure with the typical economic analysis (Khan and Damalas, 2015, p. 300).Then, one of the stated preference approaches, choice experiments (CE) is applied (Bateman et al., 2003). The monetary value of changes in agrochemicals use reduction can showed as aggregate of small rice farmers' willingness to accept (WTA) (Jianjun et al., 2017, p. 17530). Consequently, this research aims to estimate the small farmers' preferred compensation to reduce use of agrochemicals in their farms as well the empirical results may introduce the effective policy which generate from farmers.

## MATERIALS

### Research site

The research area is at Chiang Dao district, Chiang Mai province, Thailand. We conducted the data from this area is not only because this area is a big district in north of Chiang Mai province (red dot) but also located near two food safety network districts however Chiang Dao district has no food safety network which showed in figure 1. Moreover, Nunthasen and Nunthasen (2019, p. 303) mentioned that organic farming in one area has influence in its organic farming neighbouring which contribute to the strategies of Thailand's organic agriculture.

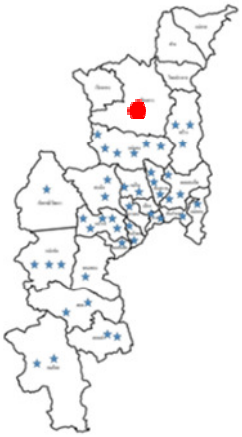

**Figure 1**: Chiang Mai Food Safety Network Map

### Survey design and data collection

The questionnaire is applied to survey the primary data from 400 agrochemicals used farmers in Chiang Dao district, Chiang Mai province by accidental sampling. The questionnaire was developed based on CE approach by applying the focus group discussion results.

The hypothetical alternatives in CE were identified by four attributes comprise of (1) reduce use of chemical fertilizers, (2) reduce use of chemical herbicides, (3) reduce use of chemical insecticides, and (4) compensation. The attributes and levels are presented in table 1. The 16 choice sets of this research were designed from fractional factorial design. The respondents were selected by systematic random sampling.

The iterative bidding technique was used to survey personal interviews. Descriptive analysis of household characteristics was applied to summarize the characteristics of the samples.

**Table 1** Attributes and levels in Choice Experiment

| Attributes | Levels |
|---|---|
| Chemical fertilizer | Status Quo, 25%, 50%, 75% |
| Chemical herbicide | Status Quo, 25%, 50%, 75% |
| Chemical insecticide | Status Quo, 25%, 50%, 75% |
| Compensation (baht/rai/year) | 573, 1,138, 1,672, 2,258 |

**Choice experiment approach (CE)**

Estimating WTA of respondents, the CE is applied and to estimate the model by conditional logit. The CE approach is a non-market valuation method which use to derive individuals' preferences for differences alternatives (Adamowicz et al., 1994). It is consistent with Lancaster's characteristics theory of demand and random utility model (Bateman, 2003).

The Lancaster's characteristics theory presented that individuals derive satisfaction of goods from their attributes they provide not from themselves (Lancaster, 1966, p.134 - 135). The random utility approach, utility of a choice, includes a deterministic component and an error component. Choices between alternatives will be a function of the probability (Birol et al., 2003, p.450). Individuals were asked to select the most preferred options from multiple choice sets. The CE approach is based on demand theory and maximize utility model. Estimation method

To estimate the coefficient of socio-economic factors and attributes in this study used the conditional logit model. The conditional logit model is similar to the logistic regression. The different is that all respondence in the logistic regression are presented one situation and choose only one choice but the respondence in conditional logit are presented to choose more than one different choice. Respondents in conditional logit model will be showed the choice one by one to compare to the status quo and respondents choose their most preference choice. Therefore, respondents in conditional logit model can choose many choices.

Parameters estimation in conditional logit model used maximum likelihoodmethod. The general model of this research is as showed in equation 1:

$$Y_{ji}=f\left(FRT_{ni}, HRB_{ni}, INS_{ni}, CMP_{ni}, Z_{mi}\right) \quad (1)$$

Where

$Y_{ji}$ is Decision to choose choice *j of* household*i*; =1if

household *i*choose choice *j*and=0if choose other choices

islevel oforganic fertilizer use instead of chemical fertilizer level *n* ofhousehold*i*including 4 levels;status quo, 25%, 50%, and75%

islevel oforganic herbicide use instead of chemical herbicide level *n* ofhousehold*i*including 4 levels;status quo, 25%, 50%,and75%

islevel oforganic insecticide use instead of chemical insecticide level *n* ofhousehold*i*including 4 levels; status quo, 25%, 50%, and75%

isPreferred compensation level *n*ofhousehold*i*including 4 levels;556, 1,112, 1,668, and2,224baht/year

isSocio-demographic factor *m* of household *i*

Marginal Willingness to Acceptor Implicit Price(IP)of each attributewhich related to farmers' willingness to accept calculated bymarginal rate of substitution (MRS) between farmers' preferred attribute and preferred compensation.

Equation 2 presents Marginal Rate of Substitution (MRS) of attributes and compensation attribute.

$$= = - \quad (2)$$

where *MWTA* is Marginal willingness to accept of attribute *n* at level *t*, *IP* is Implicit price of attribute *n*at level *t,* is coefficient of attribute *n* at level *t* and is coefficient of compensation.

Then, farmers change their preference level of organic fertilizer attribute from 0 to 1, how much compensation they will receive is calculated as presentedin equation 3;

$$=-\frac{1}{\delta}\left[v_{i1}-v_{i0}\right] \quad (3)$$

where *WTA* is Willingness to accept, $_0$is Status Quo, $_1$ is Farmer's most preferred scenario and is coefficient of compensation.

## EMPIRICAL RESULTS

### Socio-demographic characteristics results

The socio-demographic results of respondents presented that most of them were old women with a primary level of education. As well, they had worked on their fields between 31-40 years and they had small and middle farm size are presented in table 2.

**Table 2** Socio-demographic characteristics of respondents

| Variables | Percentage |
|---|---|
| Gender: Female | 56.50 |
| Age: 51-60 years | 53.50 |
| Education: Primary school | 80.00 |
| Experience on farm: 31-40 years | 33.00 |
| Farm size: not more than 10 rais | 57.75 |

Source: Field survey (2018).

### Results of attributes to agrochemicals reduction

The analysis of attributes and attributes levels to willingness to change their plantation method is presented in table 3. The table showed the probability of farmers in changing their agrochemical use in all attributes in various levels. It presented that to change the levels of agrochemical use in their farms was inverse to the probability of farmers to choose the choices. This implies that farmers will reduce the agrochemicals use in their farms if the reduction percentage of agrochemicals use increase.

**Table 3** Estimation results

| Attribute level | Coefficient | t-ratio |
|---|---|---|
| 1. Reduce chemical fertilizer 25%,increaseorganic fertilizer 75% | -0.75 | -2.79** |
| 2. Reduce chemical fertilizer 50%,increaseorganic fertilizer 50% | -0.22 | -1.31 |
| 3. Reduce chemical fertilizer 75%,increaseorganic fertilizer 25% | -0.19 | -0.87 |
| 4. Reduce chemical herbicide 25%, increase organic herbicide 75% | -0.85 | -3.68*** |
| 5. Reduce chemical herbicide 50%, increase organic herbicide 50% | -0.71 | -3.10*** |

**Table 3**

| Attribute level | Coefficient | t-ratio |
|---|---|---|
| 6. Reduce chemical herbicide 75%, increase organic herbicide 25% | -0.13 | -1.25 |
| 7. Reduce chemical insecticide 25%, increase organic insecticide 75% | -0.61 | -2.79*** |
| 8. Reduce chemical insecticide 50%, increase organic insecticide 50% | -0.49 | -1.31 |
| 9. Reduce chemical insecticide 75%, increase organic insecticide 25% | -0.56 | -2.51** |
| 10. Compensation | 0.001 | 4.12*** |

Log likelihood function = -1,395.60

Observations = 5,920

McFadden $R^2$ = 0.48

Note: * is p<0.1, ** is p<0.05, *** is p<0.01

**Willingness to accept *(WTA)* results**

Table 4 showed the WTA of farmers who chose their most preferred scenario of each attributes and the compensation of each levels including (1) to reduce chemical fertilizer 25% and increase organic fertilizer 75%, (2) to reduce chemical herbicide 25% and increase organic herbicide 75%, (3)to reduce chemical herbicide 50% and increase organic herbicide 50%, (4)to reduce chemical insecticide 25% and increase organic insecticide 75% and (5) to reduce chemical insecticide 75% and increase organic insecticide 25% were 1,250.00, 1,416.67, 1,183.33, 1,016.67 and 933.33 baht/rai/year, respectively.

**Table 4** Attributes and Compensation

| Attributes | WTA (baht/rai/year) |
|---|---|
| 1. Reduce chemical fertilizer 25%,increaseorganic fertilizer 75% | 1,250.00 |
| 2. Reduce chemical herbicide 25%, increase organic herbicide 75% | 1,416.67 |
| 3. Reduce chemical herbicide 50%, increase organic herbicide 50% | 1,183.33 |
| 4. Reduce chemical insecticide 25%, increase organic insecticide 75% | 1,016.67 |
| 5. Reduce chemical insecticide 75%, increase organic insecticide 25% | 933.33 |

## CONCLUSIONS AND RECOMMENDATION

**Conclusions and discussion**

This research investigates the willingness to accept of chemical farmers in Chiang Dao district to reduce agrochemicals in their farms. The questionnaire is used to survey the respondents by accidental sampling. The choice experiment (CE) is applied to estimate the compensation. The WTA result shows that farmers will reduce agrochemicals inputs and increase organic inputs in various levels in their farms if government supports them approximately 934-,417baht/rai/year which contrast with Yu and Cai (2015, p. 221) mentioned that WTA of farmers in reducing pesticide were larger than those in reducing fertilizer.

## Policy recommendation

According to the results, the policy makers can imply the policy which effectively encourage farmers to reduce agrochemicals and produce more organic productions for example to pay only 933.33 bath/rai/year can stimulate farmers to reduce 75% of chemical insecticide in their farms. Moreover, this method can apply to other areas to stimulate farmers to produce more agricultural products which is not only good for farmers' health, but they also make more income from organic agricultural products.

## Acknowledgements

The authors would like to acknowledge deeply to farmers in Chiang Dao district for good collaboration as well as office of agricultural research and extension, Maejo university for financial support**.**

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