Factors Affecting Green Practices Adoption in Maize Stalks, Cobs, and Peels Disposal: A Case Study of Chiang Rai Maize Farmers

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Received August 30, 2021; **Revised** October 6, 2021; **Accepted** October 10, 2021

DOI: 10.14456/ijmmt.2021.6

Abstract

Although maize cultivation has been considered one of the essential crops of Thailand's agricultural and livestock industry, it should not overlook the negative impact on people's environmental aspects and health caused by traditional maize residues disposal. This research aims to identify the factors affecting green practices adoption in maize stalk, cobs, and peels disposal. The population group of this study is the maize farmers who cultivated in Chiang Rai province. The sample of this research is the maize farmers from Theong and Chiang Khong districts. Using an interviewer-administered questionnaire, the researchers used a convenient sampling method and collected data from 410 maize farmers. The researchers used Binary Logistic Regression to analyze the factors affecting green practices adoption because the value of the dependent variable is dichotomous. With a confidence level of 95 percent, the results reveal that selling price is the most crucial factor followed by farmers' knowledge, geographical condition, and government measures, respectively. Researchers suggest that the government should utilize its policies to generate more efficient and effective outcomes by educating the farmers and facilitating the green practices adoption processes. Lastly, there should be proper and continuous projects and monitoring measures for future improvements.

Keywords: Agricultural Wastes; Open Burning; Haze Pollution; Maize; Green Agriculture

Introduction

Maize is one of the essential crops of Thailand's agricultural and livestock industry. The increase in demand from animal foods consumption in the livestock industry and the need to reduce maize import quantity lead to increasing domestic maize production. According to the Office of Agricultural Economics (2020) data in table 1, maize farming areas increased from 6.78 million rai (1 rai = 1,600 square meters) in 2018 to 7.02 million rai in 2019. The majority of maize farming areas are in the northern region of Thailand, which accounted for

67.24%. Chiang Rai has approximately 0.3 million rai of maize farming area, which is the second largest in the northern region of Thailand.

Table 1 Thailand's maize farming area by region during 2015 – 2019 (in a million rai).

Region	2015	2016	2017	2018	2019
Northern	4.55	4.47	4.52	4.59	4.72
Northeastern	1.32	1.33	1.34	1.47	1.45
Central	0.72	0.69	0.72	0.72	0.86
Total	**6.59**	**6.49**	**6.58**	**6.78**	**7.02**

Increasing maize production may have a higher level of negative impacts not only on the environment but also the health of the people living in nearby communities, for example, over-used of chemical fertilizer, soil degradation, deforestation, and air pollution from open burning of stalks, cobs, and peels (Do Amaral, 2018). The government has introduced many guidelines and policies to mitigate or solve the situation, including temporary open burning restrictions, punishment, and alternative ways of disposal with less environmental impact, e.g., making organic fertilizer and making fuel pellets from maize cobs stalks, and peels. Nevertheless, maize farmers have not widely adopted the practices.

In response to the problems mentioned above, this study aims to identify the factors affecting green practices adoption for maize stalk, cobs, and peels disposal among the maize farmers in Chiang Rai Province. The result of this study can offer government policy suggestions.

Literature Review

Previous research has studied factors affecting green practice adoption in the agricultural industry and found various factors affecting farmers' adoption.

The cost of green practices can affect green practice adoption among farmers. Some farmers are reluctant to adopt green practices because they are afraid that the cost of implementing green practices might be too high, and there is no guarantee that the practices will give favorable results or sufficient financial return (Adnan et al., 2019). The higher cost in farming makes the adoption more difficult. According to Hijbeek et al. (2019), the high investment cost is farmers' primary concern. Although the investment in greener agricultural technology will reduce the cost in the long term, most farmers do not have enough savings to invest in it initially (Bruce and Spinardi, 2018). Moreover, Ragasa et al. (2017) revealed that farming costs, e.g., seed, fertilizer, and equipment, are considerably high even in traditional farming and could be higher if the farmers adopt green practices.

Green practices can improve profitability. The study of Chinese farmers participating in green projects reported that they have got good financial benefits after adopting green practices (Chao et al., 2009). If green practices are appropriately applied, it can increase productivity; hence, the farmers have the potential to increase their revenue (Smith et al., 2017). The farmers will be more willing to adopt green practices if they perceive significant financial returns, such as higher selling prices (Adnan et al., 2019).

Knowledge regarding green practices is another critical factor affecting green practices adoption. (Luo et al., 2016). Jai-Aree (2018) found that the correct understanding of green

practices can enhance adoption among farmers. The farmers who have less knowledge about environmental health tend to burn agricultural wastes (Adeleke et al., 2017). For example, the farmers who are acknowledged that green practices can help improve soil quality will be more willing to adopt green practices (Abera et al., 2020). On the other hand, some farmers insisted that burning crop wastes can improve soil quality for cropping (Junpen et al., 2018).

The geographical area of cultivation can be the barrier to green agricultural practices adoption. The geographical condition can limit the choices of possible green practices. For instance, farmers who cultivate upland and highlands mostly dispose of the agricultural waste or residue by slashing and burning because it is the easiest and fastest way to dispose of the waste (Phuphisith et al., 2021). It is also impossible for highland farmers to plow the soil with a tractor since the tractor cannot work well on the hill (Tejajai, 2014).

The government's role is also crucial for green practices adoption. Less government effort in providing support is one of the main barriers to green agriculture (Sher et al., 2019). Li et al. (2021) suggested that the government should implement supporting measures to facilitate green practices adoption; on the other hand, the government should discourage the farmers from non-green practices. The government's policies are indeed the vital mechanic of green practices adoption (Waheed et al., 2021).

The above discussions lead to the following hypothesis, which describes the factors affecting green practices adoption in maize stalks, cobs, and peels disposal, consisting of 5 independent variables, namely, geographical condition, cost of green practice, selling price, farmer's knowledge, and government measures.

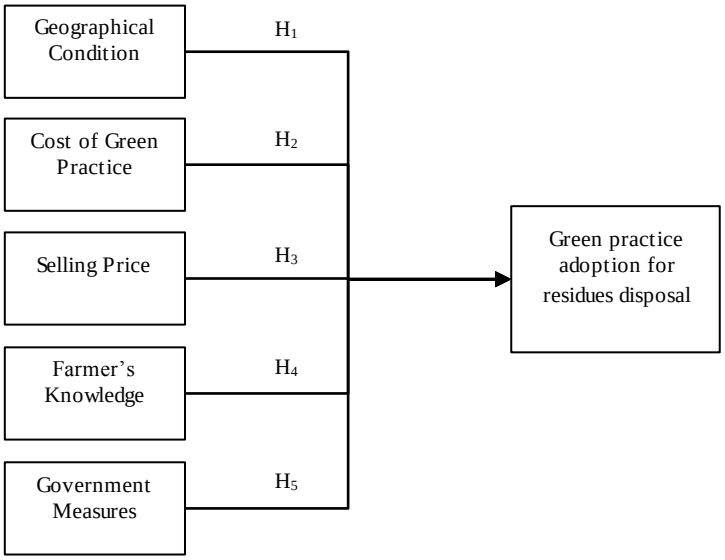

Figure 1: Conceptual framework of factor affecting green practices adoption in maize stalks, cobs, and peels disposal

H_1: The geographical condition significantly impacts green practice adoption for residues disposal.
H_2: The cost of green practice significantly impacts green practice adoption for residues disposal.
H_3: The selling price significantly impacts green practice adoption for residues disposal.
H_4: The farmer's knowledge significantly impacts green practice adoption for residues disposal.
H_5: The government measures significantly impact green practice adoption for residues disposal.

Research Methodology

Population and Sample

The population in this study is the maize farmers in Chiang Rai Province. According to the Office of Agricultural Economics (2019), approximately 32,960 maize farmers in households in Chiang Rai. The study samples the maize farmers from Theong and Chiang Khong districts because maize is widely harvested, and the hotspots are concentrated in these areas (Figure 2). This study used a convenient sampling method, with a confidence level of 95%; the researchers must collect data from at least 395 maize farmers who cultivate in Chiang Khong and Thoeng districts according to the sampling theory of Yamane (1973). The maize farmer population of the whole province was used in sample size calculation because there was a limitation in acquiring the maize farmer population from each district.

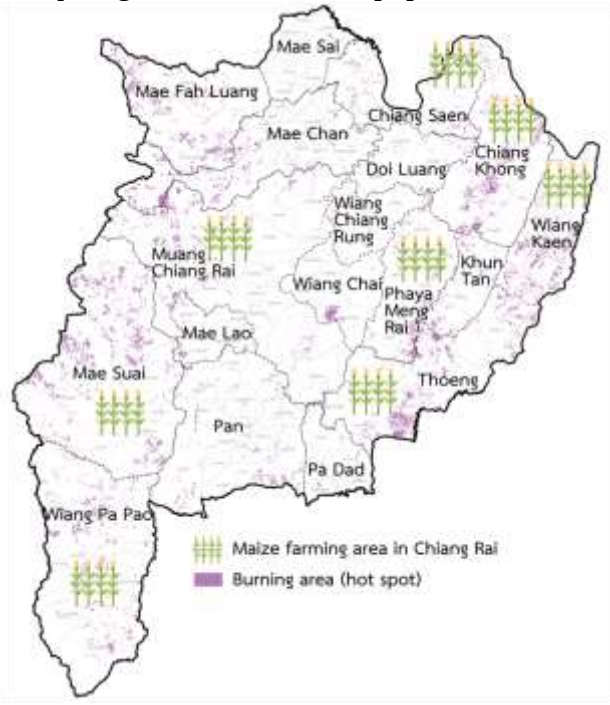

Figure 2: Burning area (hot spot) and maize farming area of Chiang Rai in 2019

Research Instruments

The researchers used a questionnaire to collect the data on factors affecting the green practice adoption in maize stalks, cobs, and peels disposal. The researchers generated the questionnaire by synthesizing information from the related literature review. The questionnaire consists of 2 parts which are:

1. Demographic of the respondent and screening question consists of the geographical condition of the plantation area, districts, and green practice adoption, which are categorical.

2. Factors affecting the green practice adoption in maize stalks, cobs, and peels disposal. The questions regarding factors affecting green practice adoption, developed from the literature and field interview, are presented with a 6-point Likert scale to rate each predictor. The questionnaire survey considers four factors which are 1) Cost of green practice consists of 3 questions, 2) Selling price consists of 4 questions, 3) Farmer's knowledge consists of 4 questions, and 4) Government measure consists of 3 questions.

A sample group of 30 farmers provides the base for reliability evaluation. The Cronbach's Alpha of the factors ranges between 0.76 to 0.90, which are considered acceptable according to the recommendation from Hair et al. (1998).

Data Collection

The researchers and assistants contact maize farmers and make an appointment to visit them at their places, whether house or plantation. The researchers and assistants interviewed the respondents and then requested the respondents to fill the questionnaires. If maize farmers are local people and cannot communicate effectively in Thai, the assistants who are fluent in the local language will translate them into Thai for accurate information.

Data Analysis

This study used binary logistic regression, which was developed from linear regression analysis and is similar to multiple regression analysis (Piegorsch, 2015). However, the result will be binary or dichotomous, for example, "yes" or "no," "pass" or "fail," and "male" or "female." The goodness of fit test uses chi-square to confirm whether the model and data are significantly in harmony. The independent variables or predictors were tested whether they have a positive or negative impact on the dependent variable (Pallant, 2010).

Results

The questionnaires were distributed manually in paper format by the researchers and research assistants, and there were a total of 422 respondents from both districts. All questionnaires were screened and checked for their completeness. This study has 410 valid responses. As shown in table 2, the demographic data illustrated 209 maize farmers from Chiang Khong and 201 from Theong, which account for 51.00 and 49.00 percent, respectively. The survey has 71.70 percent of the samples cultivated in lowland or plain areas and 28.30 percent in mountainous areas. 56.60 percent of the samples reported that they used the open burning method to dispose of the maize residues, and 43.40 percent reported that they did not.

Table 2 Demographics of respondents

Characteristics of the samples	N	%
Maize farming districts		
.1Chiang Khong	209	51.00
.2Thoeng	201	49.00
Geographical condition		
.1Plain or lowland	294	71.70
.2Mountainous area	116	28.30
Stalks, cobs, and peels disposal methods		
.1Burn	232	56.60
.2Not burn	178	43.40
Total	**410**	**100**

The researchers performed binary logistic regression to examine the samples' opportunity to report that they burned stalks, cobs, and peels and seriously impacted them. The model consisted of 5 independent predictor variables in total, 1 was a nominal scale, and 4 was a rating scale. As illustrated in table 3, the results showed that the model was statistically significant, $\chi 2$ (5, N = 410) = 181.89, $p < 0.001$: the samples who reported and did not report the adoption of green practice for residues disposal can be categorized by the model consisting of all predictors. The model can explain the variance of maize farmers using environmental-friendly method between 35.80% (Cox and Snell R Square) and 48.10% (Nagelkerke R Square), and 77.10% of the cases were categorized correctly. Table 3 showed that four predictor variables contributed statistically significantly to the model, with a confidence level of 95% ($p < 0.05$). The logistic coefficients (B) indicated that the geographical condition, farmer's knowledge, and government measures negatively while selling price has a positive relationship with the dependent variable. Therefore, H1, H3, H4, and H5 are accepted while H2 is rejected.

Table 3 The results of binary logistic regression analysis.

Predictor Variables	B	S.E.	Wald	Df	Sig.	OR	Hypothesis
Cost of Green Practice (H_2)	-0.062	0.117	0.275	1	0.600	0.94	Reject
Selling Price (H_3)	1.136	0.153	55.203	1	**0.000**	3.12	Accept
Farmer's Knowledge (H_4)	-0.845	0.166	26.045	1	**0.000**	0.43	Accept
Government Measure (H_5)	-0.377	0.162	5.412	1	**0.020**	0.69	Accept
Geographical Condition (H_1)	-1.673	0.286	34.296	1	**0.000**	0.19	Accept
Constant	2.338	1.093	4.576	1	0.032	10.36	

* statistically significant ($p < 0.05$)

Discussion and Policy Implication

The results show that geographical conditions significantly affect green practices adoption among maize farmers; this finding is consistent with the study by Phuphisith et al. (2021). The farmers living in the highland cannot use a tractor for plowing, and they do not have space to fertilize the maize stalk. They might take a slash and burn as it is the most effective and convenient method for agricultural waste disposal. Selling price is another significant factor; the farmers may not be willing to adopt green practices because the financial benefit from adopting such practices is questionable. This finding aligns with the study Ragasa et al. (2017), which proposes that the farmers adopt green practices if they perceive a positive financial benefit. For instance, if the farmers can sell their green products at a higher price compared to traditional products, they might be more willing to adopt green practices. Farmers' knowledge regarding green practices can drive green practices adoption. Knowledge regarding green practices can facilitate the process of adoption (Luo et al., 2016). In addition, the misconception regarding green practices can lead to non-environmental-friendly practices such as slash and burning (Phuphisith et al., 2021). With proper knowledge, the farmers can avoid or reduce failure. They might be more confident in green practices and adopt them. Government measures, both reward and punish, impact green practices adoption

among farmers. This finding is consistent with the study by Waheed et al. (2021), which suggested that the government should drive green practices adoption via its policies. Logically, the farmers are afraid of being punished; on the other hand, they are satisfied with support and reward from the government.

As policymaker and regulator, the government should enhance the positive factors and reduce negative factors. The government can help in promoting green practices among maize farmers. Firstly, the government should make sure that there is an appropriate market for green maize in which the farmers can access and sell their green products at reasonable prices. Therefore, the farmers can, at least, be sure that they can earn appropriate revenue. Farmers' cooperatives can be the channel to enhance farmers' knowledge regarding green practices and promote environmental-friendly practices (Puangchan, 2020). The government and local authorities should support and work with these cooperatives. They can set up demonstrate or pioneer projects of environmental-friendly agriculture and use the cooperative as a learning center for the farmers. The cooperative can also impose normative pressure – "the collective struggle of members of an occupation to define the conditions and methods of their work" (DiMaggio & Powell, 1983). If most farmers have adopted environmental-friendly practices, the rest of the farmers will be more willing to adopt such practices. The government should strictly implement every measure to support the adoption of the green practice. In addition, it should take local factors into account; for instance, there are numbers of highland farmers in the northern region of Thailand. The government should have policies that are suitable for these highland farmers. Lastly, every policy and measure should be closely monitored to make sure that these policies are continually and effectively implemented

Conclusion and Limitation

In conclusion, this article reveals drivers and barriers of green practices for maize stalks, cobs, and peels disposal among farmers in Chiang Rai province. Many factors affect green practices adoption. Therefore the policymakers should support the positive factors and reduce the negative factors. It is also essential to consider the local context for policies implementation and consistently implement them.

This study certainly has some limitations. Firstly, the scope of this study is limited to only Chiang Rai province. Secondly, this study only focuses on maize farmers' perspectives. Therefore, future research can study similar topics in other areas or more considerable spatial scope. In addition, future research can approach similar research questions from different perspectives, e.g., government authorities, suppliers, or customers' perspectives.

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