Analyzing Household Decision Making on Oil Palm Cultivation in Thailand

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Abstract

This paper analyses the dynamics of land use via the perspectives, motivations and behaviours of local landowners[‡]. The dynamics are explored in the context of an oil palm based-biodiesel development in Thailand where the advent of oil palm has caused the loss of paddy areas. A sequential mixed-method strategy, including 10 in-depth interviews and 180 responses to a questionnaire survey, indicates that the likelihood of a landowner switching traditional land for oil palm cultivation is affected by a number of factors including age and education of the head of household, number of household farming labourers, amount and source of income, land size and land right. Moreover, the results indicate that success of switching land to oil palm cultivation was determined by factors influencing willingness and capacity to change. Willingness-related factors are relevant to outcome

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‡ Looking at land use change (through the landowner's eyes) in the way that the landowners would prefer to do and not to do in various situations

expectation and social networks and connections while capacity-related factors are relevant to finance, labour, capital, land rights and transportation.

1. Introduction

The “food versus fuel” controversy (Bafes and Haniotis 2010) and indirect land-use change effects (Wiegmann et al. 2008) are important issues following the increase in demand for biomass for biofuel production (Dauber et al. 2012). These issues are serious because, with an inevitable limitation on land available for crop production, switching land use from food to biofuel crop cultivation can decrease food supply and then increase the price of food commodities which in turn seriously impacts on food affordability for food-insecure and poor people (Johansson and Azar 2007, Naylor et al. 2007).

In order to assess the potential impact on global food security, it is necessary to understand the dynamics of land use for food production after the advent of biofuel crops. This is arguably most acute in food exporting countries where the revenue earned from these exports is a significant proportion of national income. Many researchers have tried to examine the dynamics of land use change (LUC) caused by biofuel expansion, for example Al-Riffai et al. (2010), Bauen et al. (2010), Fritsche et al. (2010), Hiederer et al. (2010), Tipper et al. (2009), Tyner et al. (2010), USEPA (2010), Warner et al. (2013), Wise et al. (2009). However, these studies are mostly based on LUC modelling relying on computer simulations or extrapolations of historic data to evaluate total LUC. LUC studies based on observing perspectives, motivations and behaviours of local land owners are relatively few especially the changes of land for food production caused by biofuel crop promotion. Indeed published research on perspectives of local land owners and the government relevant to

decisions about cultivating biofuel crops is limited to a small study by Amatayakul and Azar (2008) which explores factors influencing households' (HHs') decisions regarding cultivating eucalyptus, a fuel-wood crop, in Thailand. Given these gaps in knowledge, there is an urgent need for more research to enhance understanding of land uses issues and to better analyse the socio-economic as well as environmental impact of LUC.

The research reported here increase the comprehension of dynamics of land use incentivised by biofuel development policy in Thailand. Thailand has great potential for alternative energy, especially agricultural crop based energy (Prasertsan and Sajjakulnukit 2006), and current government policy encourages the use of biofuel-based energy (Preechajarn 2008). Potential raw materials for biodiesel production are various vegetable and/or animal oils. However, biodiesel from palm oil has been considered one of the most promising renewable resources for transportation fuel in Thailand and its use has been enforced by the Ministry of Energy as a mandatory measure to substitute for conventional diesel fuel (Papong et al. 2010). The biofuel development policy of Thailand is framed at promoting them in abandoned agricultural areas and unproductive non-food areas. Based on climatic and geographic conditions, promotion of oil palm land expansion was initially intensive in the south of country. Although there has been some success in directing oil palm to abandoned paddy areas (SOPRC 2004), directing it to unproductive non-food areas has largely been unsuccessful especially in land with unproductive natural rubber (Preechajarn and Prasertsri 2011). By contrast, there has been a rapid expansion of biofuel crops in areas usually planted to paddy rice; an important food crop in Thailand. Figure 1 shows the trend in land areas planted to oil palm, rubber and rice in south of Thailand. This raises something of a conundrum for policy makers: on the one hand, switching land use from arable paddy land to oil palm might gain higher income and job creation for the rural

sector as well as enhanced energy security nationally, but the land use change might impact negatively on food security. It is this interplay between allocation of land for food and biofuel that rests at the heart of this paper, and in particular the factors that influence farming households in making these decisions.

The objective of this study is to explore factors influencing land use change. Three research questions were set. These are (1) how are farmers' livelihoods currently constructed? (2) what are the important aspects of livelihood at present? and (3) what are the drivers influencing the willingness of farmers to switch land use from traditional to biofuel crops? This research focussed upon a case study of the palm oil based biodiesel development policy in Thailand which influence farmers' decision to whether switch their paddy, natural rubber and/or abandon areas for oil palm cultivation.

2. Methods

2.1 Study site

The sources of data used for finding out factors influencing land use change incentivised by biofuel development policy involved farmer HHs. The scope of the population of farmer HHs was specific to the HHs who occupied abandoned and/or paddy and/or rubber lands and/or the HHs who had switched those lands for oil palm cultivation. The areas chosen for the study were from two different topographies. The first area is river basins on the coastal plain along the shore. Geographically, fertile plain basins are used for wet-rice cultivation. The Chianyai and Chalermprakiet districts of Nakhon Si Thammarat province and the Ranote and Sathingpra districts of Songkhla province were chosen as study site because the land has traditionally been used for paddy cultivation but some had been left abandoned and/or switched to oil palm cultivation. The second area is upland

areas on mountain range in the middle part of the southern region used for fruit trees and tree crops cultivation. The Prasaeng and Bannaderm districts of Surat Thani province were chosen as represent of this area because most land is used for rubber cultivation and/or left abandoned but some had been switched to oil palm cultivation. The study areas are shown in Figure 2. Based on chosen areas, three sites of study were also classified: (1) predominantly paddy cultivation, (2) predominantly rubber cultivation and (3) predominantly abandoned area.

2.2 Conceptual framework

The conceptual framework considered to be most suitable for the intention of this research is the Sustainable Livelihood (SL) framework (DFID 1999) because it encapsulates inclusion of motivation, perspective and behaviour. The SL framework consists of three interrelated components which influence livelihood strategies adopted by HHs in pursuit of their desired livelihood outcomes. These components are: (1) the HH asset (human, natural, financial, physical and social assets) that they have access to and use, (2) the vulnerability context (including trends, shocks and seasonality), and (3) the institutional and political environment (Adato and Meinzen-Dick 2002, Chambers and Conway 1992, Ellis 1998, Jansen et al. 2006). The SL framework is considered to provide a holistic and systematic approach for explaining HHs' decisions for pursuing their expected outcomes, and McCusker and Carr (2006) provides a review of several studies which employed the SL framework for analysing drivers in land use change.

2.3 Data collection

Data collection was of two types. Firstly semi-structured in-depth interviews were used for an initial exploration of livelihoods in the study areas. Ten interviewees in Chianyai and Prasaeng were selected by using inclusion criteria, which were specific for each group of six subcategories of land use strategies, consisting of: 1) continuing paddy cultivation; 2) switching from paddy to oil palm cultivation; 3) continuing rubber cultivation; 4) switching from rubber to oil palm cultivation; 5) continuing to leave land abandoned; and 6) switching abandoned area to oil palm cultivation. A summary of the respondent profile is shown as Table 1. The HHs in Chianyai are referred to as interviewees C1 to C6, and respondents in Prasaeng as P1 to P4. In-depth interviews were audio recorded to enable the researcher to transcribe them later.

Secondly, and following the semi-structured interviews, a structured questionnaire was used to explore land use change on across a large number (180) of households. The questionnaire was informed by the results of the semi-structured interviews described above. The questionnaire was divided into two sections:

1. HHs' characteristics such as age, gender and education of household heads (HHHs), number of HH members and HH farming labourers, annual income of main and other income and their sources, total land area, owned area, rental area, ratio of owned area and ratio of rental area to total land area.
2. Factors influencing HHs' land use decisions in adopting specific land use strategies. Factors were also ranked according to their importance.

The questionnaire-based surveys with landowners were conducted between July 2012 and April 2014. In order to select a suitable sample of landowners, agriculture offices

of the districts in the sample frame[§] were approached and asked to suggest the sub-district where HHs consistent with the sample frame were available. Then convenience sampling was conducted. Farmers were interviewed at the main centres of each community, and selection was based on their availability and willingness to respond to the questionnaire. A total of 180 farmers were interviewed for the field survey. A summary of sample size of questionnaire respondents is shown in Table 2. However, it should be noted that the table shows the number of respondents engaged in land use strategy. Each HH may have adopted more than one land use strategy and this explains why row totals do not equate to the sample size.

2.4 Pairwise comparisons

The Analytic Hierarchy Process (AHP) developed by Saaty (1980) was used to identify the exact factors influencing land use change. In essence, AHP is a multiple criteria decision-making tool for organizing and analysing complex decisions involving the comparison of decision items which are difficult to quantify. The process compute (a) the numerical weight or priority of each element using raw data derived from pairwise comparison questions, and, using the law of reciprocal comparison, (b) score normalization and the (c) average of normalized scores (Saaty 1980).

While AHP is considered to be a very useful tool, large numbers of alternative items results in difficulty in applying AHP. A larger number of pairwise comparisons and many-point scales of the intensity of judgement can cause invalidity of measurement. In order to deal with these problems, Ternary AHP (T-AHP) was adopted in this study with the

[§] A list of all those within a population who can be sampled

advantage that it does not require a larger scale of values representing the intensity of judgement (Jensen 1986, Takahashi 1990). It is difficult for human beings to present the intensity of judgement of pairwise comparison by using many-point scales as suggested by classic AHP, but they can easily compare one to another and thus say that “A is better than B” or “A is worse than B”. In this situation, unlike classical AHP which employs 1 to 9 scales, only two scales, 1 and θ , are enough to represent the preference or judgment where “1” represents “equal importance” and all ratings of “more importance” are denoted by θ ; which is an integer with $\theta > 1$. For the value of intensity of judgement (θ), this research followed the study of Encheva (2010) by setting value of θ to be equal to 2. In terms of data preparation, excel formulas were created to calculate the priority weights for each alternative factor.

2.5 Statistical analysis

Non-parametric methods, notably the Chi-square test and the Wilcoxon signed-ranks test were employed in this study. The Chi-square was used for testing relationships between HH characteristics and the likelihood of cultivating oil palm. For the Wilcoxon signed-ranks test, it was employed for testing differences between priority weights of each factor in each category of land use strategy. This test would find out exact factors influencing HHs’ decision in adopting a specific land use strategy. Based on priority weights derived from AHP, the Wilcoxon signed-ranks test classified the factors into two groups:

1. Non-influence factors. These were factors that were not mentioned by the respondents, or those that were mentioned but the priority weight was not statistically significantly different from the weight of factors not mentioned by the respondents

2. Influence factors. These are the factors that were mentioned by respondents, and where the priority weight was statistically significantly different from the weight of factors not mentioned by the respondents. These would be classified into sub-groups including: normal-influence factors and dominant-influence factors. The dominant-influence factors were the factors in the group of very-high-ranked factors for which the priority weights might not be statistically significantly different among them but were statistically significantly different from other lower-ranked factors.

3. Results

3.1 *Semi-structured interviews*

The results of the semi-structured interviews suggest that decisions over land management were dependent on a number of factors. The analysis reveals 23 factors (see Table 3) as the potential factors influencing land use decision:

Firstly the HHs preferred to obtain a return consistent with the HHs' financial status. It was mentioned by all HHs in Prasaeng that a high profit from cultivating rubber was a factor favouring the cultivation of that crop but other types of outcome were also important such as lump sum and continuous income. The lump sum income^{**} gained from a short growing period for paddy cultivation was sought by some HHs (C4, C5 and C6) who needed

^{**} Lump sum income is a single sum of return paid once for HH at the end of crop rotation. In this study, the lump sum income could be derived from paddy rice and rubber when paddy grain and rubber timber were harvested.

to circulate their liquidity whereas continuous income^{††} was sought by HHs who needed to have more security of income. Several HHs (C2, C3 and C5) reported that cultivating oil palm instead of paddy helped them gain this income. The dramatic increase in rubber prices along with assistance from the government helped rubber to be popular in Prasaeng (P1, P2, P3, P4) whereas price intervention and disaster assistance from the government made paddy popular in Chianyai (C4, C5 and C6). In addition, savings (C2 and C3) and capacity to access credit (C6) were important determinants in the success of land use switching to oil palm given that it takes a few years after planting before produce can be harvested and sold. Moreover, the findings also showed that HH consumption of produce was an important concern (e.g. C2 with paddy rice).

The second factor that helped influence decision making at the HH level was related to natural resources available to the HH. In Prasaeng, although all HHs preferred to use as much land as possible to cultivate rubber, the shallow nature of some land^{‡‡} and the appearance of diseases in the soil forced a switch from rubber to oil palm. In Chianyai, while most of the HH land had good access to an adequate water supply for paddy rice, the risk of flooding influenced some HH (C2, C3 and C6) to switch paddy land to oil palm which is more tolerant to flooding. However, some HHs continued to cultivate paddy as much as possible (C4 and C5) or maintained paddy cultivation in some areas (C6) without worrying about flooding as they preferred to rely on the disaster assistance support provided by the government. Land Rights is another factor mentioned by some HH, as can be seen in the

^{††} Continuous income is the periodical returns that HH could get from harvest crop. In this study, continuous income can be get from rubber latex harvesting (every day) and fresh oil palm fruit (approximately twice a month)

^{‡‡} Unfavourable geographic areas or infertile land e.g. acid soil, saline soil, shallow soil, soil with high proportion of rock; areas liable to flood in the rainy season; areas prone to drought.

case of rented land for paddy in Chianyai (C4, C5 and C6) and land owned by government but allocated for farmers to cultivate rubber (P1).

Thirdly, the availability of both HH labour and employed labour were important determinants for the selection of crops to plant. In Chianyai, paddy areas tended to be switched to oil palm because it requires less labour in farm management. This was consistent with the decline of HH labour because of the shift to an elderly population and migration of the youth to urban areas for study and work (C1, C2 and C3). In addition, the difficulty of employing labour in Prasaeng made some HHs continue to use their land for rubber even though they noted that it was unproductive (P3 and P4).

Fourthly, the availability of tools, equipment and public infrastructure have played an important role in determining land use. The HHs' use of their own tools and equipment, especially for paddy cultivation, helped to reduce cost (C4). Conversely, high value of tools and equipment facilitated HHs (C2 and C3) to switch their abandoned and/or paddy areas to oil palm cultivation. Moreover, the relatively high wealth of some HHs' derived from physical assets enables them to be more flexible in switching land use (C2, C3 and P1). In terms of public infrastructure, irrigation development has enabled HHs to choose to cultivate paddy a number of times on the same piece of land each year (C4, C5 and C6). In addition, development in transportation (better roads etc.) encouraged some HHs (C2 and C3) to cultivate oil palm.

Finally, social factors were also important in influencing land use change. Many forms of networks and connections have provided an opportunity for HHs to share and learn innovation, technology, best practice and government policy. This has clearly made all HH

both in Chianyai and Prasaeng more interested in alternative crops, especially oil palm, and more confident that switching land to cultivate oil palm would return.

3.2 Structured questionnaire

While the in-depth semi-structured interviews provided some clues as to the factors that were important in decision-making over land use they did not provide a sense of relative ranking. The use of more structured questionnaires was intended to help address that gap. Table 4 shows a cross-tabulation between two HH categories, oil palm grower (OP growers) and non-oil palm grower (NOP growers), and a set of HH profile variables. The results show that, while there are some similarities among the basic HH characteristics of OP growers and NOP growers, several HH characteristics of OP growers and NOP growers are significantly different. There is evidence to suggest that higher willingness to cultivate oil palm was associated with the following characteristics:

- younger HHHs (in the predominantly abandoned area)
- higher educational level (in the predominantly paddy area)
- larger numbers of farming labourers (in the predominantly abandoned area)
higher annual income of HHs (in the case of paddy and abandoned areas)
- larger total land area (in the case of predominantly rubber and abandoned areas)
- larger size of HHs' owned land (in every areas)
- higher ratio of owned area to total area (in the predominantly paddy area) and
smaller ratio of rental area to total area (in the predominantly paddy area)

In addition, the results also indicate that the willingness to cultivate oil palm differed according to the sources of main HH income. HHs which get their main income from the sale of crops (in the case of predominantly abandoned area) were more likely to be oil palm growers.

The priority weights and the ranks for factors derived from T-AHP, and significance of factors derived from the Wilcoxon signed-ranks test are shown in Table 5. It should be noted that the number of factors used in this analysis was larger than the number which was found from semi-structured interview, largely because an additional factor found from questionnaire survey, skill and knowledge of the farming labourers of the HH, was included. Findings from the field study are as follows.

Expected outcomes of land uses: The expected outcomes of profit, lump sum income, continuous income and own consumption are dominant factors influencing decisions about land use. Expectation of continuous income from oil palm cultivation was important for the decision in traditional land use but dominant in the case of switching from paddy and abandoned areas. In the case of non-switching, several expected outcomes motivated HHs to continue paddy and rubber cultivation. They were to gain output for own consumption from paddy cultivation, to receive profit from rubber cultivation, to earn a lump sum income from paddy, and to earn lump sum income from rubber cultivation. In addition, gaining benefit from government policy was ranked as an important motivation including to gain government subsidy in continuing rubber cultivation and to gain high price from government price policy and disaster assistance in continuing paddy cultivation.

Financial factors: Saving for investing in oil palm was important for allowing respondents to switch their land to oil palm. It was a dominant factor in the case of paddy

and abandoned areas and as an important factor in the case of rubber areas. Other sources of money for investment were also ranked as important factors: availability of government subsidy for switching in all traditional land use; and availability of credit for abandoned areas. In the case of non-switching, lack of saving for investment, government subsidy was the important barriers in switching in abandoned areas.

Natural resource factors: Land topography was ranked as an important factor for the decision in switching all traditional land to oil palm especially as the dominant factor in the case of rubber and abandoned areas. While not ranked as the dominant factor, concerns over flooding was important for the decision to switch from all traditional land use and diseases and pests were an important factor for the decision in switching from rubber areas. In the case of non-switching, advantages of land topography and transportation were ranked highly as a motivating factor to continue traditional land use. Specifically these were suitability of land topography for rubber and paddy cultivation, sufficiency of water supply and having an irrigation system for paddy cultivation.

Human factors: Capacity of HH labour was a dominant factor influencing the decision to switch to oil palm from paddy areas and an important factor in the switch from rubber and abandoned areas. Accessibility of employed labour was an important factor influencing the decision in the case of switching to oil palm from paddy and abandoned areas. In the case of non-switching, the significant barriers in switching to oil palm were: lack of capacity of HH labour in paddy, rubber and abandoned areas; and lacks of accessibility of employed labour in rubber area.

Physical factors: Even though not considered to be dominant, several physical factors were ranked as important in terms of influencing a decision to switch traditional areas to oil palm. These were:

- (a) Land right in paddy, rubber and abandoned areas
- (b) Transportation in paddy, rubber and abandoned areas
- (c) Tools and equipment in paddy and abandoned areas.

In the case of non-switching, some physical factors were considered as important barriers in switching to oil palm. These were: difficulty in transportation in paddy rubber and abandoned areas; lack of land right in paddy areas; and lack of tools and equipment in rubber areas.

Social factors: Networks and connections were ranked as the highest priority in the case of switching from abandoned areas and the second priority in the case of switching from paddy and rubber areas. Furthermore, farmer institutions were considered to be important when switching from rubber and abandoned areas. In the case of non-switching, a lack of networks and connections was considered to be important in the decision to leave land abandoned.

The results from this study highlight the diversity of factors which influence land use change in Thailand: The in-depth interviews showed that HHs' decisions in adopting land use strategies depended on their assets and their perceived resilience in dealing with vulnerability contexts, along with the policy and institutional contexts. Indeed a total of thirty three factors were identified as relevant in influencing land use change. The results from interviews, which were confirmed by the structured-questionnaire survey results, indicated that HHs with different land use strategies varied in their HH characteristics. Moreover,

success of switching land to oil palm cultivation was determined by several factors which were classified into two categories: willingness-related factors and capacity-related factors as summarized in Figure 3. Based on the findings from the semi-structured interviews, it is suggested that willingness to undertake change is a necessary condition for starting the decision process. Several respondents, especially in rubber area, have capacity to change their rubber to oil palm cultivation. However, the decision process could not be started because of lack of willingness to change. Factors relevant to willingness to change are outcome expectation and social networks and connections. In addition, capacity to undertake change is another condition which determines whether the land use switching is successful. Factors relevant to capacity to undertake change are relevant to finance, labour, capital, land rights and transportation.

4. Discussion

Identifying the exact factors determining whether the HHs decide to switch their land to cultivate oil palm via the implications of HHs' behaviour is very challenging. This is because HHs adopt various land use strategies for dealing with the circumstances that they faced. However a combination of SL framework and T-AHP developed in this study allowed the identification of the key factors at play in the decisions.

Even though the SL framework has been widely employed in explaining land use change, it has mostly been used as a guideline or checklist to scope and identify the possible variables for building empirical models with only some elements of the framework chosen according to the hypothesis and data availability. To date, the SL framework has not been empirically validated in the field of land use change. Based on the findings from both

the qualitative and quantitative dimensions of the research reported here, HH decisions in adopting various land use strategies which were determined by the connections, linkages and trades-off between the various elements confirms the practical use of the SL framework in this field.

T-AHP was employed to identify factors influencing complex decisions about land use change. T-AHP converts the pair-wise comparisons of the factors evaluated by the respondents to numerical weights which can be compared to one another in a rational and consistent way. The T-AHP allows the entire range of potential factors to be put into the same model by using a small sample size. Alternative quantitative approaches, such as logistic regression analysis, tend to require large sample sizes. Moreover, using T-AHP helps to reduce measurement bias. The numerical weights of factors are converted from a series of judgments based on pair-wise comparisons of the factors instead of being weighted by respondents which might be distorted by central tendency, acquiescence and/or social desirability bias. Due to the fact that AHP has to date not been used in identifying factors influencing land use change, this research provides an alternative methodology that deserve further investigation in this field.

In terms of empirical findings from data analysis, the influence of HH characteristics, willingness-related factors and capacity-related factors on the decision process and the success of switching as shown in Figure 3 were discussed below.

Firstly, differences were identified between HHs who switched all or some of their land to oil palm cultivation and HHs who maintained a more traditional use of their land (i.e. did not switch). The findings revealed that the decision whether to switch the land to oil palm was found to be heavily influenced by variables related to the HHs characteristics (age,

education, number of HH farming labourers, income, sources of income, land size, area owned, and ratio of owned and rental area to total land area). This is consistent with previous studies of land use decision making which showed that they were affected by HH demographics and educational level (Caviglia-Harris 2005, Pan and Bilsborrow 2005), HH income (Pacheco 2009, Roy Chowdhury 2006), farm size (Rosenqvist et al. 2000, Shively 1999) and land ownership type (Pichón 1996, Roy Chowdhury 2010).

Secondly, outcome expectation and social networks were willingness-related factors which determined whether HHs preferred to cultivate oil palm. HHs commonly allocated their land to cultivate crops for meeting their needs in food and income from sale of tree products. Rubber cultivation was continued because it could provide a higher profit than alternatives while paddy rice satisfied the HHs because it provided food for HH consumption and an income to underpin household liquidity. Continuous income and higher profit were expected from switching to oil palm cultivation. These findings corroborate the Law of Rent (Ricardo 1821), which suggests that decisions regarding land use are primarily influenced by the economic return of outputs produced from the land. Moreover, it is also in line with Godoy (1992), Emtage and Suh (2004), Feintrenie et al. (2010) and Ndayambaje et al. (2012) who indicated that economic returns were the primary determinants of land use change. In addition, further findings revealed that the HHs also took into consideration the relevant factors which affected the expected outcomes. These additional factors were productivity factors (land topography, water supply, flooding and disease and pests), price factors (price trend, price stability, and price policy), and assistance factors (disaster assistance and government subsidy). Overall, these findings are consistent with the ideas of Geist and Lambin (2002) and Bajocco et al. (2016) who suggest that land conditions influencing

productivity (e.g. soil quality, topography, droughts and floods) were important influences behind land use change.

In respect of social networks and connections, learning about successes and advantages of oil palm cultivation via a variety of social communications did motivate HHs interest in cultivating oil palm. These results match those of Jager et al. (2000) who suggested that farmers may repeat production or imitate the best practice of others so as to use their limited resources efficiently. Imitation is a method adopted by land managers in situations where they have various options (Pomp and Burger 1995). Nonetheless, the exchange of information between individuals is important in influencing the adoption of innovations (Berger 2001).

Finally, the results indicated that capacity-related factors determined whether HHs succeeded in switching to oil palm cultivation. These factors were roughly classified into five groups relevant to finance, labour, capital, land rights and transportation. Financial factors are the strongest determinants making land use switching successful. This is in line with earlier reports (such as Arnold and Falconer 1989, Brown 2000, Bull et al. 2006, Cossalter and Pye-Smith 2003, Hill 1986, McGaughey and Gregersen 1988, Murray 1987, Skutsch 1983, Whiteman 2003) suggesting that financial conditions, such as HH savings, credit and/or government subsidy could support HHs in switching land use successfully. In terms of capacity of labour and capital, the findings of the current study are consistent with those of Mekonnen (1998) Patel et al. (1995) and Dewees (1993) who suggested capacity of labour and capital as the factors considered by HHs in deciding commercial tree cultivation. In the case of land rights, the findings indicated that lack of absolute land use rights made switching traditional crops to oil palm cultivation impossible. This corroborates the ideas of Lele and Stone (1989) and Rasul and Thapa (2003), who suggested that insecure land

tenure was the factor restricting farmers to traditional land use practices. Finally, consistent with previous studies (Blackman et al. 2008, Blackman et al. 2012, Gatto et al. 2015, Serneels and Lambin 2001), the findings indicate that difficulty of access to the plots is an important factor influencing the land to be used for traditional crops or left abandoned.

Even though several factors determined whether switching to oil palm cultivation was successful, one unanticipated finding was the important role played by both a willingness and capacity to undertake change in determining the success of switching to oil palm cultivation. This is in line with studies of McCuaig and Manning (1982), Manning (1972) and Mandale (1984) that mentioned these conditions as determinants of land use change. In particular, the empirical results of Manning (1972) and Mandale (1984) revealed that the nature and pace of land use change were dependent on the landowners' ability or willingness to undertake changes. Moreover, consistent with the decision process for rural land use change revealed by McCuaig and Manning (1982), this study confirmed that both willingness and capacity to undertake change are simultaneously required as the prerequisite conditions of successful land use switching.

In addition, the findings from the semi-structured questionnaires suggest that willingness to undertake change is a necessary condition for starting the decision process while capacity to undertake change is a sufficient condition which determines whether the land use switching is successful. Without willingness, several plots were retained for traditional uses, whereas HHs with willingness but lacking the capacity could not succeed in switching. The findings of the current study indicate clearly that willingness to change or the capacity to do so could not guarantee success of land use switching by themselves. The switching would be successful only if willingness and capacity occurred simultaneously. This finding was interesting because it provides contextual insight explaining why some HHs

could not succeed in oil palm cultivation even though they have the willingness or capacity to change.

Due to a lack of empirical evidence to explain land use decision making such as what constitutes willingness and capacity to undertake change and the trade-offs between them, further research should be carried out employing a structural equation modelling (SEM) technique to test the more complicated hypotheses about land use decisions. SEM provides better understanding of complex phenomena involving multiple variables and is also able to construct latent variables that are not directly observed but are estimated in the model from other observed variables. Latent variable allow the estimation of structural relations of observable variables and additional latent variables to be more accurate (Schumacker and Lomax 2010).

In terms of policy implementation, the analysis reveals that there are several dominant factors influencing the decision in switching paddy to oil palm cultivation: continuous income; networks and connections; saving for investment; and capacity of HH labour. This finding confirms that it is possible for paddy to be substituted by oil palm cultivation. However, the findings are not properly justified from the energy policy point of view of Thailand. This is because oil palm was strictly promoted mainly for non-food areas to make sure that it would not disturb food areas (Preechajarn and Prasertsri 2011, Wattana 2014). In order to follow up the loss of paddy area and solve the resultant problems effectively in time, this study suggests the government should conduct monitoring of the relevant factors influencing land use switching from paddy to oil palm cultivation. The lack of such monitoring is likely to pose the challenge of food or fuel dilemma.

5. Conclusion

This study highlighted the determining factors influencing land use decisions based on the implications of the perspectives, motivations and behaviours of local landowners in Thailand. Qualitative analysis revealed that HHs adopted the most appropriate land use strategy for their livelihood. Regarding the capacity to manage the land in the way that HHs preferred, the findings showed that it is largely dependent on expected income, HH assets and resilience to deal with vulnerability contexts, and policy and institutional contexts. Based on this finding, 23 factors were identified as the potential factors influencing land use decision. According to quantitative analysis for identify exact factors influencing decision to cultivate oil palm, the results indicated that there are differences in the basic household profiles of oil palm growers and non-growers. The likelihood to cultivate oil palm was associated with HH human resource (age, education, and number of farming labourers), and HH wealth (income and occupied land area). In addition, verification of the potential factors by statistical analysis indicated that success of switching land to oil palm cultivation was determined by several factors. They were classified into two categories: willingness-related factors and capacity-related factors. Willingness-related factors are relevant to outcome expectation and social networks and connections while capacity-related factors are relevant to finance, labour, capital, land rights and transportation.

This study clearly confirms that the SL framework could be practically used in the field of LUC to explain HH decisions in adopting various land use strategies which were determined by the connections, linkages and trades-off between the various elements. In addition, factors relevant to the HH asset, the vulnerability context, the institutional and political environment, and the expected outcomes of land use play an important role for HH in adopting various land use strategies. Moreover, the results derived from observing

perspectives, motivations and behaviours of local landowners go beyond LUC modelling approaches relying on computer simulations or extrapolations of historic data, which often analyze LUC without explaining them. Improved understanding of determinants of land use for biofuel crop is an important precondition to design sustainable biofuel development.

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Table 1. Summary of land use strategies of the key respondents

Key respondents	Stable abandoned	Abandoned to oil palm	Abandoned to rubber	Abandoned to other crop	Stable paddy	Paddy to oil palm	Paddy to livestock	Stable rubber	Rubber to oil palm
C1	✓	✓		✓				✓	
C2	✓				✓	✓	✓		
C3		✓				✓	✓		
C4					✓				
C5					✓				
C6					✓	✓			
P1		✓						✓	✓
P2		✓						✓	✓
P3								✓	✓
P4			✓					✓	

Table 2. Summary of sample size of questionnaire respondents

Land categories/ Districts	Sample size	Oil palm grower categories		Land use strategies					
		OP grower	NOP grower	Continuing paddy cultivation	Switching paddy to oil palm cultivation	Continuing rubber cultivation	Switching rubber to oil palm cultivation	Continuing leaving land abandon	Switching abandon area to oil palm cultivation
Predominantly paddy area									
Chianyai	30	24	6	21	18	-	-	3	9
Ranote	30	15	15	26	15	-	-	-	-
Predominantly rubber area									
Prasaeng	30	27	3	-	-	29	12	-	15
Bannadern	30	20	10	-	-	29	6	-	14
Predominantly anandoned area									
Chalermprakiet	30	30	-	1	8	-	-	4	22
Sathingpra	30	3	27	19	1	-	-	30	2
Total	180	119	61	67	42	58	18	37	62

Note: Table shows the number of respondents engaged in the strategy. Each HH may have adopted more than one land use strategy and this explains why row totals do not equate to the sample size.

Table 3. Factors influencing land use decision

Factors
Expected outcomes of land use
1. Profit
2. Lump sum income
3. Continuous income
4. Own consumption
Financial factors
5. Saving for investment
6. Credit for investment
7. Price stability
8. Trend of price
9. Policy of price
10. Government subsidy
Natural resource factors
11. Land topography
12. Water supply
13. Diseases/pests
14. Flooding
15. Disaster assistance
Human factors
16. Capacity of HH labour
17. Accessibility of employed labour
Physical factors
18. Transportation
19. Tools and equipment
20. Irrigation
21. Land rights
Social factors
22. Networks and connections
23. Farmer institutions

Table 4. Similarities and differences among the basic HH characteristics of OP growers and NOP growers

Characteristics	Predominantly paddy area OP grower (n=39) NOP grower (n=21)	Predominantly rubber area OP grower(n=47) NOP grower (n=13)	Predominantly abandoned area OP grower (n=47) NOP grower (n=13)
1. Age of HHH (years) (Pearson Chi-Square)	3.436 ^{NS}	0.098 ^{NS}	6.163* HHs who are younger than 61 years old were more likely to be OP growers (72%) than NOP growers (48%)
2. The number of years HH have lived there (years) (Pearson Chi-Square)	0.923 ^{NS}	1.013 ^{NS}	2.926 ^{NS}
3. Education of HHHs (Pearson Chi-Square)	4.510* HHs who completed education higher than high school were more likely to be OP growers (41%) than NOP growers (14%)	2.455 ^{NS}	0.003 ^{NS}
4. Number of family members (Pearson Chi-Square)	0.001 ^{NS}	6.269 ^{1/}	0.063 ^{NS}
5. Number of household farming labourers (Pearson Chi-Square)	0.220 ^{NS}	0.908 ^{1/}	6.128* HHs who have more than one farm labourer were more likely to be OP growers (78%) than NOP growers (48%)
6. Annual income of HH (Baht) (Pearson Chi-Square)	6.128* HHs with more than 200,000 Baht were more likely to be OP growers (67%) than NOP growers (33%)	1.159 ^{NS}	10.094** HHs with more than 200,000 Baht were more likely to be OP growers (55%) than NOP growers (15%)
7. Source of main income (Pearson Chi-Square)	2.308 ^{2/}	0.572 ^{2/}	4.877* HHs who get their main income from the sale of crops were more likely to be OP growers (82%) than NOP growers (56%)
8. Total land area (Ha.) (Pearson Chi-Square)	3.730 ^{NS}	8.748** HHs who occupy a total area of over four Ha were more likely to be OP growers (62%) than NOP growers (15%)	6.607* HHs who occupy a total area of over two Ha were more likely to be OP growers (72%) than NOP growers (33%)
9. Area owned (Ha.) (Pearson Chi-Square)	8.308** HHs who own an area of over three Ha were more likely to be OP growers (72%) than NOP growers	8.748** HHs who own an area of over four Ha were more likely to be OP growers (62%) than NOP growers	6.877** HHs who own an area of over two Ha were more likely to be OP growers (64%) than NOP growers

	(33%)	(15%)	(30%)
10. Area owned/total land area (%) (Pearson Chi-Square)	7.253** HHs who owned more than 50% of the land they work were more likely to be OP growers (85%) than NOP growers (52%)	NA	0.599 ^{2/}
11. Rental area (Ha.) (Pearson Chi-Square)	3.799 ^{NS}	NA	0.599 ^{2/}
12. Rental area/total land area (%) (Pearson Chi-Square)	4.835* HHs with less than 25.01% rental land were more likely to be OP growers (72%) than NOP growers (43%).	NA	0.599 ^{2/}

Note:

* = significant at $p < 0.05$; ** = significant at $p < 0.01$, *** = significant at $p < 0.001$,

NA = No statistics are computed because data is a constant,

1/ = Invalid statistic because one cell of cross-tabulation for Chi-square analysis has expected count less than 5

2/ = Invalid statistic because two cells of cross-tabulation for Chi-square analysis have expected count less than

Table 5. The priority weights, ranks and influences for factors influencing HHs' land use strategies

Factors / Land use strategies	Continuing paddy cultivation		Switching paddy to oil palm cultivation		Continuing rubber cultivation		Switching rubber to oil palm cultivation		Continuing leaving land abandon		Switching abandon area to oil palm cultivation	
	Weight (%)	Rank	Weight (%)	Rank	Weight (%)	Rank	Weight (%)	Rank	Weight (%)	Rank	Weight (%)	Rank
Expected outcomes of land use												
Profit	3.78	11	3.77	10	5.6	2	4	13	3.8	6	3.9	10
Lump sum income	5.99	3	3.42	17	4.49	5	3.37	18	3.8	6	3.28	17
Continuous income	3.51	17	7.1	1	3.78	10	4.38	8	3.8	6	6.12	3
Own consumption	6.57	1	3.34	19	3.65	13	3.37	18	3.8	6	3.28	17
Financial factors												
Saving for investment	3.63	12	6.25	3	3.72	12	5.43	3	6.5	1	5.93	4
Credit for investment	3.51	17	3.67	13	3.65	13	3.58	14	3.8	6	3.65	13
Price stability	3.58	15	3.34	19	3.65	13	3.37	18	3.8	6	3.33	15
Trend of price	3.51	17	3.34	19	3.65	13	3.37	18	3.8	6	3.28	17
Policy of price	3.97	10	3.34	19	3.65	13	3.37	18	3.8	6	3.28	17
Government subsidy	3.56	16	3.76	11	4.05	7	5.05	4	4.45	5	3.69	11
Natural resource factors												
Land topography	5.47	4	4.56	7	7.43	1	6.73	1	3.8	6	6.39	2
Water supply	4.37	8	3.49	14	3.65	13	3.56	15	3.8	6	3.28	17
Diseases/pests	3.51	17	3.45	15	3.88	9	4.56	6	3.8	6	3.28	17
Flooding	3.51	17	4.62	6	3.65	13	4.95	5	3.8	6	5.34	5
Disaster assistance	4.45	7	3.45	15	3.65	13	3.37	18	3.8	6	3.28	17

Table 5. (Continued)

Factors / Land use strategies	Continuing paddy cultivation		Switching paddy to oil palm cultivation		Continuing rubber cultivation		Switching rubber to oil palm cultivation		Continuing leaving land abandon		Switching abandon area to oil palm cultivation	
	Weight (%)	Rank	Weight (%)	Rank	Weight (%)	Rank	Weight (%)	Rank	Weight (%)	Rank	Weight (%)	Rank
Human factors												
Capacity of HH labour	6.15	2	5.78	4	5.53	4	4.29	9	5.9	2	4.82	7
Skill/Knowledge	3.61	13	3.42	17	3.75	11	3.55	16	3.8	6	3.31	16
Accessibility of employed labour	3.51	17	3.72	12	4.43	6	4.06	12	3.8	6	4.02	9
Physical factors												
Transportation	3.99	9	4.25	8	5.6	2	4.29	9	5.4	4	4.48	8
Tools and equipment	3.59	14	4.12	9	3.99	8	3.51	17	3.8	6	3.47	14
Irrigation	4.62	5	3.34	19	3.65	13	3.37	18	3.8	6	3.28	17
Land rights	4.58	6	4.85	5	3.65	13	4.42	7	3.8	6	5.22	6
Social factors												
Networks and connections	3.51	17	6.29	2	3.65	13	5.85	2	5.45	3	6.45	1
Farmer institutions	3.51	17	3.34	19	3.65	13	4.17	11	3.8	6	3.67	12

Note: Table show priority weights, ranks and influences for factors influencing HHs' decisions to adopt land use strategies

- Dominant-influence factor: a factor in the group of very-high-ranked factors for which the priority weights might not be statistically significantly different among them but were statistically significantly different from other lower-ranked factors
- Normal-influence factor: a factor that was mentioned by respondents, and of which the priority weight was statistically significantly different from the weight of factors not mentioned by the respondents ( ) and the weight of factors in the dominant group ( )
- Non-influence factors: a factor that was not mentioned by the respondents, or a factor that was mentioned by the respondents but of which the priority weight was not statistically significantly different from the weight of factors not mentioned by the respondents

Figure 1. Area of paddy rice, natural rubber and oil palm in the south of Thailand.

Source: OAE(2012)

Figure 2. Location of the study areas in Thailand

Figure 3. Factors influencing land use decisions

Supplementary online information: Similarities and differences among the basic HH characteristics of OP growers and NOP growers

Characteristics	Predominantly paddy area		Predominantly rubber area		Predominantly abandoned area	
	OP grower (n=39)	NOP grower (n=21)	OP grower (n=47)	NOP grower (n=13)	OP grower (n=47)	NOP grower (n=13)
1. Age of HHH (years)	< 61 years: 28 HHs (72%)	< 61 years: 10 HHs (48%)	< 51 years: 24 HHs (51%)	< 51 years: 6 HHs (46%)	< 61 years: 27 HHs (82%)	< 61 years: 14 HHs (52%)
	>= 61 years: 11 HHs (28%)	>= 61 years: 11 HHs (52%)	>= 51 years: 23 HHs (49%)	>= 51 years: 7 HHs (54%)	>= 61 years: 6 HHs (18%)	>= 61 years: 13 HHs (48%)
	Pearson Chi-Square 3.436 ^{NS}		0.098 ^{NS}		6.163*	
2. The number of years HH have lived there (years)	< 41 years: 18 HHs (46%)	< 41 years: 7 HHs (33%)	< 41 years: 29 HHs (62%)	< 41 years: 6 HHs (46%)	< 41 years: 17 HHs (52%)	< 41 years: 8 HHs (30%)
	>= 41 years: 21 HHs (54%)	>= 41 years: 14 HHs (67%)	>= 41 years: 18 HHs (38%)	>= 41 years: 7 HHs (54%)	>= 41 years: 16 HHs (48%)	>= 41 years: 19 HHs (70%)
	Pearson Chi-Square 0.923 ^{NS}		1.013 ^{NS}		2.926 ^{NS}	
3. Education of HHHs	< High school: 23 HHs (59%)	< High school: 18 HHs (86%)	< High school: 21 HHs (45%)	< High school: 9 HHs (69%)	< High school: 23 HHs (70%)	< High school: 19 HHs (70%)
	>= High school: 16 HHs (41%)	>= High school: 3 HHs (14%)	>= High school: 26 HHs (55%)	>= High school: 4 HHs (31%)	>= High school: 10 HHs (30%)	>= High school: 8 HHs (30%)
	Pearson Chi-Square 4.510*		2.455 ^{NS}		0.003 ^{NS}	
4. Number of family members	< 5 persons: 24 HHs (62%)	< 5 persons: 13 HHs (62%)	< 5 persons: 38 HHs (81%)	< 5 persons: 6 HHs (46%)	< 5 persons: 23 HHs (70%)	< 5 persons: 18 HHs (67%)
	>= 5 persons: 15 HHs (38%)	>= 5 persons: 8 HHs (38%)	>= 5 persons: 9 HHs (19%)	>= 5 persons: 7 HHs (54%)	>= 5 persons: 10 HHs (30%)	>= 5 persons: 9 HHs (33%)
	Pearson Chi-Square 0.001 ^{NS}		6.269 ^{1/}		0.063 ^{NS}	
5. Number of household farming labourers	=1 person: 9 HHs (23%)	=1 person: 6 HHs (29%)	<= 2 persons: 32 HHs (68%)	<= 2 persons: 7 HHs (54%)	=1 person: 7 HHs (21%)	=1 person: 14 HHs (52%)
	> 1 person: 30 HHs (77%)	> 1 person: 15 HHs (71%)	>2 persons: 15 HHs (32%)	>2 persons: 6 HHs (46%)	> 1 person: 26 HHs (78%)	> 1 person: 13 HHs (48%)
	Pearson Chi-Square 0.220 ^{NS}		0.908 ^{1/}		6.128*	
6. Annual income of HH (Baht)	< 200,001Baht: 13 HHs (33%)	< 200,001Baht: 14 HHs (67%)	< 300,001Baht: 21 HHs (45%)	< 300,001Baht: 8 HHs (62%)	< 200,001Baht: 15 HHs (45%)	< 200,001Baht: 23 HHs (85%)
	>=200,001Baht: 26 HHs (67%)	>=200,001Baht: 7 HHs (33%)	>=300,001Baht: 26 HHs (55%)	>=300,001Baht: 5 HHs (38%)	>=200,001Baht: 18 HHs (55%)	>=200,001Baht: 4 HHs (15%)
	Pearson Chi-Square 6.128*		1.159 ^{NS}		10.094**	
7. Source of main income	Sale of crops: 35 HHs (90%)	Sale of crops: 21 HHs (100%)	Sale of crops: 45 HHs (96%)	Sale of crops: 13 HHs (100%)	Sale of crops: 27 HHs (82%)	Sale of crops: 15 HHs (56%)
	Non-sale of crops: 4 HHs (10%)	Non-sale of crops: 0 HHs (0%)	Non-sale of crops: 2 HHs (4%)	Non-sale of crops: 0 HHs (0%)	Non-sale of crops: 6 HHs (18%)	Non-sale of crops: 12 HHs (44%)
	Pearson Chi-Square 2.308 ^{2/}		0.572 ^{2/}		4.877*	

Supplementary online information. (Continued)

Characteristics	Predominantly paddy area		Predominantly rubber area		Predominantly abandoned area	
	OP grower (n=39)	NOP grower (n=21)	OP grower (n=47)	NOP grower (n=13)	OP grower (n=47)	NOP grower (n=13)
8. Total land area (Ha.)	<= 5 Ha: 14 HHs (36%)	<= 5 Ha: 13 HHs (62%)	<= 4 Ha: 18 HHs (38%)	<= 4 Ha: 11 HHs (85%)	<= 2 Ha: 11 HHs (33%)	<= 2 Ha: 18 HHs (67%)
	> 5 Ha: 25 HHs (64%)	> 5 Ha: 8 HHs (38%)	> 4 Ha: 29 HHs (62%)	> 4 Ha: 2 HHs (15%)	> 2 Ha: 22 HHs (67%)	> 2 Ha: 9 HHs (33%)
Pearson Chi-Square	3.730 ^{NS}		8.748**		6.607*	
9. Area owned (Ha.)	<= 3 Ha: 11 HHs (28%)	<= 3 Ha: 14 HHs (67%)	<= 4 Ha: 18 HHs (38%)	<= 4 Ha: 11 HHs (85%)	<= 2 Ha: 12 HHs (36%)	<= 2 Ha: 19 HHs (70%)
	> 3 Ha: 28 HHs (72%)	> 3 Ha: 7 HHs (33%)	> 4 Ha: 29 HHs (62%)	> 4 Ha: 2 HHs (15%)	> 2 Ha: 21 HHs (64%)	> 2 Ha: 8 HHs (30%)
Pearson Chi-Square	8.308**		8.748**		6.877**	
10. Area owned/total land area (%)	<= 50: 6 HHs (15%)	<= 50: 10 HHs (48%)	-	-	<100: 1 HH (3%)	<100: 2 HHs (7%)
	> 50: 33 HHs (85%)	> 50: 11 HHs (52%)	-	-	=100: 32 HHs (97%)	=100: 25 HHs (93%)
Pearson Chi-Square	7.253**		-		0.599 ^{2/}	
11. Rental area (Ha.)	<= 2 Ha: 30 HHs (76%)	<= 2 Ha: 11 HHs (52%)	-	-	= 0 Ha: 32 HHs (97%)	= 0 Ha: 25 HHs (93%)
	> 2 Ha: 9 HHs (23%)	> 2 Ha: 10 HHs (48%)	-	-	> 0 Ha: 1 HH (3%)	> 0 Ha: 2 HHs (7%)
Pearson Chi-Square	3.799 ^{NS}		-		0.599 ^{2/}	
12. Rental area/total land area (%)	<= 25: 28 HHs (72%)	<= 25: 9 HHs (43%)	-	-	=0: 32 HHs (97%)	=0: 25 HHs (93%)
	> 25: 11 HHs (28%)	> 25: 12 HHs (57%)	-	-	>0: 1 HH (3%)	>0: 2 HHs (7%)
Pearson Chi-Square	4.835*		-		0.599 ^{2/}	

Note: Table shows similarities and differences among the basic HH characteristics of OP growers and NOP growers

* = significant at $p < 0.05$; ** = significant at $p < 0.01$, *** = significant at $p < 0.001$,

NA = No statistics are computed because data is a constant,

1/ = Invalid statistic because one cell of cross-tabulation for Chi-square analysis has expected count less than 5

2/ = Invalid statistic because two cells of cross-tabulation for Chi-square analysis have expected count less than 5