UNIVERSITY OF COPENHAGEN
FACULTY OF SCIENCE

Development Discrepancy

A study of agrochemical land cultivation in the context of sustainable government incentives in Ban Ba Yai

Interdisciplinary Land Use and Natural Resource Management

April 6th, 2018

Authors:
Anna Sofie Starup Andersen
Christina Schwöppe
Emil Borello Skjødt
Louise Strange
Monica Quevedo
Morten Hørkild Sten

Word count: 11.617

Declaration

Supervisors:

Thorsten Treue
Daniel Ortiz Gonzalo

Authors:

Anna Sofie Starup Andersen – htv815

Christina Schwöppe – sqw866

Emil Borello Skjødt – fkr508

Louise Strange – mjw995

Monica Quevedo – zrm329

Morten Hørkild Sten – fm214

Table of authors:

Section	**Authors**
Abstract	ALL
Introduction	ALL
Methodology	ALL
Results	ALL
Discussion	ALL
Conclusion	ALL

Abstract

In the aftermath of the Green Revolution in the 1960s an inherent proliferation of agrochemicals was experienced. Excessive use of agrochemicals exert a negative impact on the environment leading to soil depletion. In relation to this, the Royal Thai Government is attempting to implement capacity building programs for farmers to reduce chemical inputs. This project aims at understanding the rationale behind farming practices in the village of Ban Ba Yai in northeast Thailand, where farmers' remain applying agrochemicals on their fields despite such government programs. Our results show that multiple factors such as the historical agricultural development in Ban Ba Yai, poor soil conditions as well as formal and informal institutions all influence farmers' choice of agricultural practices. Moreover, farmers' perceptions on sustainable agriculture conflict with the government programs. In sum, our project shows that a gap remains between policy makers and local farmers, which results in government programs having little effect in creating change in Ban Ba Yai.

Acknowledgements

This report is part of the SLUSE 2018 Joint Field Course in Thailand, in cooperation between Roskilde University and University of Copenhagen in Denmark, and Kasetsart University in Thailand. Firstly, we would like to thank SLUSE for the opportunity to do fieldwork in the rural setting of Ban Ba Yai. The input, guidance and effort of Thai teachers from Kasetsart University, Dr. Naroon Waramit, Dr. Chatchai Ngernsaengsaruay, Dr. Wannana Soontornnaruerangsee and SLUSE coordinators is very much appreciated and helpful. In addition, we thank our supervisors from the University of Copenhagen, Dr. Thorsten Treue and (soon to be Dr.) PhD-student Daniel Ortiz-Gonzalo, for providing us valuable critiques and comments as well as being available and welcoming from early morning to late evening during the entire course. This fieldwork was conducted in collaboration between the students from University of Copenhagen and the students of Kasetsart University in Bangkok. Therefore, we extend special gratitude to our counterparts from Thailand and the Philippines; Ciara Sophia L. Roxas, Nanthaporn Usaard and Ton Ruechekorn, without whom we would not have achieved as much as we did. The same for our interpreters, Nisa Kp T.T. and Chonlawit Tosing, for being very professional and enlightening. They are truly great company and we thank them for good times and coffee trips with our hopes of meeting again. We would also like to express our gratitude to the villagers of Ban Ba Yai who opened their homes and village to us. Finally, we thank Wang Nam Khiao District Office, Agricultural Extensionist Mr. Teeipar Sriksonyoo as well the Head of Sub-District Office in Udom Sap Sub-District, Mr. Phiset (our driver), and the Village Headman, Mr. Thanet Wanking, whom was always available to help us, even if we were just dropping by without an official appointment. Thank you all.

TEAM BAN BA YAI

CONTENTS

List of Tables and Figures

Abbreviations

BBY	Ban Ba Yai village
C	Carbon
DO	Dissolved Oxygen
EC	Electrical Conductivity
F	Female
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GPS	Global Positioning System
HH	Household
MC	Mainly chemical input farming
MO	Mainly organic input farming
M	Male
N	Nitrogen
P	Phosphorus
OECD	The Organisation for Economic Co-operation and Development
PLEN	Department of Plant and Environmental Sciences
PRA	Participatory Rural Appraisal
RCT	Random Choice Theory
SOM	Soil organic matter
SQ	Sub-question
SSI	Semi-structured interview

1. Introduction

In Thailand, agriculture has played a significant part in the development of the national economy as well as in raising the general standard of living amongst people. Agriculture today engages approximately 40% of the Thai workforce and plays an important role in rural livelihoods in relation to household consumption and for income generation (OECD, 2013). This was mainly achieved through reforms in the agricultural sector in the context of the Green Revolution of the late 1960s; a movement with the aim of increasing yields and ensuring food security for growing populations, agrochemicals, new crop varieties, and other technologies were introduced (Hazell, 2009). Thus, agricultural intensification has been evident in Thailand with its increasing use of agrochemicals since the 1960s (Kasem & Thapa, 2011).

The presiding ideology of development in the early 1960s' Green Revolution era rested on overall economic growth, where the needs of individuals and communities were less important than the growth of a nation as a whole (Kelly *et al.*, 2012). Although a connection between economic growth and development might seem straightforward, there are many factors influencing the living conditions of people that are not connected to an increasing gross domestic product (GDP). Economic growth is an average figure of a society's wealth and does not automatically include distributive effects and issues of inequality. Further, it is measured in recorded market values, which excludes non-marketed goods such as life expectancy, knowledge, or happiness (Sen, 1988). As a reaction to this, new development policy approaches arose in the 1990s. These had a more participatory focus*,* and aimed at building capacities, thus empowering local villagers to develop skills and knowledge (Kelly *et al.*, 2012).

In the context of excessive use of agrochemicals that exert a negative impact on the environment (German *et al.,* 2017), the Royal Thai Government faces the challenge of mitigating these effects while balancing the reliance of the Thai farmers on agrochemicals for higher yields (Panuwet *et al.*, 2012). In this context, authorities implement workshops and trainings to teach farmers ways of reducing the use of agrochemicals by replacing or supplementing these with organic fertilizers (Agricultural Extensionist, SSI 2018). In our field site, the rural village of Ban Ba Yai (BBY) in northeast Thailand, such workshops have been held to create changes in local agricultural practices. An example of these is the 9101 program aiming at *"cut production costs, increase production and upgrade agricultural product standards"* (The Nation, 2017). Nevertheless, villagers still appear inclined to use agrochemicals on their fields. Hence, our research question is:

Why do the farmers in Ban Ba Yai use agrochemicals in spite of government programs toward more sustainable farming practices?

We unfold this question by addressing the following sub-questions:

***SQ1**. How do soil and irrigation water conditions affect agricultural practices in Ban Ba Yai?*

***SQ2.** How and why have the villagers' cultivation practices changed over time?*

***SQ3.** What institutions affect the choice of agricultural practices in Ban Ba Yai and how?*

***SQ4.** What do villagers perceive as good agricultural practices and how are these related to present government agricultural programs?*

In answering these questions, this report is organized as follows: The chapter successive to the Introduction, briefly presents our theoretical framework. This is followed by chapter 3 which outline our methodology. Following this, chapter 4 presents our results and analysis structured around the four sub-uestions. Furthermore, we critically discuss these results through the lens of our theoretical framework. Critical reflections on methods and results are presented in chapter 6. In conclusion, chapter 7 argues that government programs that solely aim at capacity building seem to not reduce the chemical fertilizer use of farmers, as they are lacking financial incentives to change behavior.

1.1 The Study Site

Our study takes place in the village of Ban Ba Yai, in Nakhon Ratchasima Province (see figure 1). The village is located in the northeast of Thailand, which is known as the rice-basket of Thailand containing the largest area of rice cultivation in the country (Utaranakorn & Yasunobu, 2016). The average temperature in Nakhon Ratchasima Province is 27.1℃ with a range of 20℃– 35 ℃ and an average annual rainfall of 1,093mm/yr (The World Bank Group, 2016). The climate in Thailand is considered tropical wet and dry or savanna climate according to the Köppen-Geiger climate classification (Köppen & Geiger, 1954). This region consists of alluvial lands (Panagos *et al.*, 2011) where soils are mainly podzolic which are typically characterized by low nutrient status and low pH (Osman, 2013) (see Appendix A for the general soil characteristics in the study area). Despite these rather poor soil conditions, the inhabitants of this province are widely engaged in agricultural activities. There are 268 households in BBY, and most of them derive their main income from agriculture (Headman, SSI 2018). Farming systems in BBY are predominantly market oriented crop production systems and livestock is rarely kept. Most of the villagers are small-scale farmers, cultivating about 14 rai of land (median, own questionnaire database). Typical crops include rice, sugarcane, cassava, and corn. Some people also grow vegetables and fruits for own consumption in small scale. In this region, there are three main seasons: The cool period from November until February, the hot period from March to April, and the rainy period from late April to October (Papademetriou & Dent, 2000).

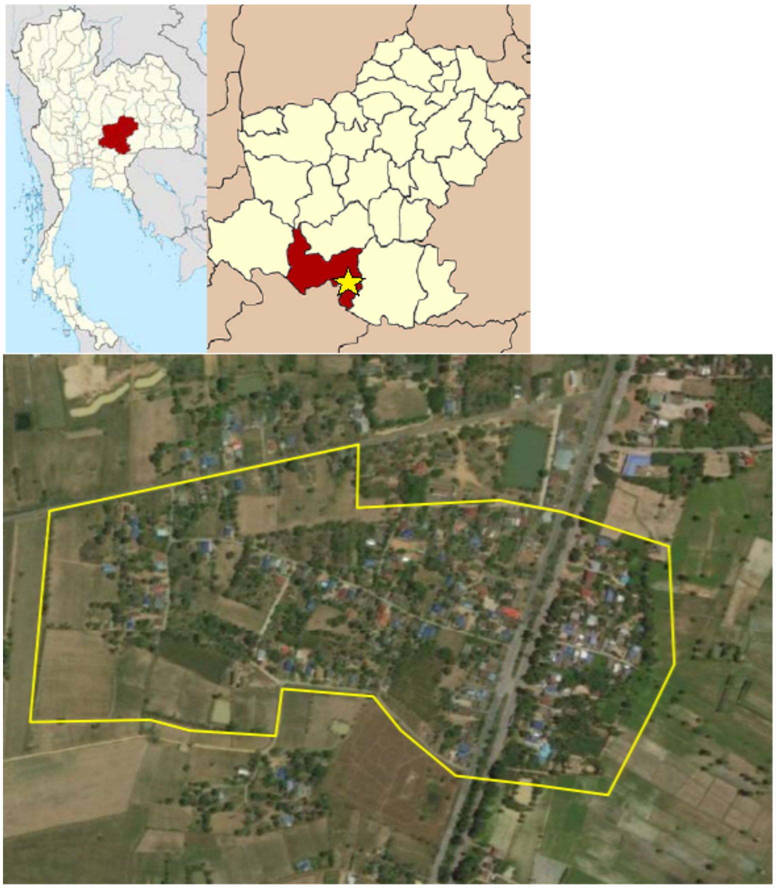


Figure 1: Location of study site and the village boundary

2 Theoretical Framework

In line with the above considerations on economic growth and development, we organize our project around household-level decision making, using the *Rational Choice Theory* (RCT). With the aim of understanding human behavior, RCT assumes that rational individuals maximize their utility through conscious choices. The theory is centered on the identification of available options and the choice of the most preferred according to consistent criteria (Levin & Milgrom, 2004).

In this report, we treat households as unitary units that maximize their utilities according to the RCT. Whether a household adopts practices that are proposed in government programs or not, depends on consistent criteria that are shaped by institutional interplay, possible treadmills, and soil conditions, which will be described in the following.

2.1 The Importance of Institutions

Understanding the role of institutions related to agricultural practices in BBY is central, as they define the incentive structures of societies and economies. Here we follow North's (1991, 97) definition of institutions as the "rules of the game" in a society, which *"are the humanly devised constraints that structure political, economic and social interaction"*. However, Czech (2014) argues that institutions do not represent constraints only, but also create opportunities. Institutions are made up of both formal and informal structures; the formal include laws and regulations, while the informal institutions include elements such as religion, social classes, values, norms, traditions, customs, and codes of conduct (KIT, 2012; North, 1991). However, it is crucial to be aware of the complexity of institutional environments. For instance, even though formal institutions exist in a given environment they may be modified or even overruled by informal institutions (Powell, 1991).

2.2 The Agricultural Treadmill

The past century's new technologies, policies, and production patterns have provided economic opportunities for developing countries. This technological change has been a major driving force in agricultural development, which has greatly affected farm structures and rural economies (Ward, 1993). Although the adoption of technologies has reduced the per-unit financial cost of production while increasing the farmers' output, these technologies are also the reason why prices on farm commodities have decreased immensely over the past century. This phenomenon is referred to as the *agricultural treadmill* (Levins & Cochrane, 1996). When new technology is introduced, the first and often non-risk-averse farmers who adopt them will benefit from the lower unit costs of production and prosper from the increase in output, until other farmers' adoption of the technology increases overall supply and drive prices down. Consequently, farmers find themselves in a treadmill where, to maintain or increase their income, they are forced to adopt new technologies in order to increase production or reduce costs.

2.3 Soil Constraints

One of the most important aspects of farming is soil fertility (Magdoff & Van Es, 2009). Maintaining high soil fertility under continuous intensive cultivation, is a constant challenge for farmers, and can greatly affect the choice of agricultural practices. Soil fertility results from the complex interactions of physical, chemical, and biological properties and can be defined as the ability of the soil to supply nutrients in available forms and in adequate amounts required for normal growth and reproduction of plants (Osman, 2013). Some common parameters of soil fertility are indicated by the amount of nitrogen (N), pH, soil organic matter (SOM) and electrical conductivity (EC). The pH of the soil is an important chemical property that measures the acidity of the soil, which determines the availability of nutrients for the plants (Moebius-Clune *et al.,* 2016). One of the most important plant nutrients, and often the most limiting in tropical soils, is N. Very little of this nutrient is retained in the soil, and much of the N added from fertilizers is lost through leaching or denitrification (Osman, 2013). N deficiencies are often compensated by the application of organic or chemical fertilizers. Most mineral soils contain less than 5% SOM, but this small amount has tremendous effect, providing food for microorganisms, storing nutrients, retaining water and generally making the soil more fertile (ibid.). The decomposition rate of organic matter is controlled by microbial activity, which is higher in tropical soils with warmer climates, and therefore often causes SOM levels to be lower than in temperate soils (Jørgensen, 2010). EC measures the salinity of the soil. All agricultural soils contain some level of salt, which is caused by soil nutrients and the salinity of the irrigation source. However, if the salinity is too high it can have damaging effects on the crops (Osman, 2013).

3 Methodology

This chapter outlines the different methods that we applied to gather data in this project. To answer our research question and sub-questions, we triangulate data by applying both qualitative and quantitative methods. Firstly, we present methods for data collection and after that, we introduce methods for statistical data analysis.

3.1 Data Collection Methods

All data was gathered during a field visit to BBY village (01/03/18-10/03/18, time schedule in Appendix B). During this field work, our interdisciplinary research team[1] consisted of nine students from Copenhagen and Kasetsart University and two interpreters.

3.1.1 Questionnaire Survey

During the field research, we conducted a *household questionnaire* (Olsen, 2006) covering 36 of the total 268 households of BBY. The socioeconomic data obtained serves as input for statistical methods (see section 3.3) and will contribute to addressing sub-questions mainly SQ2 and SQ3. Besides providing socioeconomic data, the questionnaire served as an instrument to identify households for further interviewing, Participatory Rural Appraisal (PRA) sessions and soil sampling. Therefore, the survey was conducted in the beginning of the field trip.

The questionnaire (see Appendix C) was developed in a dynamic process of discussing drafts within our team and with supervisors, pilot-testing, translation, and continuous adjustment. The pilot-testing was undertaken in the field with two household heads in BBY. Despite the limited number of pilot-tests, we identified some logical errors

[1] Note that while this report is solely composed by the students from Copenhagen University, the entire research team contributed to the study design and to the data gathering.

and cultural inadequacies and became more familiar with the questions. The final questionnaire consists of nine questions in four sections: Background, Livelihoods, Agricultural Practices, and Government Programs.

The selection of households was made by *stratified random sampling* (Foreman, 1991) as this technique allows to collect representative and unbiased data within different stratums such as households that adopted practices after attending government workshops and households that continue with their usual practices (for questionnaire distribution see Appendix D). According to the village headman (Headman, SSI, 2018), only few households changed practices according to government programs promoting the reduction or replacement of chemical fertilizer. The headman indicated a list of households that fall into that category. The other households were selected by using the roll of dice (i.e. selecting the next household with a number from 1-6). In case the preselected household was not present the neighbouring household was interviewed. Table 1 shows mean values of key variables (see section 3.2) for both groups (households on list and randomly sampled households).

Table 1: Means of key variables for both stratums

Variable[a]	**HH size**	**Age of hh head**	**Average annual income**	**Debt_THB**	**Attended government program**	**Changed behaviour after program**[b]
Mean random sample	3.8	54.0	0.9	135,728.9	0.5	0.36
Mean HHs on list	4.4	57.9	1	171,999.2	0.7	1
p-value (Significance[c]**)**	0.1852 (/)	0.2141 (/)	0.3473 (/)	0.2593 (/)	0.1470 (/)	0.009 (**)

[a] Variables are explained in the model equations 3.2
[b] if they attended the training
[c] / means no significant difference in mean. *** (**; *) indicates 0.1% (5%; 10%) significance levels.

Whereas there are no significant differences in household size, age of the household head, income levels, debt, and the participation in government programs, 100% of the households on the list that attended a government program, changed their agricultural practices, compared to 36% of the randomly selected households (significance level: 5%). This renders our selection method justified in order to ensure a good representation of households that experiment with agricultural practices taught in the programs.

3.1.2 Soil Sampling and Analysis

With the purpose of comparing soil properties of different cropping systems, we conducted *soil sampling* (FAO, 2006), which revealed site features such as top- and subsoil characteristics. Soil sampling provides us with the input for statistical analyses to understand local conditions for growing crops, as addressed in sub-question SQ1.

We used information from the questionnaire to identify specific sample plots according to the amount of fertilizer used for their rice fields (see table 2 in connection with figure 2). According to our questionnaire data, 30 out of 36 households cultivate rice. Therefore, and due to time constraint, we limited our sampling to rice fields to obtain comparable results. According to the households' fertilizer use, six locations were selected for sampling; three from rather organic rice cropping systems (MO group) and three where mostly chemical fertilizer is used (MC group). Soil samples were taken with a 5cm diameter auger. In each of the rice plots, two composite samples (EPA-SA, 2005) were collected from topsoil (0-20cm) and subsoils (20-60cm). Samples were collected in the border of plots in case of flooded rice fields and in the middle of the field when sites were dry (for distribution of soil samples see Appendix E).

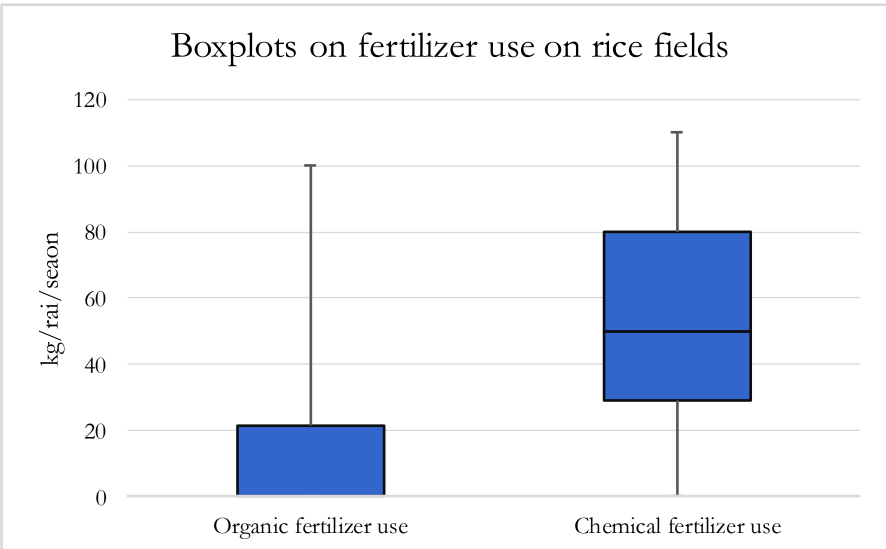


Figure 2: The distribution of MO and MC fertilizer use.

Table 2: Values of MO and MC according to our interview.

	Type of fertilizer (kg/rai/season)	
ID and Group	**Organic**	**Chemical**
1 MO	100	5
2 MO	20	0
3 MO	100	100
4 MC	50	100
5 MC	0	110
6 MC	0	100
Average of all 30 rice farmers	15.21	51.23

The samples were air-dried, grinded and set aside in plastic bags while in Thailand. Once in Denmark, we analysed soil samples at the PLEN university laboratory in Copenhagen. Samples were grinded once more and passed through a 2-mm sieve prior to analysis. Soil texture was determined by the *feel method* (FAO, 2006). We measured the pH and the electrical conductivity (EC) in a 1:2.5 soil:water solution (Peech, 1965; Bower & Wilcox, 1965). Total C and N were analyzed according to the *Dumas Combustion* method (Gonick *et al.*, 1945) using vario MACRO cube elemental analyzer (Elementar Analysensysteme GmbH, Hanau, Germany). Soil Organic Matter (SOM) was calculated using the Van Bemmelen conversion factor 1.72 based on the assumption that organic carbon in soils is 58% of organic matter (Nelson & Sommers, 1982).

3.1.3 Water Sampling and Analysis

Water sampling (Li and Migliaccio, 2011) was conducted to complement soil investigations. Parameters such as nitrates and phosphates were analyzed with the *colorimetric method* (Shinn, 1941). Salinity and pH were measured with a Multiparameter Analyser (Consort C6030). We selected two sites; a pond where three samples were taken, and a stream where two samples were collected (for distribution of water samples see Appendix F). During the hot season, the main function of both water bodies is to serve as irrigation sources for most crops. According to Hanseok *et al.* (2016), in Asia, more than 70% of the total irrigation water is used for rice production. This leads to a direct impact on soil performance and crop yields which makes water sampling useful for our project.

3.1.4 GPS Mapping

While preparing and conducting our fieldwork, we have used satellite images to get an overview of the physical space in and around BBY. We made waypoints with our GPSs of all our activities. Marking sites of questionnaires and soil samples were important to map the spatial distribution of gathered information. To do this, we transferred waypoints into Google Earth Pro (Google Earth, 2018) and onto the GIS-software program ArcMap (ESRI, 2018) through which the maps were made. Hence, the obtained data served to depict the distribution of samples and to facilitate the further analysis as well as giving a graphic presentations.

3.1.5 Semi-Structured Interview

To get a more detailed understanding of the rationale behind agricultural practices in BBY and specifically capturing villagers' perceptions (SQ4), we performed *semi-structured interviews* (SSI, see Appendix G for interview guide) as introduced in Kvale & Brinkmann (2009). We conducted nine interviews; four expert interviews and five interviews with villagers of various age groups, educational backgrounds, income levels, and implementing different cultivation practices. We chose informants based on the questionnaire data to get a diverse picture (see table 3 for an overview of the respondents and characteristics valued as relevant) and their willingness to talk us for further interviewing. The structure of the interview guide is related to our research question and sub-questions.

Table 3: SSI Informants.

Name[2]	Age and gender	Education (years completed)	Land ownership	Income	Cultivation practice (cultivated area in rai in brackets)
Sarawut	74 (M)	4	Own	Below 35,000	Rice (5), MC, irrigation, machinery, sells rice mill.
Tanawat	81 (M)	4	Own	Between 150,000–1,000,000	Rice (22), sugar cane (2), irrigation, machinery, has additional mixed (2) field
Ploy	52 (F)	4	Own	Between 35,000– 150,000	Sugarcane (6), rice (2), no irrigation, machinery, has started sweet potato
Natcha	56 (F)	4	Own	Below 35,000	Rice (15), irrigation, machinery, sells to mill+cooperative (depending on the price).
Praew	36 (F)	18	Own and rented.	Between 150,000–1,000,000	Cassava (75), no irrigation, machinery
Expert interviews: Headman, Assist. Prof. Naroon Waramit (specialist in agricultural practices and agricultural policies) the Agricultural Extensionist of Wang Nam Khiao District Office, and a sub-district official.					

[2] Names of villagers are pseudonyms to guarantee anonymity.

3.1.6 Participatory Rural Appraisal (PRA)

We organized four sessions[3] of *Participatory Rural Appraisal* (PRA) (Chambers, 1981) with the aim of enabling the villagers to express and share their knowledge and experiences concerning agricultural conditions in the village. For these sessions, we took the role of facilitators and aimed at examining farmers' previous experiences and challenges particularly related to agricultural changes. To mitigate the expected language barrier between facilitators, interpreters, and respondents, we prepared and discussed questions with Thai group members prior each session.

Timeline on agricultural development in BBY

The first PRA aimed at reconstructing a timeline focusing on agricultural development in BBY. The seven participants were mainly selected based on their age (60+) to reach as far back into the past as possible. The purpose of this session was to get insights into key events influencing the development of current agricultural practices as well as identifying significant agricultural changes in the past (SQ2). Before the session, we prepared a timeline with different key events (see Appendix H) so that we were able to gather information along the timeline and also to help the participants recall important knowledge. The events were translated into Thai and Buddhist calendar years. We started by presenting the key events as well as asking about the first settlements in BBY. Throughout the session, we asked guiding questions concerning the introduction of central agricultural inputs such as crop types, agrochemicals, heavy machinery, and different influential institutions.

[3] PRA 1 and 2, and PRA 3 and 4 (respectively) took place on the same date with the same villagers participating.

Historical diagramming of crop and fertilizer usage

We continued the second PRA on creating a diagram for crop and fertilizer development. The diagram consists of two columns, one for 1960 and one for 2018. These dates were selected in accordance with results from the timeline, as numerous events happened in the 1970s. The template diagram is depicted in figure 3.

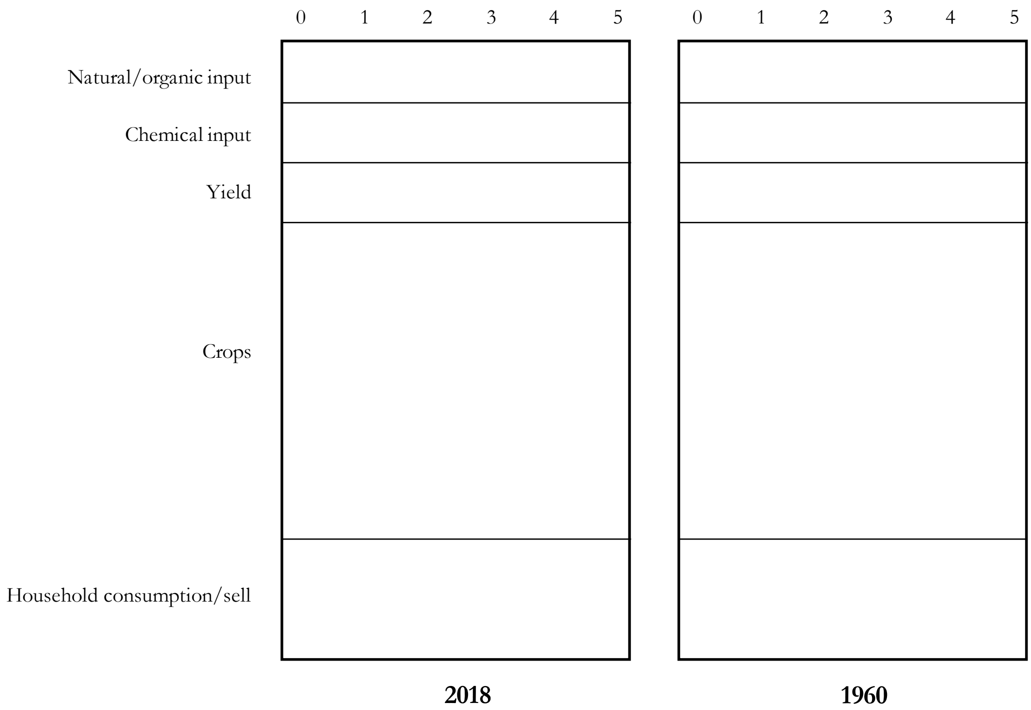


Figure 3: Template diagram for PRA 2.

Beginning from the top of the diagram in the 2018-column, we asked participants to quantify the amount of the first three components (natural or organic input, chemical input and yield) on a scale from 0-5, where 0 = none and 5 = very high. In the crop component participants were asked to place stickers with the different crops as they perceive the current proportion of crop composition. According to the types of crops that the participants placed in the crop component, we then asked them to state how much of their yield is being sold versus consumed. After completing the 2018-column, the same procedure repeated for 1960.

Pros and cons of chemical fertilizers and pesticides

In the third PRA, we facilitated a discussion on advantages and disadvantages of agrochemicals. To ensure diversity, six participants were chosen based on different criteria from the questionnaire such as age, gender, income sources, and participation in government programs. The farmers' daily work with agrochemicals enables them to critically reflect on this type of input.

To open dialogue, participants were first asked to identify which type of agrochemicals are normally used in their crops. To understand better the community belief system, we stirred the discussion on the benefits of using those agrochemicals to later turning towards disadvantages. The expected outcome was to capture the farmers' perceptions on chemical use (SQ4).

Institutional diagram

This fourth session was constructed around uncovering possible institutions affecting agricultural circumstances and choices of the villagers in BBY (SQ3). Thus, the aim of the session was for the villagers to agree on the importance of different institutions by discussion and *ranking* (Bernard, 2006). In order to focus the mindset of the villagers on different institutions affecting agriculture, we initially asked them to list all types of things affecting their choices of farming. In case the brainstorm would get stuck, we probed examples mentioned during earlier SSIs. After the brainstorm, we presented a large circle that constituted the border of BBY (Appendix I). In addition, we handed to them circles of three different sizes. Following, we asked the villagers to select institutions from their list and place them in the circles; institutions of highest importance should be placed in the largest circles, of medium importance in middle sized circles, and the ones of minor importance in the smallest circles.

3.2 Statistical Data Analysis

This section presents two different approaches of presenting and analysing data. Descriptive statistics are an important tool to summarize and visualize data and form the basis of quantitative analyses, whereas inferential statistics go beyond this by inferring from the sample characteristics to the entire population (Everitt & Skrondal, 2010). This includes testing for significant differences across survey groups and correlations between features. We use the programs Microsoft Excel 16.11.1 (Microsoft Excel, 2017) and Stata 15.1 (Stata, 2017) to conduct our statistical analyses.

3.2.1 Descriptive Statistics

Descriptive statistics will be generated for socioeconomic and biophysical data and will hence contribute to the site description and help answering SQ1, SQ2, and SQ3. We used values and thresholds from literature to assess the overall soil quality. Whether water from the two sampled water bodies is suitable for irrigation will be assessed by comparing the parameter means with Thailand's national standard levels (Royal Irrigation Department, 2011). Besides the generation of values that summarize basic features of the data, we generate graphs to visualize the data.

3.2.2 Inferential Statistics

The quantitative data obtained through the questionnaires serves as a source to construct a set of variables for further analysis via multivariate models. These models contribute to answering SQ2 and SQ3. We investigate the observed chemical fertilizer usage and if this can be attributed to the recent participation of a government program.

Government programs, described in the introduction and in section 4.3.2, aim at reducing the chemical input by substitution with organic fertilizers. With the questionnaire data, we can test whether the participation in government programs has a presumingly negative effect on the amount of chemical fertilizer applied on the field. This correlation can be tested with a *multivariate linear regression using ordinary least squares (OLS) estimation and calculating robust standard errors* (Everitt & Skrondal, 2010).

$$CHfer_{ik} = \beta_0 + \beta_1 edu\_hhh_i + \beta_2 inc\_av_i + \beta_3 inc\_agr_i + \beta_4 crop_{ik} + \beta_5 rai_{ik} + \beta_7 gov\_train_i + \varepsilon_{ik}$$

, where

$\beta_l \ (l \in 0;7)$	is the coefficient of the respective variable (l=0 is the constant),
$CHfer_{ik}$	is a continuous variable indicating the seasonal usage of chemical fertilizer in kg/rai of household *i* on field *k*,
edu_hhh_i	s an ordinal variable indicating the number of years of schooling of the household head of household *i*,
inc_av_i	is a categorical variable indicating the average income of household *i* (Below THB 35,000=0, Between THB 35,000 and THB 150,000=1, Above THB 150,000=2),
inc_agr_i	is an ordinal variable indicating the importance of agriculture as income source to household *i* (most important=4, not important=0),
$crop_{ik}$	is a categorical variable indicating the crop of household *i* on field *k* (Rice=0, Sugarcane=1, Cassava=2, Corn=3),
rai_{ik}	is an ordinal variable indicating the size of field *k* of household *i*,
gov_train_i	is a binary variable indicating the participation of governmental programs of household *i* (Did not participate=0, Participated=1), and
ε_{ik}	is the error term for household *i* and field *k*.

The decision to include a limited number of control variables in the model stems primarily from the small sample size (54 crop specific observations of 34 households[4]). According to Harrell (2013), 10-20 observations per covariate[5] allows for a good model performance with reasonable sized effects. Typical household specific variables such as household size, dependency ratio, or age of the household head were omitted for this reason.

It is generally believed that household and farm characteristics are important for the adoption of alternative farming practices (Uaiene, 2011; Teklewold et al., 2014; Manda et al., 2015). However, there is mixed evidence concerning the effect of the age of the household head. Whereas Kassie et al. (2013) postulates a positive relationship between age and adoption of new practices due to higher know-how and social capital, Manda et al. (2015) finds a negative link, presumingly due to an unwillingness to change cultivation practices. Therefore, the age of the household head

[4] Two of the 36 surveyed households are not practicing agriculture and were hence excluded.

[5] Note that categorical variables are treated as a set of binary variables. Therefore, each categorical variable produces *n-1* covariates as there are *n* categories (*-1* as there is always one base category).

was omitted in this study. Education is mostly seen as an important factor to adopt new practices (Moser & Barrett, 2003; Pender & Gebremadhin, 2008; Meshram *et al.*, 2012). In addition to the broad consensus in literature, interviewing the Agricultural Extensionist of the District Office hinted at similar links (Agricultural Extensionist, SSI, 2018). Income is another important variable (Davis *et al.*, 2009). Noltze *et al.* (2013) suggests that having farming as a main income source renders adoption of new cultivation practices less likely. Income is therefore included in our model in terms of average annual income and in terms of income sources. It is generally found that smaller fields tend to be managed more intensely (Udry, 1996) that is why we include the amount of rai cultivated. Including the crop species in our analysis controls for crop specific differences.

4 Results & Analysis

Our project aims at understanding the rationale behind farmers' persisting agrochemical use despite government programs promoting more sustainable inputs. In this chapter, we present the results organized by the subquestions. Hence, we start of elaborating on soil and irrigation water conditions, followed by results related to current cultivation practices and changes since the 1960s. Afterwards, we present results related to institutions that appear important for farming. Finally, the perceptions of villagers concerning good agricultural practices and the conducted government programs.

4.1. Village Soil and Irrigation Water Conditions in Relation to Agricultural practices [SQ1]

This section will compare soil and irrigation water properties of MO farms and MC farms to understand local conditions for rice cultivation during the hot season. We take into account that we only gathered few samples and the lack of cultivation history of specific fields (see also section 5.2). In conclusion, soils are very low in C, N and SOM. Irrigation water characteristics, pH, and EC in soil suggest that they are suitable for agricultural purposes.

4.1.1. The Soils of Ban Ba Yai

Ranges of clay content differ between the MO and MC group, with a slightly higher clay content for the MO group (10-60% versus 10-40%). These are generally big ranges and differences can stem from local variabilities. Some results of the soil analysis are shown in figure 4 below (for all results see Appendix J). It shows a pH range of 5.2-6.1, which according to Thiagalingam (2000) indicates slightly acidic pH for both groups. However, the minimum values differed by 0.5 (equivalent to 9%), which means that the MC group has more acidic soils compared to the MO group. This is likely due to the acidifying effects of cultivating crops with chemical fertilizers (Osman, 2013). According to Fondriest (1993), a range between 5.5-6.5 indicates that the soil is low in lime, nonetheless, this range is satisfactory for most crop production systems including rice (Mosaic, 2018). However, pH of soil samples from flooded rice fields are higher, due to anaerobic conditions, than those taken from dry fields which may influence the plant availability of nutrients (Mamum *et al.*, 2015).

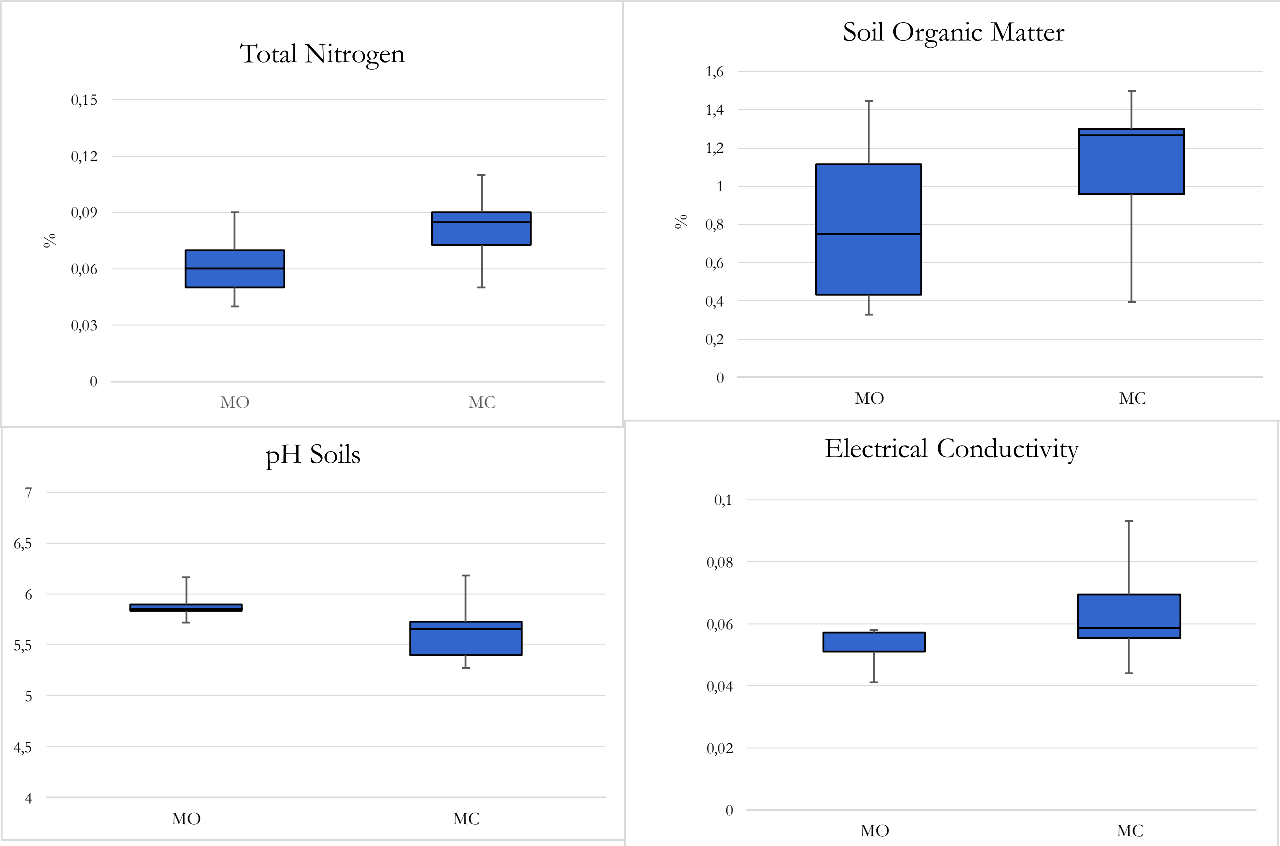


Figure 4: Soil analysis results (n=12).

Comparison of soil properties among both groups. The grey boxes indicate 2nd and 3rd quartiles. The line between two boxes delineates the mean value. Whiskers represent minimum and maximum values. The boxplots indicate higher amounts of N, SOM and EC in the MC group. Also the pH seems to be lower in the MC group.

The measured EC varies between 0.041-0.093mS/cm, which is a very low level according to Thiagalingam (2000). The values of both groups fall within the rice salinity tolerance level of <3.0mS/cm (Fondriest, 2011). In the MC soils, we measured a higher EC (up to 0.093mS/cm), which may be connected to the usage of fertilizers, as values were higher in the topsoil than in the subsoil (see Appendix J). Results of total N and C revealed little variation in the spatial distribution among the samples. According to APAL (2018), the values represent a very low amount of total N in soils for both groups. The analysis also shows that the N and C content is higher in the topsoil, for both groups (see Appendix J). This may be related to the higher SOM discovered in this horizon compared to the horizon below. The average SOM was found to be 0.96%, which is very low according to Moebius-Clune *et al.* (2016). Variability of SOM is influenced by parameters such as water content, soil type, vegetation, and management (Paul, 2016).

According to Funakawa *et al.* (1997), the C and N content is most likely in organic form due to the acidic soil properties. However, our analysis does not distinguish between organic or inorganic, only the total amount.

Organic N would be bound in the plants and therefore immobile in the soil, whereas inorganic N (i.e. from chemical fertilizer) would be mobile. A high amount of N in the soil could indicate excessive fertilizer use, if measuring at a time where the plant would have had the opportunity to take up the N it needs (Osman, 2013). During an SSI, an informant emphasized her awareness of having soil problems. She explained her inaccessibility to measuring tools and stated that *"There's nutrient scarcity but I don't know how to measure the soil fertility and that's why I use synthetic fertilizers"* (Praew, SSI, 2018). This lack of in-depth knowledge on soil properties appears to amplify the problem and increases dependency on agrochemicals. In conclusion, low values in measured variables indicate poor soil conditions for both groups, making the use of fertilizers necessary for farmers to attain adequate yields.

4.1.2. Quality of Irrigation Water in Ban Ba Yai

The main objective of the water analysis was to supplement soil studies by assessing whether the water is suitable for irrigation purposes. Results are shown in table 4. Appendix K shows that the water quality for irrigation purposes meets Thailand's national standards. There are neither detectable levels of salinity in the water, nor traces of N and phosphorus (P), meaning that fertilizer input from leaching is likely not excessive and that irrigation sources are presumingly not infused with salty water. In addition, low levels could be caused by the location of the area in the uplands, as the probability of salty water infusion lowers extremely with distance from coastal areas.

Table 4: Averaged results of water analysis (n=5)

Location	pH	Salinity (ppt)	NO3 (mg/L)	PO4 (mg/L)
Stream	6.41	0	0	0
Pond	8	0	0	0

Despite the water quality parameters being within the permitted values, Novakova & Nagel (2009) explain that the movement of nitrates differed significantly in different seasons and during different stages of crop activity. For this reason, we emphasize that our analysis is a snapshot of events occurring in a particular period of time. For more reliable results., it would be necessary to extent the monitoring period and increase sample sizes. This being said, the impact on soil performance points from tested water sources seems to be negligible during the hot season.

4.2 Land Cultivation over Time in Ban Ba Yai [SQ2]

In this section, we present the content of the timeline created in PRA 1 and the historical diagramming created in PRA 2. Key events identified by the villagers are presented chronologically. This section concludes that the agricultural practices in BBY have changed drastically in the timespan 1960s-2018 and that the introduction of agrochemicals played a key role.

4.2.1 Historical Outline of Agricultural Development

The timeline created by the villagers takes point of departure in the 1960s, when the Green Revolution came to Asia. During the following decades, the villagers reported that they acquired access to irrigation, livestock, new types of crops like cassava and corn, and new varieties of rice. The livestock was primarily used for manure. Following this, the Thailand Land Department started issuing the land title *Chanote*[6] around 1970, providing many villagers a true land ownership title deed. Some key events were identified by the villagers during the period of 1973-1975, where chemical fertilizers were introduced to the village. Two years after the introduction of fertilizers, the villagers were able to start selling some of their crops for the first time instead of keeping it only for own consumption. They noted that this was because the chemical fertilizers and irrigation allowed them to grow rice in the hot season, thus providing higher annual yields. Mechanised agriculture also started during this time, decreasing manual labour by using agricultural machinery. Eventually, some investors such as Nestlé, started buying land in BBY from around 1986-1991 and some farmers reported selling parts of their land to these investors. The village began producing a bigger variety of crops in the late 1990s with the introduction of sugarcane. At this time, they also started using tractors for their agriculture. The participants identified a flood in 2003; Floods are not an uncommon phenomenon in BBY as expressed by Natcha: *"We cannot cultivate anything else than rice, because the fields are sometimes flooded when it rains too much"* (Natcha, SSI, 2018). Several important events were identified in the period 2008-2011, starting with the establishment of the agricultural sub-district office. In 2008, the government introduced a guaranteed minimum price on rice, which helped farmers deal with volatile prices. In 2011, the government also introduced a subsidy scheme, allowing farmers to sell their rice to the government above market prices. During this period, livestock also started to decrease in BBY. According to the villagers, this decrease was related to bad smell in the village. In 2014, the government started promoting crop rotation practices which included a corn production scheme, economically incentivizing farmers to grow more than one type of crop on the same area of land in sequenced seasons (see also section 4.3.2). The Ministry of Agriculture introduced the agricultural program 9101 in 2017, aiming to provide farmers with the capacity to produce their own organic fertilizers (Agricultural Extensionist, SSI, 2018). The same year, the villagers emphasized that the canal was dredged, providing farmers with a continued functioning of their irrigation system, which is controlled by the irrigation officer.

[6] This type of title grants the holder of this document full rights over the land, to deal with or to use it, and to the exclusion of others (Siam Legal, 2016).

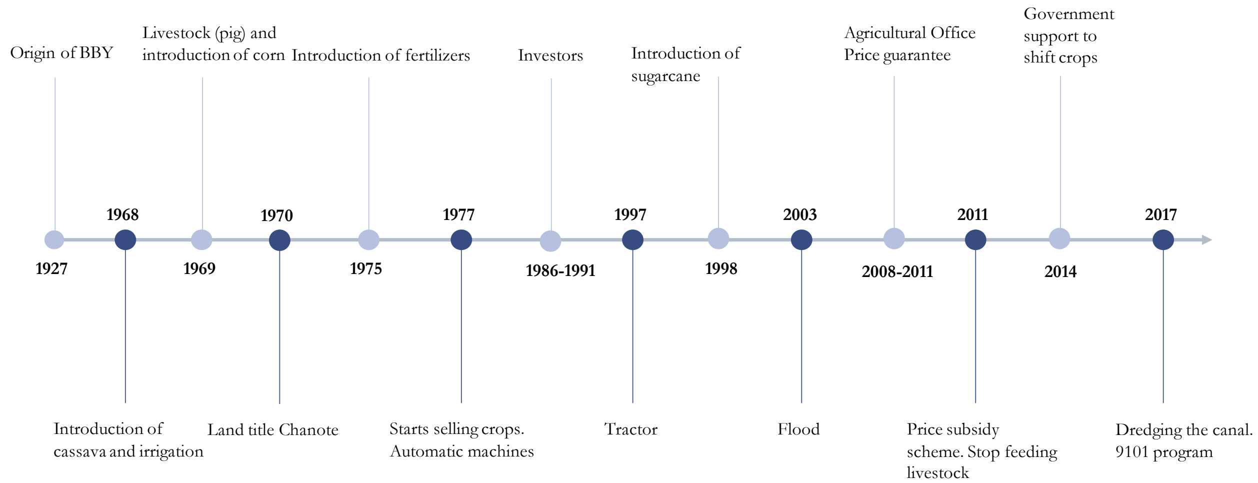


Figure 5: Timeline from PRA 1

4.2.2. Changes in Agricultural Composition

As illustrated in figure 6, in the 1960s villagers did not use any type of fertilizer input to their fields. According to the PRA attendants, this was because the soil was very fertile and, organic or chemical input was low. As of 2018, the yields had gone up along with the use of fertilizers, both chemical and organic.

As figure 6 shows, starting from the top part of the figure, villagers perceived their yields in the 1960s very low (1.5) compared to the higher value of 4 in 2018. It becomes evident that according to the villagers, the increase in yields is connected to the usage of chemicals fertilizers. In the 1960s, the crop composition in BBY consisted of rice and corn, where the majority was rice. In 2018 the main crop is still rice, but a larger crop variety is cultivated including corn, cassava and sugarcane. Corn is divided into two purposes, for human consumption and for animal fodder. In the 1960s they cultivated mostly rice and smaller amounts of corn and sugarcane. For 2018, the relative proportion of rice has gone down and been replaced by sugarcane, corn and the introduction of cassava into their crop system. However, rice is still the main crop in the village.

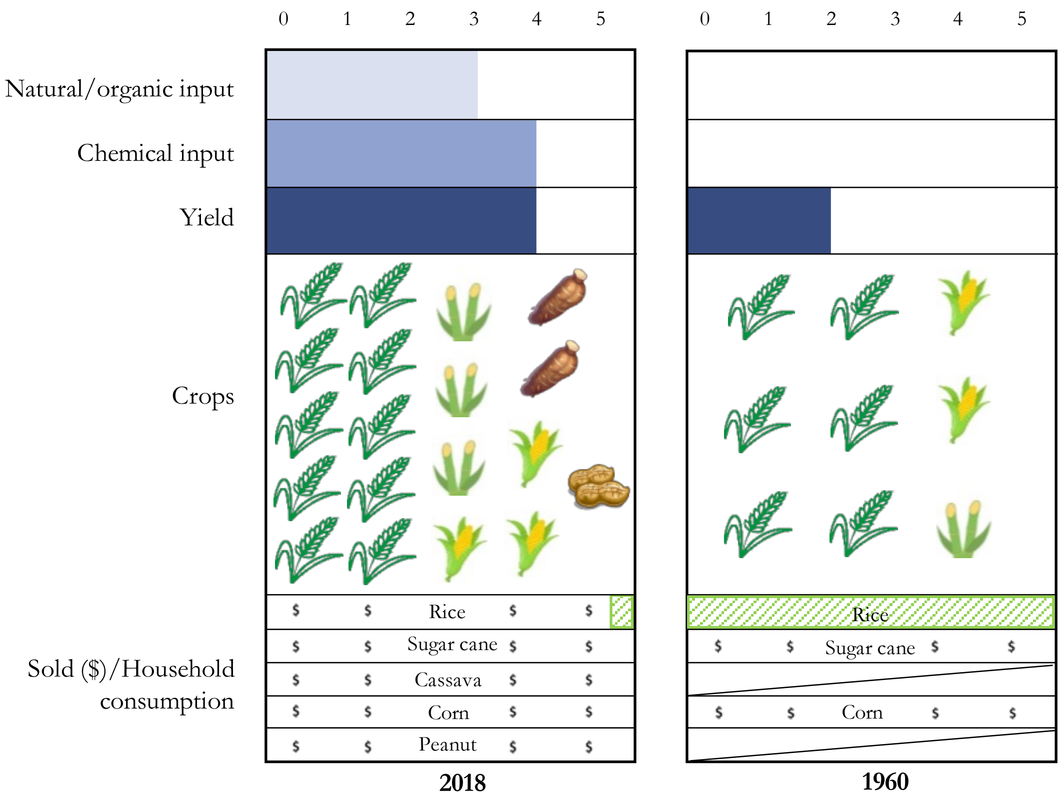


Figure 6: Poster from PRA 2

Supplementing the results from this PRA, the questionnaire data offers statistics on current practices. The average use of type of fertilizer per crop in 2018 is presented in figure 7, excluding outliers (n=34). According to the graph, cassava and to a lesser extent sugarcane seem to be cultivated using more organic input compared to rice and corn. The average yield per crop is seen in figure 8 (n=34). Note that the difference in crop yield is related to crop type, as sugarcane and cassava are high-biomass crops, whereas rice and corn are not. According to FAO (2018), the national average paddy rice yields in Thailand increased from 284 kg/rai in 1961-1965 to 485 kg/rai in 2012-2016. These can be used as proxies for the 1960s and the 2010s, and therefore compared to our data. According to our questionnaire, the average rice yields in BBY is 650 kg/rai. Even with the possible uncertainties of nation-based averages it is striking that the yield in BBY is 34% higher than the national average, however this may be due to large variations in yields across the nation.

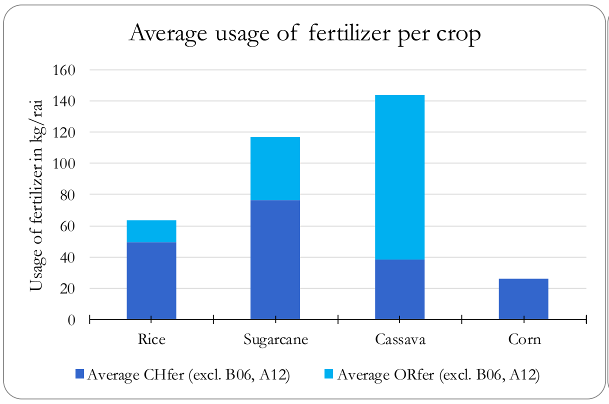


Figure 7: Average usage of fertilizer per crop

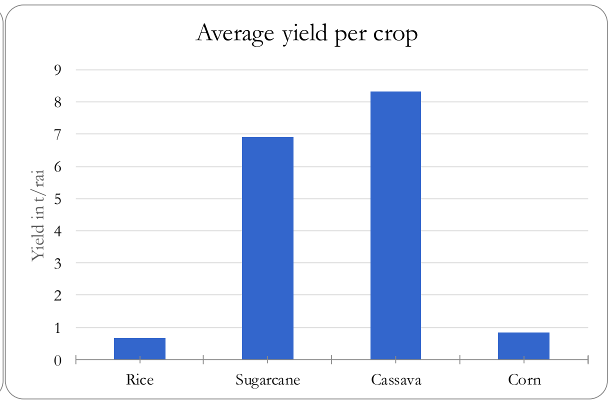


Figure 8: Average yield per crop

The total cultivation in BBY divided by crops in seen in figure 9, as per questionnaire data (n = 34). Here, we see that rice is still the main crop among the surveyed villagers, followed by cassava.

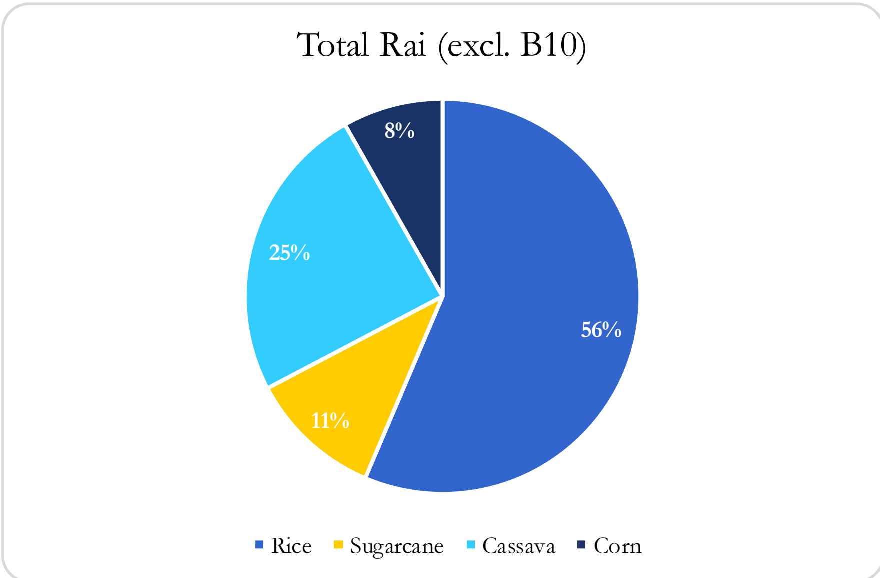


Figure 9: Total cultivation area per crop (n=34).

The PRA revealed that in the 1960s, the production of rice was exclusively for own consumption, whereas In 2018 the majority of the rice production is sold on the market. In 2018 most crops are produced only for selling; only about 10% of the rice is kept for own consumption. In conclusion, we see that use of fertilizers has helped yields increase, making it possible for people to sell a larger proportion of their overall agricultural production. Essentially, the village shifted from mainly subsistence farming in the 1960s to mainly cash cropping in 2018.

4.3 Institutions Affecting Agricultural Practices [SQ3]

After the comprehensive overview of how agriculture has developed in BBY, this section unfolds which institutions are affecting the choice of agricultural practices and how. Moreover, we explore the effect of the present government programs.

4.3.1 Institutions Affecting Agriculture in Ban Ba Yai

In this section, we present the different institutions that the villagers in BBY have identified as being influential to their agricultural practices during the PRA 3. As presented in the table 5, villagers identified both formal and informal institutions according to the level of importance.

Table 5: Results from PRA on institutions (in arbitrary order)

Level of importance	Institutions
High	Middleman Sugarcane factory Irrigation office The mill for selling crops
Medium	The spirits Community/big farming Agricultural Extension Office People renting out tractors The Headman
Low	Rice department (for seeds) Community cooperative Agricultural bank Program for organic farming GAP (Good agricultural practice)

Apart from the community cooperative, all major buyers of cultivated crops are placed in the high importance category. Supplier of agricultural inputs like irrigation, machinery, seeds, and credits are placed throughout the table. Differences in placement could stem from access structures (irrigation being centrally managed by that office versus multiple people renting out tractors) or relative importance of some inputs (seed supply is only important in times of extreme weather events). Political institutions and programs were ranked as medium to low. Overall, there is a clear tendency of economic institutions being more influential on the villagers' farming decisions.

According to the PRA results, agriculture constitutes a major income source so that they seem to consider alternative practices proposed in government programs only, if they have an economic benefit from it.

Complementary to the institutions identified in the PRA, the villagers we interviewed also elaborated on how institutions influence their way of farming. The informant Ploy said that the sugarcane factory is not only a buyer of her sugarcane but also taught her how to cultivate this crop as well as how to use agrochemicals. Further, she states that she became a member of the factory in order to profit from cheaper and free fertilizer supply (Ploy, SSI, 2018). These statements make clear that the sugarcane factory in this case, is exerting a more comprehensive role than just buying farmers' crops. Altogether, the factory provides a market, the know-how, and financial incentives through affordable inputs, thus exemplifying how one institution can exert various impacts on farming in BBY.

Moreover, our data shows that different institutions, both formal and informal, interplay and overlap in how they impact agricultural choices. An example is illustrated by Natcha: *"I learned how to farm from my parents and by attending workshops. My parents did not use any agrochemicals and cultivated rice only"* (Natcha, SSI, 2018). In this case we see how agricultural practices are created in a combination of the informal institution of family traditions and the formal institution of government programs.

Furthermore, our data portrays how informal institutions, in this case in the shape of informal networks and communication channels, can overrule formal arrangements and create structural inequality. In an interview, the woman Praew revealed that she does not, to the same extent as other farmers, rely on particular buyers of crops, having a strong network in the trading scene (Praew, SSI, 2018). Also, her average annual income falls in the highest income bracket (above THB 150,000) while also having a high level of educational level (18 years). For her, this connection means that through her informal contacts, she has the capacity to steer through the jungle of information, obtaining the best prices, advices, and seed quality. Consequently, you could argue, that the informal institutions of a large network, high income and high educational level, creates unequal access to information, thus creating unequal agricultural starting points for farmers.

4.3.2 Changing agricultural practices through government programs

Now we have seen how the different formal and informal institutions that the villagers have outlined affect their agricultural practices. In this section, we will narrow the focus to the different government programs promoting sustainable agricultural practices in BBY, to get a better understanding of what their presence means to the villagers' agricultural practices.

Figure 10 provides an overview of the government programs implemented in BBY according to the questionnaire data:

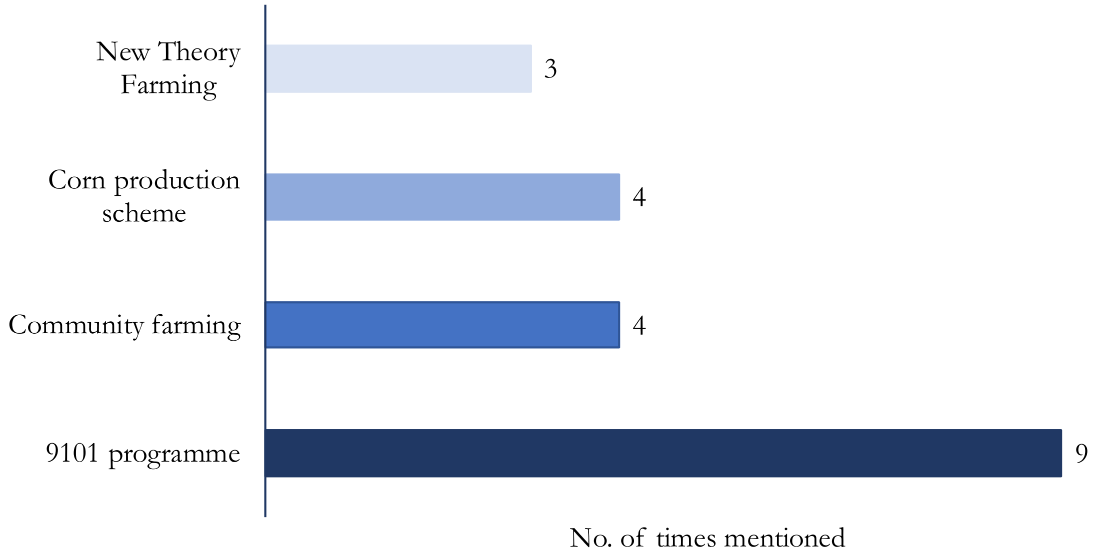


Figure 10. Number of times government programs were mentioned in questionnaire survey (n=34)

In general, farmers underline positive aspects about these programs however many highlights different challenges. For instance, one farmer is resigned about her unsuccessful cultivation practice in relation to the corn production scheme. She stated during the questionnaire: *"I don't know how to grow the corn. My plants are dying. I am ashamed to send photos to the officers. I won't receive any money for this anyways."* Another farmer, Tanawat, criticed the program, despite doing sequence farming with cassava and sugarcane himself. In his opinion, rice and corn are not suitable for sequence farming, as corn requires less water. If the neighbouring farmer still cultivates rice next to corn fields, excessive water would ruin his crops (Tanawat, SSI, 2018). From figure 10 we see that 9101 program is the initiative mentioned most times, consequently most well known by villagers. Compared to the 9101 program, the other programs were not mentioned to the same extent, thus seemed less present in the mind of villagers.

Furthermore, we asked the respondents if someone from their household have attended any agricultural governmental program and whether or not they changed any practices after attending. Figure 11 summarises the various explanations that the respondents mentioned when investigating the effectiveness of the programs.

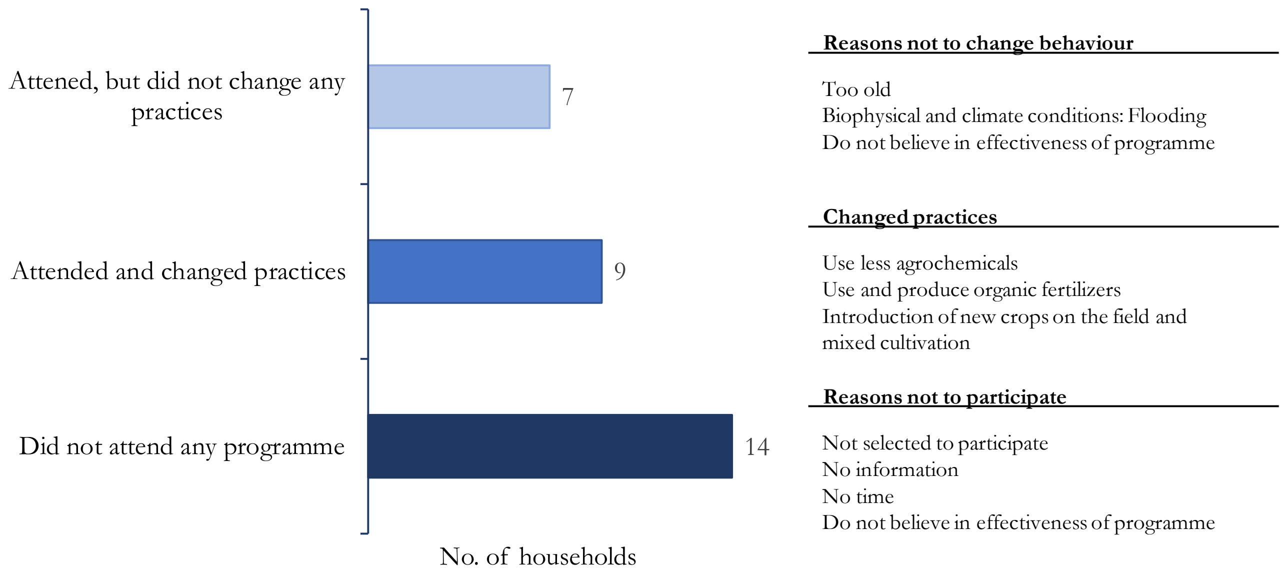


Figure 11: Farmers attendance to government programs (n=34)

For most of the farmers attending programs and changing practices, their changes concerns crop cultivation and the usage of agrochemicals with either using less or complementing with organic fertilizers. However, Tanawat exemplified a barrier to using organic fertilizers: *"The formula and ingredients are difficult to remember, and it takes a long time to make the organic fertilizers. We have the money to make it, but it takes too many materials and time to make."* (Tanawat, SSI, 2018) Moreover, one of the reasons mentioned for not changing behavior after attending the program was that the farmer do not believe in the effectiveness of the program. This explanation is also mentioned as a reason for not attending the program in the first place. This could indicate that the values and convictions of farmers' are somehow contradicting the ones of the government.

4.3.3 Effectiveness of government programs in relation to chemical fertilizer usage

The qualitative results presented in the previous section shows that many factors influence the feasibility and effectiveness of government programs on sustainable agriculture. Now we use a statistical model to test whether government programs have an effect on the use of chemical fertilizers.

In an interview with the Agricultural Extensionist of the District Office the negative effects of chemical is recognized; using too many agrochemicals affects the premium quality of agricultural products and has negative impacts on the environment and especially on biodiversity and soil conditions. As a major constraint to shifting towards more sustainable farming techniques, he identifies the farmers' lack of knowledge when it comes to sustainable and organic agriculture. Workshops and trainings organized by public authorities constitute a way to overcome this barrier without forcing farmers to change their cultivation practices (Agricultural Extensionist, SSI, 2018). Looking at the average chemical fertilizer use of the 30 out of 36 surveyed households that cultivate rice[7], data suggests that households who attended the program use on average higher amounts of fertilizer on their rice fields (figure 12).

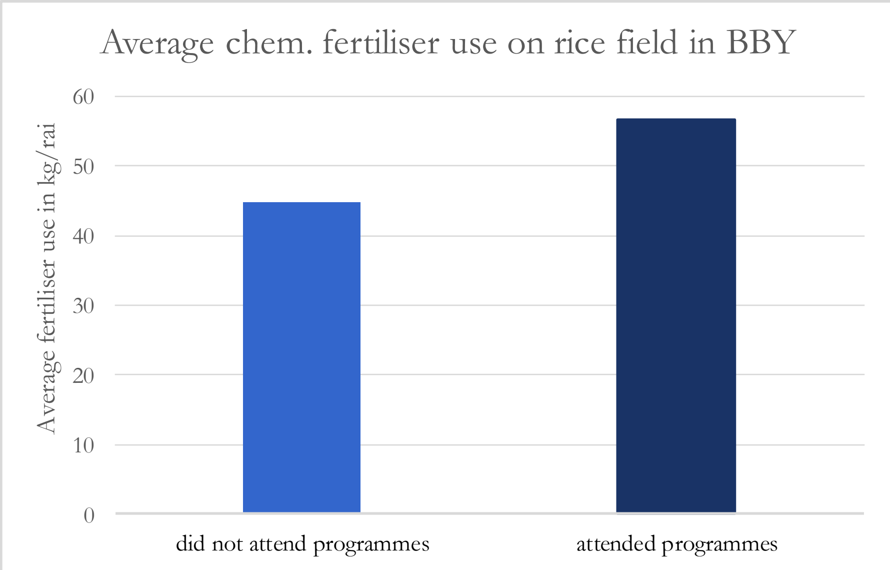


Figure 12: Average chemical fertiliser use on rice fields, in terms of program attendance

Similarly, fewer households that attended the program seem to use organic fertilizer on their rice fields (figure 13). Whereas 42.9% of the surveyed households that did not attend any of the programs already use organic fertilizer on their rice fields, only a third of the households that attended programs do so.

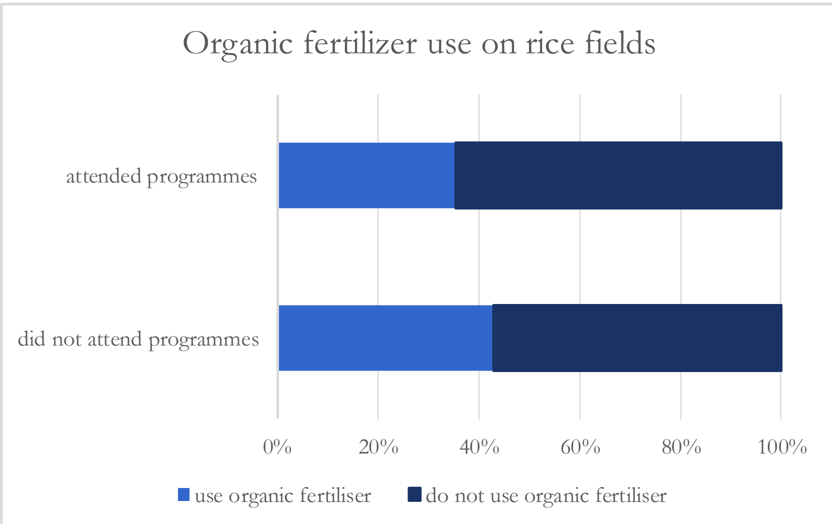


Figure 13: Organic fertiliser use on rice field, in terms of program attendance

[7] We only present the rice data here, to eliminate differences in fertilizer use that are crop dependent. Since most of the households cultivate rice, this figure still provides a good estimate for average fertilizer use.

Our data represents the period of time that we were present in the village, therefore we can only make limited statements about the households' behavioral changes over time. However, when we asked the household heads whether they changed their agricultural practices after attending the workshops, 62.5% of the households stated that they partly adapted some practices.

We conducted a regression to test whether the participation in government workshops have a presumingly negative effect on the amount of chemical fertilizer applied on the field. The original output and a reader-friendly summary table can be found in Appendix L. Due to the limited observation size implying limited possibilities to include variables, the proportion of variance in the dependent variable, which can be explained by the independent variables, is relatively low (R-squared=0.35; i.e. 35% of the variance of chemical fertilizer use can be explained by the model).

In conclusion, with this in mind and looking at the output, most variables do not appear to exert a significant effect, including the variable of interest gov_train_{ik}. The model results seem to support what descriptive statistics on rice production suggested earlier: The program does not affect the overall fertilizer use of BBY.

Factors that do seem to correlate with fertilizer use are connected to income: The higher agriculture is ranked as income source the lower is the chemical fertilizer usage (with a marginal effect of -12.4 kg/rai). Having an annual income of above THB 150,000 reduces the amount of fertilizer used even further by 49.9 kg/rai comparing to the base income level (Between THB 35,000 and 150,000). Lastly, villagers of BBY seem to use 26.8 kg of chemical fertilizer more per rai when cultivating sugarcane (compared to rice).

In summary, institutions buying or distributing crops are perceived as having the highest importance in relation to agriculture, although the point remains that formal and informal institutions interplay and overlap in shaping agricultural circumstances as well as the way in which farmers in BBY orient their agricultural practices.

4.4. Divergent Perceptions and Challenges of Agricultural Development Programs [SQ4]

As we saw in the previous section, various governmental programs are present in BBY, however the effectiveness of these remain rather unsuccessful. Therefore, this section will uncover the farmer's perceptions and ideas about what constitutes good agricultural practices and discover how these relate to government agricultural programs.

4.4.1 Village perceptions of agrochemicals

Looking at our questionnaire data, 97.1% of the villagers use chemical fertilizers for their main crop. However, several villagers explained that agrochemicals can have negative effects. For instance, one respondent said during the questionnaire that she believes chemicals are harmful and therefore protects herself in the field with rubber boots and long pants. Moreover, the villager Tanawat noted that: *"Fertilizers make the soil hard to dig, then people need* *machinery for rice, sugarcane, and cassava"* (Tanawat, SSI, 2018). However, the villagers spoke generally positively about agrochemicals. Looking at the result from PRA 4 on pros and cons concerning agrochemicals (see table 6) only one negative aspect was pointed out by the group of respondents. Participants show a clear inclination towards using chemical fertilizers and pesticides due to the numerous mentioned advantages. Benefits mentioned are mainly related to a perceived increase of efficiency and productivity in agriculture.

Table 6: Model of the pro and con table constructed in PRA 4.

PROS	CONS
- Makes the crops look healthier	- Soil problems
- More yield	
- Faster growth	
- Effective for all crops	

The participants emphasized the healthier look of the crops that had been cultivated using agrochemicals. When asking about taste, they agreed that there was no difference between using and not using pesticides. Despite the facilitators' probing questions in finding out negative aspects of using agrochemicals, only one was identified. Although attention about organic products has increased in recent years and several policies on sustainable agricultural practices have been promoted by the government (Panuwet *et al.*, 2012), the initiatives that have reached BBY has had little success in modifying local perceptions on chemical inputs.

4.4.3 Economic Motivation

During an interview, as an answer to the question: "*What is organic farming?"* our informant Ploy stated: "*Organic farming is for gardens, not for main fields"* (Ploy, SSI, 2018). This illustrates that Ploy's immediate thoughts regarding organic farming, is that it does not go well with cultivation of main fields, i.e. commercial farming.

As seen in section 4.3, respondents mention the importance of both middlemen, the cooperative, and the rice mill; all institutions whom have direct contact with farmers and can determine price levels for crops. Moreover, this seems to show that the economic aspects of agriculture are of importance to the farmers. Hence, there is an economic motive for the farmers to continue their current practices instead of changing their practices towards more organic farming. As noted by the headman: *"Only a few villagers are interested [in the government program] because the products of organic fertilizer take longer than synthetic, so the price of production is affected. You get more product with synthetic and that's why it's hard to change to organic" (Headman, SSI, 2018).* Furthermore, as explained by the villager Praew (SSI,

2018) *: "Organic takes more time and it's more expensive".* Overall, farmers tend to display a lack of interest towards organic products due to insufficient economic potentials and economic benefits of agrochemicals.

4.4.4 Government Ideology vs. Local Perception

As stated in the introduction, the 9101 program aims to increase production, lower production costs, and improve the product standards. Even though it is the program most farmers are aware of, relatively few had actually participated (see figure 11 in section 4.3.2). Of the people who participated, 62.5% stated that they made changes in their practices; changes which are, according to the headman, often at an experimental level. According to our questionnaire, some farmers were aware of the existence of programs but did not remember particularities, such as the name of the program, while other farmers did participate and still could not recall the name. Consequently, our data suggests that many farmers have a limited and diffuse knowledge of these programs. This could indicate a certain irrelevance of these programs to the farmers' agricultural economic circumstances.

In summary, the ideals of the 9101 program do not seem to correspond to the reality of farming in BBY, which may relate to both economic factors as well as the farmers' perception of quality of crops cultivated with agrochemicals. Hence, there seems to be a long way from policy to practice.

5 Discussion

5.1 Discussion of Results

Despite the Thai government's apparent intentions to promote more sustainable agricultural practices, the results of this project have demonstrated that it is not straightforward to design and implement such policies in ways that lead to actual change. In this section, we will discuss the results from our analysis in relation to our theoretical framework.

Governmental programs in BBY can be seen in the context of the development approaches with a focus on participation and capacity building that emerged in the 1990s. In academia, programs such as the 9101, have been criticized for failing the empowerment aspects related to capacity building (Kelly *et al.*, 2012). Instead of being an instrument for the villagers to develop tools to negotiate political power structures under which they live, and thus empowering them to make their own economic choices, it is argued that dominant power structures in and beyond local communities are reproduced (Henkel & Stirrat, 2001). Furthermore, Cornwall (2002) argues that these programs are often meant to give poor people a part in incentives designed for their benefit, and thus it implies that the actual decision about what serves the farmers interest is made by others than the actual farmers. This perspective suggests diverging standpoints of the government and farmers, which we have seen in section 4.4, seems to be the case in BBY.

The way that farmers in BBY are practicing agriculture in 2018 is greatly influenced by the introduction of technologies into agriculture such as machinery and agrochemicals in the 1970s. The rapid adoption of these new technologies has not only made farmers in BBY dependent on those, may also have had an influence in a competitive market with declining crop prices (McKirdy & Paranasamriddhi, 2017) ultimately placing the farmers in the agricultural treadmill: farmers increasing dependency on agrochemicals, disrupts soil conditions and consequently amplifies the need to use more agrochemicals and maintain effective crop control (Ward, 1993). Thus, our results could indicate that farmers in BBY have fallen into this agricultural treadmill, which makes the adoption of new (or old) organic practices economically infeasible as the use of agrochemicals creates greater dependence on further chemical input and hereby reproduces this way of practicing agriculture (ibid.).

Related to the agricultural treadmill, a recurring topic in this project has been the role that institutions play in agricultural practices of the farmers in BBY. Williamson (2000) underlines the interdependence between informal and formal institutions related to change making but moreover argues, that informal institutional change takes longer since it is related to cultural heritage, habits and traditions created over time (ibid.) For instance, the governmental programs in BBY, can be seen as a formal institution, with the specific aim to transform Thailand's agriculture into more sustainable practices. However, changing agricultural practices, which farmers have applied for decades, seems to be challenging since they are shaped by routines and habits: *"It takes long a time to change cultivation habits and to grow organic vegetables. Villagers are familiar with that"* (Tanawat, SSI, 2018).

Even though the argument throughout this project revolves around the hesitation of farmers to change practices, we have to remember that farmers previously made dramatic changes in their agricultural practices, when agrochemicals were introduced in the 1970s. Why then, do farmers perceive the transition to more sustainable practices as a greater obstacle? The answer to this could relate to rational choices in relation to economic maximisation. Cultivating with agrochemicals lead to quick economic profits while in the transition from agrochemicals to organic input agriculture, the time period before obtaining economic gain will be much longer due to the circumstances of the agricultural treadmill. Thus, from an economic perspective, as a relatively poor farmer not being able to sacrifice longer periods of time without economic income, keeping on using agrochemicals is the rational choice.

Moreover, one can argue, that the problem of change making arises because the ideas of government programs do not fit farmers' perceptions and local circumstances that in turn are shaped by formal and informal institutions. For instance, one farmer argues that he does not want to change according to a government program about sequencing rice and corn for subsidies because "*corn requires less water, so if the farmer next to my field still cultivates rice, it will not work*" and further underlines that in his opinion: "*rice is not suitable for sequence farming*" (Tanawat, SSI, 2018). Thus, the perception of the farmer is related to his agricultural circumstances created, among other factors, by informal institutions in the shape of embedded practices. Another evident barrier for introducing more sustainable farming practices in BBY is the lacking market for organic products (Agricultural Extensionist, SSI, 2018; EIC, 2017). Also, existing national certification schemes for such premium products cannot compete with higher international standards. Thus, more than one certification would be needed. This is a challenge not only for the producers, but for the entire supply chain (ibid.). On the other hand, it is often argued that the higher prices consumers are willing to pay for organic products evens out lower yields due to organic inputs. From 1999-2013 sales of organic food products increased fivefold globally, and are not only more profitable than those produced with agrochemicals, they are also more friendly in terms of human and environmental health (Reganold & Wachter, 2016). According to the Officer, the only markets for organic products are Bangkok and Tourist reservoirs, both remote to BBY (Agricultural Extensionist, SSI, 2018).

5.2 Framework and Methodology Critique

Overall the methods that we applied within our framework worked were very successful to complete the objective of this project. Some general improvements that apply to all methods would relate to preparation and knowledge of our field-site. However, this was challenging due to a tight time-schedule.

A challenge constituted the use of interpreters to overcome language and cultural barriers. This was especially evident during the PRAs, where the larger amount of people participated. Traditionally in PRAs, the visual result of the exercise is not necessarily the main part of the outcome. The discussion that revolves around creating the visual material is just as, if not more, interesting as the visual material itself. Even with the outstanding work of the interpreters of the group, our knowledge of the discussion in Thai would necessarily be limited due to several translations. In order to counter this challenge one of the Thai group members took notes of the discussion in Thai, and translated the parts that in her opinion were of most relevance to our project. Of course this would present us with data filtered through translation and opinion, but given the time restriction and language barriers, we consider this as the way of getting most possible value from our data. To avoid cultural inappropriate behavior, our interpreters were involved in the design of interview guides and alerted the interviewer, if a certain question was misplaced. Having a male and a female interpreter mitigated gender related problems.

In addition to that, there are some methodology-related limitations that we are aware of. Most limitations are mitigated in the light of the different types of data that were gathered to compare and triangulate in this report. No data and analyses in connection with that data will stand alone in this report but constitute only part of the entire interdisciplinary scope.

A major constraint is the limited time in the field and gathered amount of information. We are aware that all quantitative data (on soils, water, and socioeconomic features) only provides a snapshot of the reality in BBY. For soil, we were only able to analyze a few parameters indicating soil fertility, but there are several other important indicators like phosphorous, potassium and cation exchange capacity (CEC). The stratified soil samples were also somewhat heterogeneous e.g. some samples were from dry fields and others were from flooded fields. Ideally, we would have liked more homogenous samples to reduce other variables that might affect the result and would had collected more samples to have a representative sample. Concerning the household survey, we could not ask households before and after the program to see changes of fertilizer use on household-level, so that we rely on the comparison of two groups: households that attended programs and those that did not.

Concerning GPS mapping, it was a challenge to find the exact village boundaries, as certain fields that belong to villagers of BBY were already located within the neighboring village and vice-versa. Hence, official boundaries that include agricultural areas provided by the sub-district were inaccurate. For the scope of our project, we only needed the boundaries of the residential area and relied on information provided by the headman.

We developed the questionnaire in a process of continuous adjustment taking into account feedback from experts, peers, and through pretesting. Despite this, we realized in the aftermath that we should have included a question on on- and hot season farming to ensure a more precise data reporting from households on yields and fertilizer use. Concerning the sampling method, we faced the challenge of not having a complete lists of households in BBY for random sample selection. A suitable alternative is a random walk. However, this method implies a higher chance of being selected for those households where the head is home during sampling times (from 9-12 and 14-18). Another limitation concerning the sampling method was addressed in the chapter 3 itself: In order to identify households that changed their farming practices after attending government workshops, we had to rely on information for the headman. It can be critical to rely on key informants for information on the target population. The key informant often has own interests and can exert power by indicating certain households while not mentioning others. We were aware of this limitation and proved ex-post that there are no significant differences in household composition and other important features. The only difference is the change rate after attending workshops (see table 1 in section 3.2.1).

A central limitation of our empirical approach is the small sample size of 54 items. Despite statistically significant results, the small sample size impedes us to rely on the central limit theorem to assume that the distributions of our variables approach the normal. This implies that the assumption of normally distributed error terms is likely to be violated. To mitigate this limitation, model estimations included the calculation of robust standard errors. Due to time constraints in the field and the reliance on interpreters for data gathering, it is possible that real and reported values differ. Additionally, the small sample size leaves our model more sensitive to measurement errors and outliers and may ultimately compromise its credibility.

Data gathering and analysis stand under the premise of the framework developed in chapter 2. Our framework treats households of unitary units that rationally maximize their preferences. There exist no theoretical foundation for the validity of such simplified assumption. For a study showing that the allocation of agricultural input on different plots/fields within a household is significantly related to the gender of the plot manager refer to Udry (1996). For the sake of this project and considering time and resource restrictions, the unitary approach is a good tool to uncover the rationale behind farming practices. Moving beyond the unitary household model, would imply modeling interaction between household members, which is complex and would not add much value to our approach.

5.3 Reflections on Group Work

Before the fieldwork, we had many assumptions on what our study site would be like. Our supervisors told us to be flexible, and adaptable, as presumptions could turn out to be wrong. It was clear from the beginning, that our research question needed an interdisciplinary approach, to provide the best answer. At the start of the fieldwork, planning about what to do and when to do it was a bit unstructured. Though, communication and cooperation with our thai counterparts and the interpreters was very good, and we put emphasis on including everyone in the planning and preparation, which made data collection much easier and more successful. We quickly found a routine and became very productive and structured, allowing us to gather a lot of information in a short amount of time. This was helped a lot by the fact that we were quite a big group, so we had the opportunity to be very effective.

Thus, we used each other as resources in illuminating our topic thoroughly, as well as challenging each others perspectives and hereby examining the field as broadly as possible.

5.4 Ethical Challenges

For fieldwork in general, several ethical challenges may arise, such as power relations, sensitive information or unexpected outcomes (Reyes-García & Sunderlin, 2011). For example unequal power relations between villagers and researchers or authorities, such as the headman, district offices or government. Even though there had been a process of selection of negotiation between the villages and the partnering universities as well as pre-fieldwork visit by Thai students and Danish supervisors, we are rather unaware of how it was carried out. In all data collection in the village we promised anonymity and that the information was for learning outcomes only. Also, when doing fieldwork we are asking people to take time to work with us. As such, the information we gathered was presented to the village at the end of the fieldwork to gather feedback, and to give something back to the villagers. Keeping in mind, that after only ten days in their village, our knowledge is limited. As mentioned we put strong emphasis on including everyone, in preparation and carrying out of all activities. This also helped us to be careful about not crossing any cultural or social borders that might have existed, or avoid question or themes of too sensitive character. For example we made sure not to ask too much into government, local authorities or military questions, when we sensed that the topic was sensitive. And as mentioned, we always made sure to explain our purpose before talking to villagers, so that they to the greatest extent possible, were aware about our purpose.

6 Conclusion

In the context of rural Thailand, where the use of agrochemicals is a common practice, we wanted to explore why households in Ban Ba Yai do not adapt their farming towards more sustainable practices proposed in government programs. We found that there are several government programs present in BBY seeking to promote more sustainable agricultural practices. However, despite these apparent intentions, the results of this project has demonstrated that effectiveness of such programs is not straightforward. The analysis showed that this is connected to several factors: The formal and informal institutions shapes the agricultural circumstances for farmers in BBY, which also is related to the choices villagers make. Related to this, the introduction of fertilizers in the context of development programs in the 1970s as well as commodification of crops created a market for cash crops, which created a quick path to economic income. To keep up with production, farmers in BBY are experiencing a dependency on using agrochemicals, which may have contributed to the poor soil conditions where the farmer consequently finds themselves in the agricultural treadmill. Moreover, the transition from agrochemical input to organic input agriculture is currently too time consuming and expensive. Therefore, from the farmers' perspective, the choice of not changing agricultural practices is the most rational choice to make. Finally, our results show that the programs implemented by the government do not seem to match the circumstances and perceptions shared by many farmers. Consequently, government agricultural programs remain ineffective in creating change in Ban Ba Yai.

7 References

APAL, 2018. *Soil Test Interpretation Guide*. [online] Australian Precision Agricultural Laboratory. Available at: http://www.apal.com.au/images/uploads/resources/Soil_Test_Interpretation_Guide_1.pdf [Accessed 24th March 2018].

Bardhan, P. and Udry, C, 1999. *Development Microeconomics*. Oxford University Press Inc.

Bernard, H.R. 2006. *Research methods in anthropology, qualitative and quantitative approaches.* 2. ed., Thousand Oaks, Calif: Sage Publications.

Bower, C. A. and Wilcox, L.L., 1965. *Soluble salt methods of soil analysis*. In: Methods of Soil Analysis. Part 2. Am. Soc. Agron.1060 Journal of Food, Agriculture & Environment, Vol.8 (3&4), July-October 2010 Madison, Wisconsin, USA 9:933-940 [Accessed 5 Feb 2018]

Chambers, R. 1981. *Rapid rural appraisal: Rationale and repertoire*. Public Administration and Development, 1(2), pp. 95–106. [Accessed 20 Feb 2018]

Cornwall, A. 2002. *Beneficiary, Consumer, Citizen: Perspectives on Participation for Poverty Reduction*. Sida Studies, p. 11.

Czech, S. 2014. *Institutions as enabling constraints*. A note on social norms, social change and economic development. Ekonomia i Prawo. Economics and Law.", Polszakiewicz B., Boehlke J. (ed.), Vol. 13, No. 2/2014, pp. 309-319. DOI: http://dx.doi.org/10.12775/EiP.2014.023.

Davis, B., P. Winters, T. Reardon, and K. Stamoulis. 2009. *Rural nonfarm employment and farming: Household-level linkages*. Agricultural Economics 40 (2): 119–123.

EIC. 2017. *Thailand's production of organic foods has healthy growth potential*. Economic Intelligence Center. Published in: Bangkok Post/Asia In Depth: Asia Focus section, Feb 6th 2017. Available at: https://www.scbeic.com/en/detail/product/3362

EPA-SA. 2005. *EPA Guidelines: Composite Soil Sampling*. [online]. Issued March 2005. Environmental Protection Agency of South Australia. Available at: www.epa.sa.gov.au/files/8370_guide_composite.pdf

ESRI. 2018. *ArcGIS Desktop, ArcMap*. Release version 10.4. URL: http://desktop.arcgis.com/en/documentation/. Environmental Systems Research Institute (ESRI). Redlands, California, USA.

Everitt, B. S. & Skrondal, A., 2010. *The Cambridge Dictionary of Statistics.* 4th Edition ed. Cambridge: Cambridge University Press.

FAO. 2006. *Guidelines for soil description*. [e-book] Rome. Available at: http://www.fao.org/docrep/019/a0541e/a0541e.pdf [Accessed 24th March 2018]

FAO. 2018. *FAOSTAT corporate database*. [online] Available at: http://www.fao.org/faostat/en/#data [Accessed 29th March 2018].

Fondriest, 1993. *Soil and irrigation water interpretation manual.* [pdf] USA. Available at: http://www.fondriest.com/pdf/hach_2495900_manual.pdf [Accessed 24th March 2018]

Foreman, E. K., 1991. *Survey Sampling Principles*. New York: Marcel Dekker.

Funakawa S., T. Sota, S. Hitoshi, T. Kaewkhongkha, T. Hattori & K. Yonebayashi. 1997. *Ecological study on the dynamics of soil organic matter and its related properties in shifting cultivation systems of Northern Thailand*. Soil Science and Plant Nutrition, 43:3, 681-693, DOI: 10.1080/00380768.1997.10414793

German, R. N., C. E. Thompson, and T. G. Benton. 2017. *Relationships among multiple aspects of agriculture's environmental impact and productivity: a meta-analysis to guide sustainable agriculture*. Biol Rev Camb Philos Soc, 92: 716-38.

Google Earth. 2018. *Google Earth Pro for Desktop*. Google. Available at: https://www.google.com/intl/da/earth/desktop/

Gonick, H, D.D. Tunnicliff, E.D. Peters, L. Lykken and V. Zahn. 1945. *Determination of Nitrogen by Combustion Improved Dumas Apparatus and Recycle Procedure*. Industrial & Engineering Chemistry Analytical Edition. 17 (11), 677-682 DOI: 10.1021/i560147a001

Hanseok, J., Hakkwan, K and Taeil, J. 2016. *Irrigation Water Quality Standards for Indirect Wastewater Reuse in Agriculture: A Contribution toward Sustainable Wastewater Reuse in South Korea*. Water 2016, 8, 169. doi:10.3390/w8040169

Harrell, F.E., 2013. *Regression modeling strategies*: *as implemented in R package 'rms' version*, 3(3).

Hazell, Peter B. R. 2009. *Transforming agriculture: The Green Revolution in Asia*. In Millions Fed: Proven successes in agricultural development. Spielman, David J.; Pandya-Lorch, Rajul (Eds.). Chapter 3 Pp. 25-32. Washington, D.C.: International Food Policy Research Institute (IFPRI).

Henkel H. & Stirrat R. 2001. *Participation as spiritual duty; empowerment as secular subjection*. In: Cooke B, Kothari U, editors. Participation: the new tyranny? Zed Books; London: 2001. pp. 168–184.

Jørgensen, R.G. 2010. Organic matter and Micro-organisms in tropical soils. In P. Dion (Ed.), Chapter 2 *Soil biology and agriculture in the tropics*. Soil Biology Series 21 (pp. 17-44).

Kasem, S., and Thapa, G. B. 2011. *Crop Diversification in Thailand: Status, Determinants, and Effects on Income and Use of Inputs*. (Article). Land Use Policy 28, no. 3: 618-628.

Kassie, M., M. Jaleta, B. Shiferaw, F. Mmbando, and M. Mekuria. 2013. *Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania*. Technological Forecasting and Social Change 80 (3): 525–540.

Kelly, M., P. Yutthaphonphinit, S. Seubsman and A. Sleigh. 2012. *Development Policy in Thailand: From Top-down to Grass Roots*. Asian Soc Sci. 2012 November ; 8(13): 29–39. doi:10.5539/ass.v8n13p29.

KIT, Agri-ProFocus and IIRR, 2012. *Challenging chains to change: Gender equity in agricultural value chain development*. KIT Publishers, Royal Tropical Institute, Amsterdam.

Köppen, W. und R. Geiger, 1954: *Klima der Erde (Climate of the earth)*. Wall Map 1:16 Mill. Klett-Perthes, Gotha.

Kvale, S. og Brinkmann, S. 2009. *Interview: Introduktion til et håndværk*. 2. udgave. Hans Reitzels Forlag, København.

Levins, R.A. and Cochrane, W.W., 1996. *The treadmill revisited.* Land Economics, 72(4), pp.550-553.

Levin, J. and P. Milgrom. 2004. *Introduction to choice theory.* Available at: https://web.stanford.edu/~jdlevin/Econ%20202/Choice%20Theory.pdf.

Li, Y. and K. Migliaccio. 2011. *Water quality concepts, sampling, and analyses*. Boca Raton, Fla: CRC Press.

Magdoff, F. & H. van Es. 2009. *Building Soils for Better Crops*. 3rd Edition. Brentwood: SARE.

Mamun M., M.M. Haque, Q. Khaliq, M.A. Karim, A. Karim, A. Mridha and M.A. Saleque. 2015. *Assessment of Soil Chemical Properties and Rice Yield in Tidal Submergence Ecosystem*. Bangladesh Agronomy Journal, 18(2), pp.79–87.

Manda, J., A.D. Alene, C. Gardebroek, M. Kassie, and G. Tembo. 2015. *Adoption and Impacts of Sustainable Agricultural Practices on Maize Yields and Incomes: Evidence from Rural Zambia*. Journal of Agricultural Economics. DOI: 10.1111/1477-9552.12127.

McKirdy E. & A. Paranasamriddhi. 2017, September 27. F*ormer Thai PM Yingluck sentenced to five years over rice scheme*. CNN. Retrieved from https://edition.cnn.com/2017/09/27/asia/thailand-yingluck-shinawatra-verdict/index.html

Meshram, V., N. Chobitkar, V. Paigwar and S.R. Dhuware. 2012. *Factors affecting on SRI system of Paddy Cultivation in Balaghat District of Madhya Pradesh*. Indian Research Journal of Extension Education 1(Special Issue): 202–204.

Microsoft Excel. 2017. *Microsoft Excel for Mac*. Release 16.11.1 (180319). Redmond, WA, USA.

Moebius-Clune, B.N., D.J. Moebius-Clune, B.K. Gugino, O.J. Idowu, R.R. Schindelbeck, A.J. Ristow, H.M. van Es, J.E. Thies, H.A. Shayler, M.B. McBride, K.S.M Kurtz, D.W. Wolfe, and G.S. Abawi, 2016. *Comprehensive Assessment of Soil Health – The Cornell Framework*, Edition 3.2, Cornell University, Geneva, NY.

Mosaic. 2018. *Soil pH. Crop nutrition.* [online] Available at: http://www.cropnutrition.com/efu-soil-ph [Accessed 24th March 2018].

Moser, C.M., and C.B. Barrett. 2003. *The disappointing adoption dynamics of a yield-increasing, low external-input technology: The case of SRI in Madagascar.* Agricultural Systems 76 (3): 1085–1100.

Nelson, D.W. and L.E. Sommers, 1982. *Total carbon, organic carbon and organic matter*. In: A.L. Page, R.H. Miller and D.R. Keeney) Methods of soil analysis. Part 2 Chemical and Microbiological Properties, pp: 539-579.

Noltze, M., S. Schwarze, and M. Qaim. 2013. *Impacts of natural resource management technologies on agricultural yield and household income: The system of rice intensification in Timor Leste*. Ecological Economics 85: 59–68.

North, D. C. 1991. *Institutions*. The Journal of Economic Perspectives, Vol. 5: pp. 97-112.

Novakova K. and Nagel D. (2009). *The Influence of Irrigation on Nitrates Movement in Soil and Risk of Subsoil Contamination*. Soil and Water Research. 4, 2009 (Special Issue 2): S131–S136

OECD. 2013. *Structural Policy Country Notes: Thailand.* [pdf] OECD. Available at: https://www.oecd.org/site/seao/Thailand.pdf [Accessed 19 February 2018]

Olsen, H. (2006). *Guide til gode spørgeskemaer.* København: Socialforskningsinstituttet

Osman, K.T. 2013. *Soils: Principles, properties and management.* Springer Science+Business Media, Dordrecht, The Netherlands.

Panagos P., A. Jones, C. Bosco, K. P. S. Senthil 2011. *European digital archive on soil maps (EuDASM): Preserving important soil data for public free access.* International Journal of Digital Earth, 4 (5), pp. 434-443.

Panuwet, P., W. Siriwong, T. Prapamontol, P. Ryan, N. Fiedler, M. Robson and D. Barr. 2012. *Agricultural Pesticide Management in Thailand: Status and Population Health Risk*. Environmental Science & Policy 17: 72-81.

Papademetriou M. K. and Dent F. J. 2000. *Food and agriculture organization of the united nations regional office for Asia and The Pacific.* FAO [online]. Available at: http://www.fao.org/docrep/003/x6906e/x6906e00.htm#Contents [Accessed 05th April 2018]

Paul, E. A. 2016. *The nature and dynamics of soil organic matter: Plant inputs, microbial transformations, and organic matter stabilization.* Soil Biology and Biochemistry, Vol. 98, July 2016, Pp. 109-26. [Accessed 29th March 2018]

Peech, M. 1965. *Hydrogen ion activity*. In: C. A. Black (eds). Methods of soil analysis, Part 2. Chemical and microbiological properties # 9, ASA, Madison, USA, pp. 914-925.

Pender, J., and B. Gebremedhin. 2008. *Determinants of agricultural and land management practices and impacts on crop production and household income in the highlands of Tigray*. Ethiopia. Journal of African Economies 17 (3): 395–450.

Powell, W. W. 1991. *Expanding the scope of institutional analysis.* In W. W. Powell & P. J. DiMaggio (Eds.), The new institutionalism in organizational analysis: 183-203. Chicago: University of Chicago Press.

Reganold, J. P. & J. M. Wachter. 2016. *Organic agriculture in the twenty-first century*. Nature Plants. vol. 2, Article number: 15221. doi:10.1038/nplants.2015.221

Reyes-García, V. & W. D. Sunderlin. 2011. *Why Do Field Research?*. In: A. Angelsen, H. O. Larsen, J. F. Lund, C. Smith-Hall and S. Wunder (eds). Measuring Livelihoods and Environmental Dependence: Methods for Research and Fieldwork. Pp. 17-32. Earthscan, London, UK.

Royal Irrigation Department. 2011. *Order no. 73/2554 re: Amending of Preventive and Solutions on Poor Quality of Discharged Water into Irrigation Canal and Connected Part of the Irrigated Areas*. [pdf] Available at: http://www.secot.co.th/secot_ww/StandardSECOT/6คุณภาพน้ำ.pdf [Accessed 24th March 2018]

Sen, A., 1988. *The concept of development.* Handbook of Development Economics, 1, pp. 9-26.

Shinn M. 1941. *Colorimetric Method for Determination of Nitrate.* Ind. Eng. Chem. Anal. Ed., 1941, *13* (1), pp 33–35,DOI: 10.1021/i560089a010

Siam Legal. 2016. *Title Deeds.* Available at: http://www.siam-legal.com/realestate/thailand-title-deeds.php [Accessed Feb 4th 2018]

Stata. 2017. *Stata* Release version 15.1. Documentation available at: https://www.stata.com/features/documentation/. StataCorp LLC, Texas, USA.

Teklewold, H., M. Kassie, and B. Shiferaw. 2013. *Adoption of multiple sustainable agricultural practices in rural Ethiopia*. Journal of Agricultural Economics 64 (3): 597–623.

The Nation, 2017. *NOD TO PROJECT 9101.* [Online] Available at: http://www.nationmultimedia.com/detail/Economy/30319895 [Accessed 4 April 2018].

The World Bank Group, 2016. *Climate Change Knowledge Portal.* [Online] Available at: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisCCode=THA [Accessed 5 April 2018].

Thiagalingam, K. 2000. *Soil and plant sample collection, preparation and interpretation of chemical analysis*. A training manual and guide. [pdf] Australian Contribution to National Agricultural Research System in PNG (ACNARS). Prepared by AACM International Project Managers and Consultants Adelaide, Australia. Available at: https://nanopdf.com/download/a-handbook-for-interpretation-of-soil-and-plant_pdf [Accessed 24th March 2018]

Uaiene, R. 2011. *Determinants of agricultural technology adoption in Mozambique*. In: African Crop Science Conference Proceedings 10: 375–380.

Udry, C., 1996. *Gender, agricultural production, and the theory of the household*. Journal of political Economy, 104(5), pp.1010-1046.

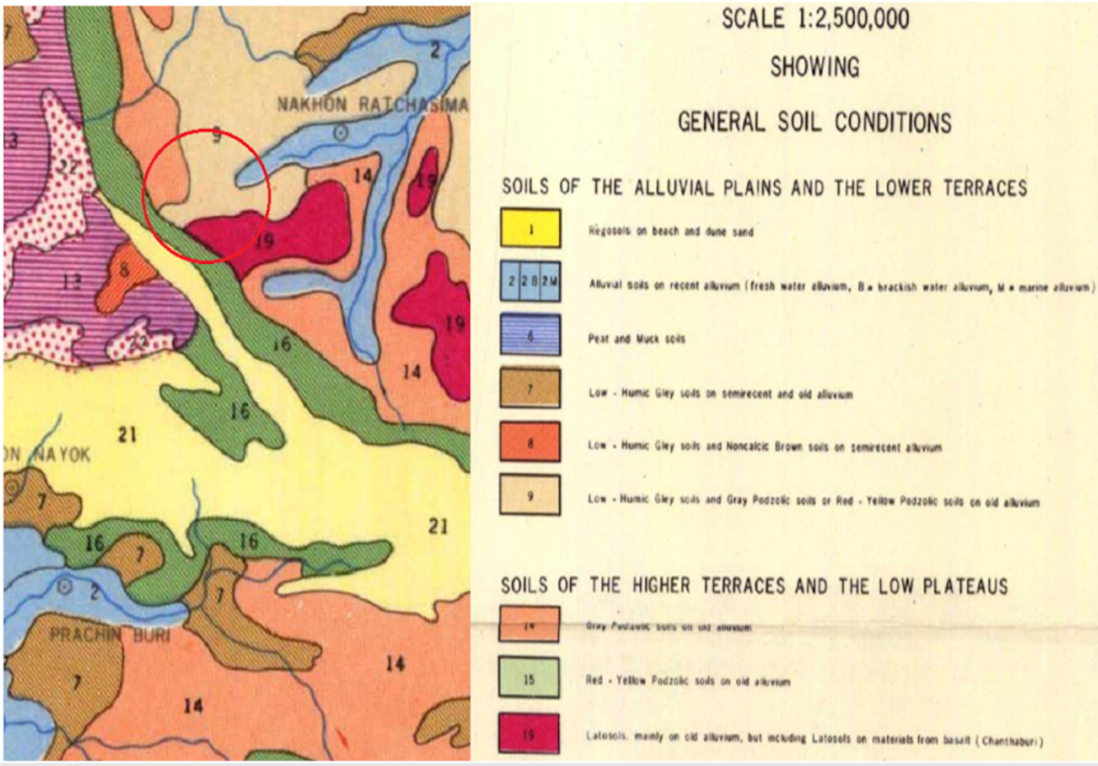
Utaranakorn, P., K. Yasunobu. 2016. *Rice Farmers' Attitudes toward Farm Management in Northeastern Thailand*. Journal of Agricultural Science, vol. 8., No. 8. DOI:10.5539/jas.v8n8p21

Ward, N. 1993. *The Agricultural Treadmill and the Rural Environment In the Post-Productivist Era*. Sociologia Ruralis 1993. Volume XXXIII (3/4), pp. 348-364. Blackwell Publishing Ltd.

Williamson, O.E. 2000. *The New Institutional Economics: Taking Stock, Looking Ahead*. Journal of Economic Literature Vol. XXXVIII (September 2000) pp. 595–613.

Appendix A

Soil map of study area



General soil conditions in the study area (marked with the red ring). Our study site is primarily podzolic soils on old alluvium (nr. 9 and 14). Complete map in this link in the European Soil Data Centre (ESDAC). From: Land Development Department, Kasetsart University, the Applied Scientific Research Corporation of Thailand and FAO.

Appendix B

Time schedule of fieldwork

Date	02/03/18	03/03/18	04/03/18	05/03/18	06/03/18
Morning	*Journey to destination*	- Interview with Headman - Preparation of interview guide for Prof.	- Meeting with Headman: Identify village boundary & stratums for questionnaire sampling - Pilot testing of the questionnaire	- Collection of questionnaires - Preparation of PRA sessions	- Participant observation: Rice harvest - Soil sampling - Collection of Questionnaires - Meeting with Agriculture Extension Office of the district - Meeting with sub-district office
Afternoon	- Welcome - Project presentations from Thai & Danish groups - Preparation of interview guide for Headman - First visit to Ban Ba Yai village	- Presentation in basecamp of progress - Questionnaire development & expert group discussion - Interview with Assist. Prof. Naroon Waramit	- Water sampling - Questionnaire revision & translation - Preparation of Interview guide for SSI - Preparation of questionnaire sampling method	- Collection of questionnaires - Preparation of PRA sessions - Preparation of interview guides for officers	- Interviews with villagers - Preparation of PRA sessions - Data entry questionnaire
Methods applied	GPS Mapping	GPS Mapping, SSI	GPS Mapping, Water sampling	GPS Mapping, Questionnaire survey	GPS Mapping, Participant observation, Questionnaire survey, SSI, Soil sampling

Date	07/03/18	08/03/18	09/03/18	10/03/18	11/03/18
Morning	- Preparation of PRA sessions - Preparation of Soil sampling and SSIs	- Soil sampling - PRA preparation	- Soil sampling - Interviews with villagers	*Buffer day* - Preparation of soil samples - Preparation of community meeting	*Return to Bangkok*
Afternoon	- Interviews with villagers	- PRA session 1 & 2	- PRA session 3 & 4	- Community meeting: Presentation of research project and preliminary results	
Methods applied	GPS Mapping, SSI	GPS Mapping, PRA, Soil sampling	GPS Mapping, PRA, Soil sampling, SSI		

Appendix C

Household Questionnaire
แบบสอบถามครัวเรือน

This questionnaire has been developed by a group of students of Copenhagen University whose aim is to conduct a research on the different agriculture strategies in the village of Ban Ba Yai. It will take around 20 minutes to finish. The questionnaire is **anonymous** and all questions are optional. There are no right or wrong answers. Thank you very much for your cooperation.

แบบสอบถามชุดนี้จัดทำขึ้นโดยกลุ่มนักศึกษาจากมหาวิทยาลัยโคเปนฮาเกน โดยมีจุดประสงค์ในการทำวิจัยเรื่องรูปแบบการทำเกษตรกรรมในรูปแบบต่างๆในหมู่บ้านบะใหญ่ โดยใช้เวลาในการทำแบบสอบถามประมาณ 20 นาที แบบสอบถามชุดนี้**ไม่ได้เปิดเผยรายชื่อ**ผู้ตอบแบบสอบถามและ หากไม่สะดวกใจสามารถเลี่ยงในการตอบแบบสอบถามได้ และแบบสอบถามนี้จะไม่มีคำตอบผิดหรือข้อถูก ขอขอบคุณที่ให้ความร่วมมือ

Section A: Background
ส่วน ก.: ข้อมูลพื้นฐาน

Questionnaire No: Date: Interviewer Team: GPS Reference point:

A1. Household composition
How old are you? อายุเท่าไหร่
How many people live with you in the household. What are their ages and gender?
มีสมาชิกในครอบครัวกี่คน ระบุเพศ และอายุ

Person ID ข้อมูล	Age อายุ	Gender เพศ (M,F) (หญิง, ชาย)	Comments เพิ่มเติม
1. Hhh			
2.			
3.			
4.			
5.			
6.			
7.			

A2. Education

QUESTION คำถาม	ANSWER คำตอบ
How many years of school/formal education did you complete? ระดับการศึกษา	years ปี

Section B: Livelihoods ส่วน ข.: รายได้เลี้ยงชีพ

B3. Land ownership สิทธิในการครอบครองที่ดิน
Please fill the table below. กรุณากรอกตามตารางด้านล่าง

QUESTION คำถาม	ANSWER คำตอบ
What is your type of land ownership? ประเภทในการครอบครองที่ดิน	I own land มีที่ดินของตนเอง □ I rent land เช่าที่ดินผู้อื่น Both มีทั้งที่ดินของตนเองและเช่าที่ดินผู้อื่น □ Other: อื่นๆ ___________________________
If ticked 1: หากเลือกข้อ 1 Is your land title C*hanote/Nor Sor See*? มีโฉนดที่ดิน/ น.ส.4 หรือไม่	Yes □ No, specify: ___________________________
If ticked 2: หากเลือกข้อ 2 Did you sell part of your land to Nestlé or similar investors? ได้ขายที่ดินให้เนสท์เล่หรือนายทุนอื่น ๆ หรือไม่	Yes No

B4. Main income sources แหล่งที่มารายได้หลัก
What is your household's main income source, please consider also government transfers like pensions or subsidies and remittances from family members working outside the region as income source?
แหล่งที่มารายได้หลักมาจากอะไร กรุณาคำนึงรายได้เงินโอนของรัฐบาล เช่น บำนาญ หรือ เงินช่วยเหลือ และการส่งเงินจากสมาชิกในครอบครัวผู้ไปทำงานต่างบ้าน
What is your second most important income source?
แหล่งรายได้อันดับสองมาจากไหน
What is your third most important income source?
แหล่งรายได้อันดับสามมาจากไหน
What are other income sources of your household?
มีแหล่งรายได้อื่นนอกเหนือจากนี้ไหม

Typical income sources are: Agriculture, Livestock, Business, Paid labor, Governmental transfers, and Remittances แหล่งที่มาของรายได้ทั่วไป: เกษตรกรรม, ปศุสัตว์, ธุรกิจส่วนตัว, รับจ้าง, รายได้เงินโอนรัฐบาล, การส่งจากลูกหลาน

INCOME SOURCE แหล่งที่มาของรายได้
1.

2.
3.
Other: อื่น ๆ

B5. Annual income and outstanding debt ข.5 รายได้ประจำปีและหนี้ค้างชำระ

QUESTION คำถาม	ANSWER คำตอบ
Considering all sources, how much is your average annual income? พิจารณาจากทุกแหล่งรายได้ คุณมีรายได้เฉลี่ยต่อปีเท่าใด	Below THB 35,000 Between THB 35,000 and THB 150,000 Between THB 150,000 and THB 1,000,000 Above THB 1,000,000
Do you have debts at the moment? ตอนนี้มีหนี้หรือใหม่	Yes มี □ No ไม่มี □
If yes หากใช่กรุณาตอบด้านล่าง	
How much? มีหนี้เท่าไหร่	Baht บาท
From what? เป็นหนี้เพราะ	

<u>Section C: Agricultural Practices ส่วน ค.: รูปแบบการทำการเกษตร</u>

Now, we would like to know more about your agricultural practices and the different crops you cultivate.
โปรดระบุรูปแบบการทำการเกษตรและพืชผลต่าง ๆ ที่เก็บเกี่ยว

C6. Basic information on production ค.6. ข้อมูลทั่วไปเกี่ยวกับ
Please state your three most important crops? Fill out the table for these.
โปรดระบุพืชที่ปลูกมากที่สุดไปน้อยที่สุด สามลำดับ กรอกแบบสอบถามในตาราง

Crop พืชผล	Area (rai) พื้นที่	Type and amount of fertilizer used (kg/rai/season)	Pesticides (kg/rai/ season) จำนวนยาฆ่าแมลงที่ใช้ (กก./1	Irri-gation แหล่งน้ำชลประทาน	Machi-nery การใช้เครื่องจักร	Yield (kg/area/season) ผลผลิต (กก./พื้นที่/การเก็บเกี่ยว)	Main market แหล่งขาย

	(ไร่)	จำนวนปุ๋ยที่ใช้ (กก./1 ไร่/การเก็บเกี่ยว)		ไร่/การเก็บเกี่ยว)				
		Animal manure ปุ๋ยคอก □ Crop residues ซากพืช □ Chem. UREA ปุ๋ยยูเรีย □ Chem. N,P,K ปุ๋ย NPK □ Chem. DAP ปุ๋ย DAP □ Other อื่น ๆ: ________________						Exchange within the village แลกเปลี่ยนภายในหมู่บ้าน □ Local market ตลาดนัด Remote, larger markets ตลาดใหญ่ Middleman พ่อค้าคนกลาง Contract farming พันธสัญญา □ Other อื่น ๆ: ________________________________
		Animal manure ปุ๋ยคอก □ Crop residues ซากพืช □ Chem. UREA ปุ๋ยยูเรีย □ Chem. N,P,K ปุ๋ย NPK □ Chem. DAP ปุ๋ย DAP □ Other อื่น ๆ: ________________						Exchange within the village แลกเปลี่ยนภายในหมู่บ้าน □ Local market ตลาดนัด Remote, larger markets ตลาดใหญ่ Middleman พ่อค้าคนกลาง Contract farming พันธสัญญา □ Other อื่น ๆ: ________________________________
		Animal manure ปุ๋ยคอก □ Crop residues ซากพืช □ Chem. UREA ปุ๋ยยูเรีย						Exchange within the village แลกเปลี่ยนภายในหมู่บ้าน □ Local market ตลาดนัด Remote, larger markets ตลาดใหญ่ Middleman พ่อค้าคนกลาง

		□ Chem. N,P,K ปุ๋ย NPK □ Chem. DAP ปุ๋ย DAP □ Other อื่น ๆ: ______________						Contract farming พันธสัญญา □ Other อื่น ๆ: ____________________________

QUESTION คำถาม	ANSWER คำตอบ
Do you cultivate other crops? คุณได้เพาะปลูกพืชอื่น ๆ หรือไม่ Do you have the same crops on the same field every year? คุณปลูกพืชชนิดเดิมทุก ๆ ปีหรือไม่	

<u>Section D: Government programmes ส่วน ง: การอบรมโดยรัฐบาล</u>

D8: Government Incentives for sustainable agricultural practices เงินจากรัฐบาลเพื่อรูปแบบการทำการเกษตรยั่งยืน

QUESTION คำถาม	ANSWER คำตอบ
Do you receive money or other kind of benefits from the government for practicing non-chemical input agriculture, for example subsidies, certifications or free/cheaper products and/or tools? คุณได้รับเงินหรือผลประโยชน์ใดๆจากรัฐบาลเพื่อสนับสนุนการทำเกษตรอินทรีย์ เช่น เงินช่วยเหลือ ใบประกาศ หรือผลิตภัณฑ์ฟรี/ ถูกกว่า และ/หรือเครื่องมือ	Yes ใช่ □ No ไม่ □
If yes, specify (what kind, on what and how much): *หากใช่ กรุณาระบุ (ประเภทใด และเท่าไหร่)*	

D8: Capacity building/workshops การสอน/ การอบรม

QUESTION คำถาม	ANSWER คำตอบ

Did a household member participate in programmes or workshops on sustainable farming practices? สมาชิกภายในครัวเรือนได้เข้าร่วมโครงการหรือการอบรมโครงการการเกษตรยั่งยืน	YES ☐ NO ☐
if yes หากใช่	
What was the name of the programme ชื่อโครงการ	
When was it held? โครงการจัดขึ้นเมือ	
Who organized it? ผู้จัดโครงการ	
Did you change your practices after attending the workshop? คุณได้ปรับเปลี่ยนวิธีการทางการเกษตรหลังจากเข้าร่วมอบรมหรือไม่	YES ใช่ ☐ PARTLY เล็กน้อย ☐ NO ไม่เปลี่ยน ☐
If yes and partly, please specify how? *หากปรับเปลี่ยน หรือปรับเปลี่ยนเล็กน้อย กรุณาระบุว่าอย่างไร*	
If no, please specify why? *หากไร้การเปลี่ยนแปลงใดๆ กรุณาระบุว่าทำไมจึงไม่เปลี่ยนรูปแบบการทำการเกษตร*	

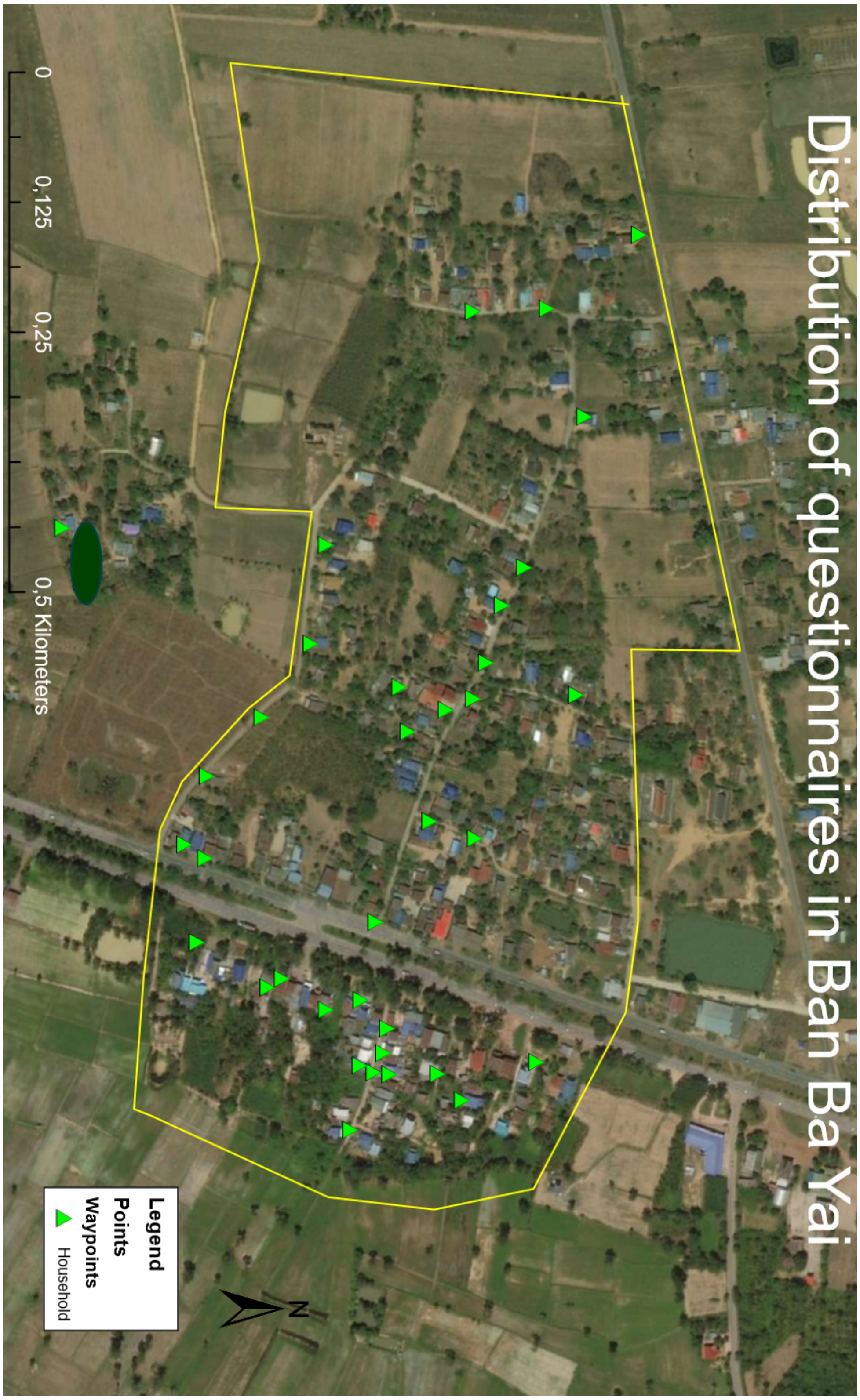
Thank you very much for participating in this questionnaire. It is very helpful for us and our study.

ขอขอบพระคุณอย่างสูงในการเข้าร่วมทำแบบสอบถาม
การทำแบบสอบถามครั้งนี้สร้างประโยชน์ให้พวกเราอย่างมากในการศึกษาครั้งนี้

Also, we might be interested in contacting you for further interviewing or soil sampling in your fields. Can we have your phone number, so we can get in touch later? Any particular time of day or week that suits best?

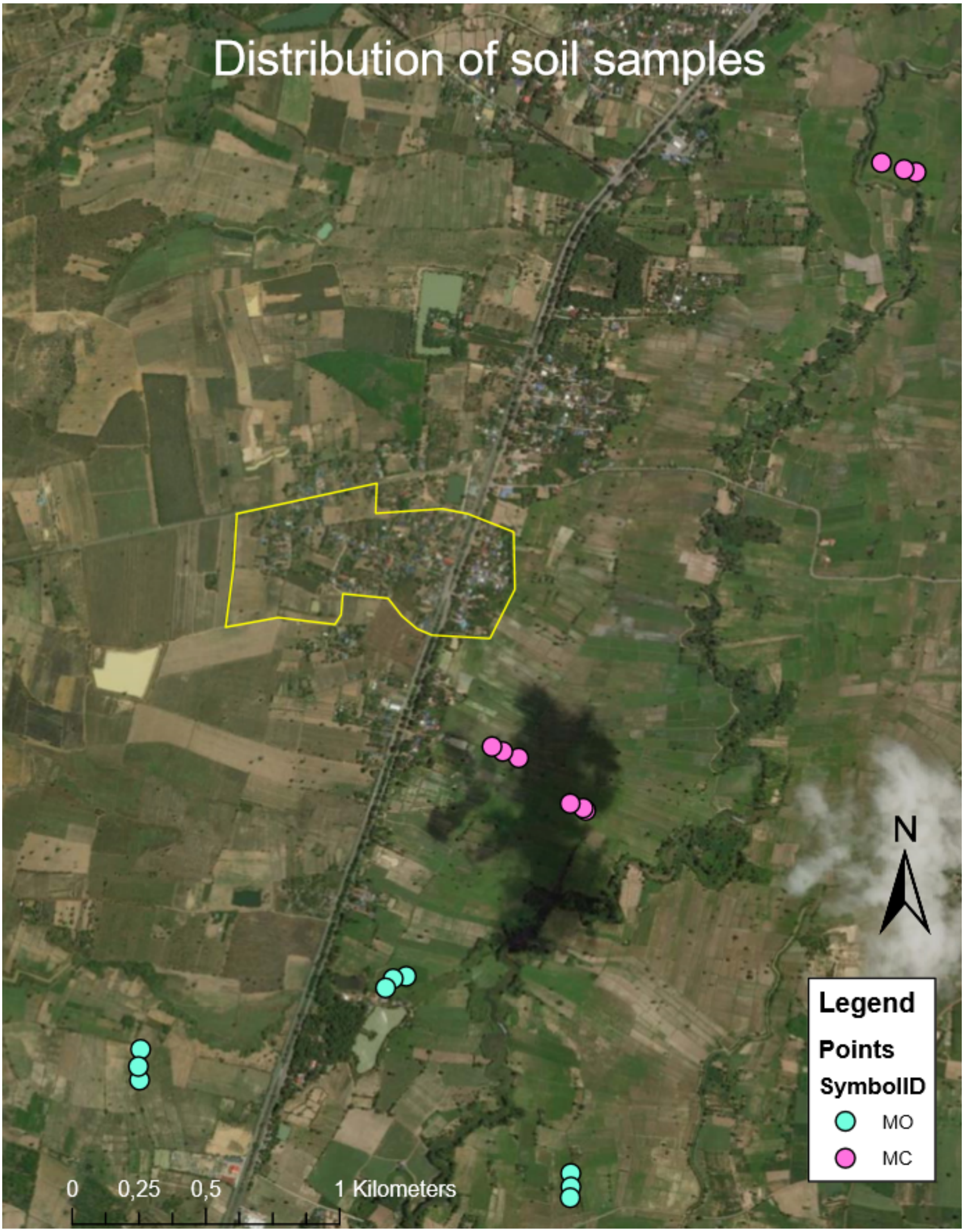
และหากทีมวิจัยของเราจะขอความอนุเคราะห์ในการสอบถามเพิ่มเติมและการทดสอบดินในไร่นา
รบกวนขอเบอร์โทรศัพท์เพื่อที่เราจะสามารถติดต่อได้ในภายหลัง
รบกวนขอเวลาที่สะดวกระหว่างวันหรือวันที่ว่างภายในอาทิตย์น

Appendix D



Distribution of questionnaires in Ban Ba Yai
0
0,125
0,25
0,5 Kilometers
Legend
Points
Waypoints
Household
N

Appendix E


Distribution of soil samples
N
Legend
Points
SymbolID
MO
MC
0
0,25
0,5
1 Kilometers

Appendix F


Distribution of water samples
019P
018P
017P
022P
021P
0 0,125 0,25 0,5 Kilometers
Legend
Waypoint ID
Sample point
N

Appendix G

Interview guide

Intro: Thank you for participating in this interview with us. We are a group of students from the University of Copenhagen and Kasetsart University and we are here to conduct research on the different agriculture strategies in the villages of Ban Ba Yai. The interview will be **anonymous,** all questions are optional and there is no right or wrong answer. The interview will take around **45** minutes to complete.

ID	
Name	
Age (Gender)	
Education (years completed)	
Land ownership	
Income	
Cultivation	
Comment	

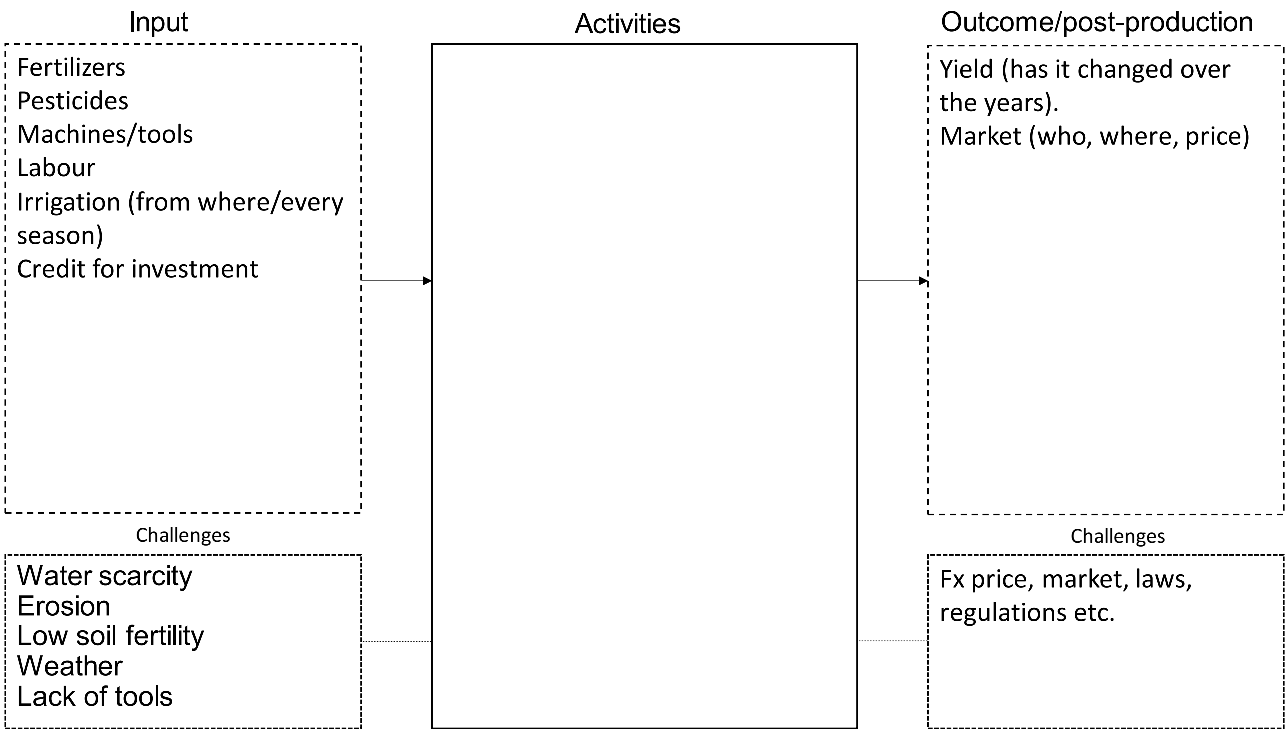
Research question	Interview questions
Introduction	*In this first part of the interview, we're going to ask you some questions regarding your farming practices*
What are the farmer's current agricultural practices?	• How much land do you cultivate? • What crops do you cultivate? • How do you cultivate them? **<u>USE FLOW DIAGRAM FILL OUT INFORMATION FROM QUESTIONNAIRE PRIOR TO INTERVIEW.</u>**
What is the rationale behind the choice of crops and where does the current farming practices come from?	• Why do you cultivate those crops? • Where do you sell your crops and why (price)? • How did you learn to farm and to use agrochemicals? • How long have you cultivated this land? • Have your changed your agricultural practices over time?

<table>
<tr><td>Part 2</td><td>Now, we would like to know more about formal and informal rules, norms and traditions that might affect your farming practices.</td></tr>
<tr><td>Which institutional factors influence the farmer’s agricultural practices?

Why/why not do farmers sell to big investors and what is their opinion about their presence</td><td>Formal:
• Are there any rules/laws/regulations that affect the way you farm?

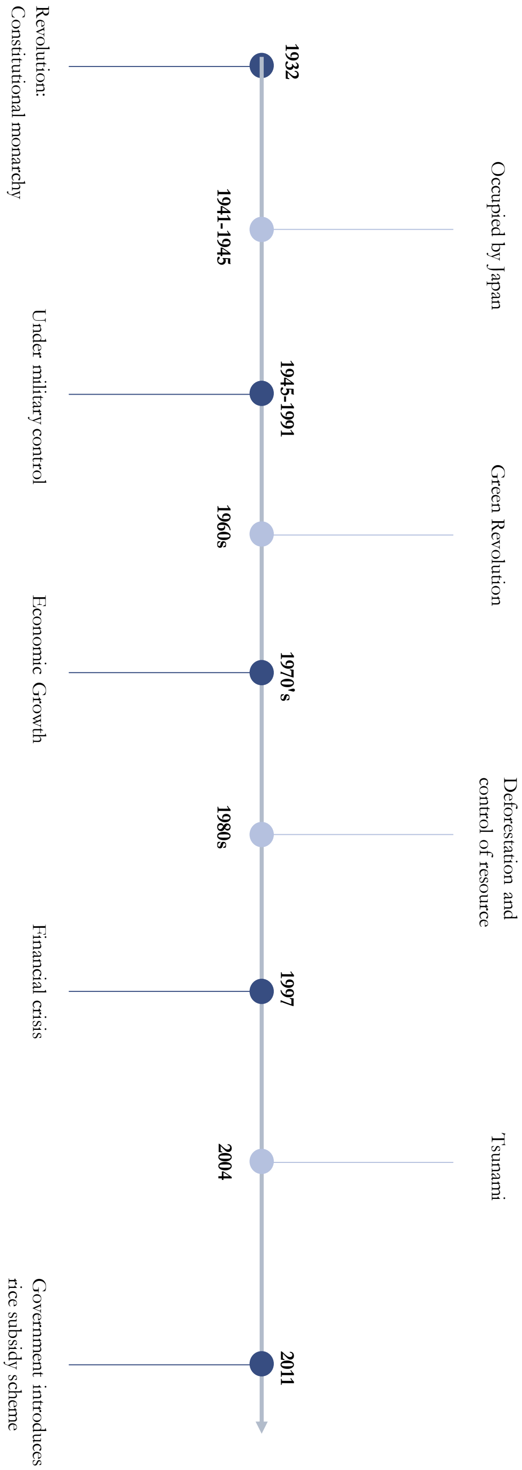
Informal:
• Are there any norms, customs or traditions in the community affecting the way you farm?
• Is there a relation between spirits and agricultural practices and results?

Ownership, investors and Nestle
• We have heard that corporate investors buy land in the area, what do you think about this?
• What is good and bad about these corporate investors?
• Many villagers have sold their land, and we can see that you have/ haven’t? Why/why not?</td></tr>
<tr><td></td><td>Government workshops and programs
• Have you heard of any government programs promoting more sustainable agricultural practices such as organic?
• IF YES: What do you think about them?
• Have you participated in any of the programs? Why/why not? (Ask about the “list”)
• Have you changed your practices after participating? why/why not?
• What would make you change practices?</td></tr>
<tr><td>If the farmers could freely choose, how would they practice agriculture?</td><td>• How would you ideally like to practice agriculture?</td></tr>
</table>


Input
Fertilizers
Pesticides
Machines/tools
Labour
Irrigation (from where/every season)
Credit for investment
Challenges
Water scarcity
Erosion
Low soil fertility
Weather
Lack of tools
Activities
Outcome/post-production
Yield (has it changed over the years).
Market (who, where, price)
Challenges
Fx price, market, laws, regulations etc.

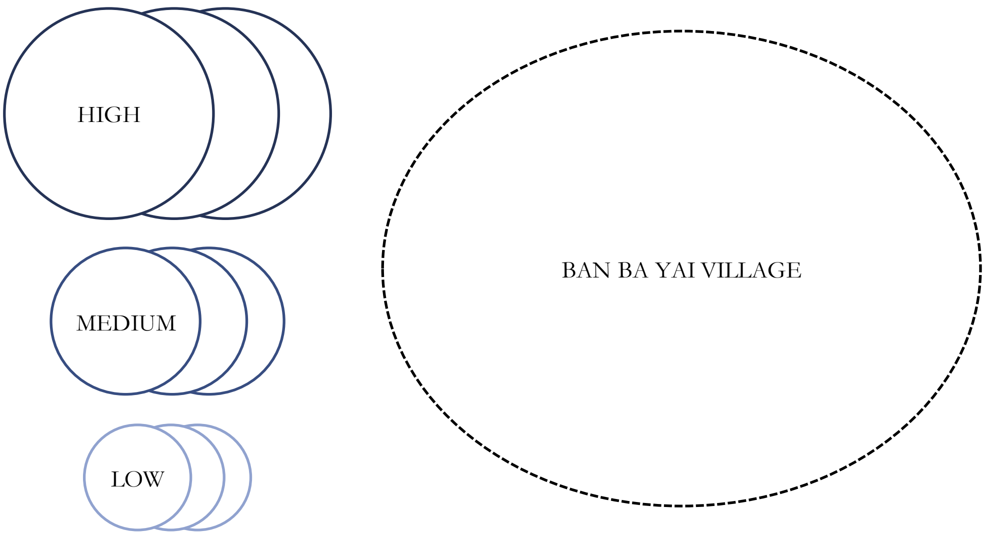
Appendix H

Template with our key events in timeline

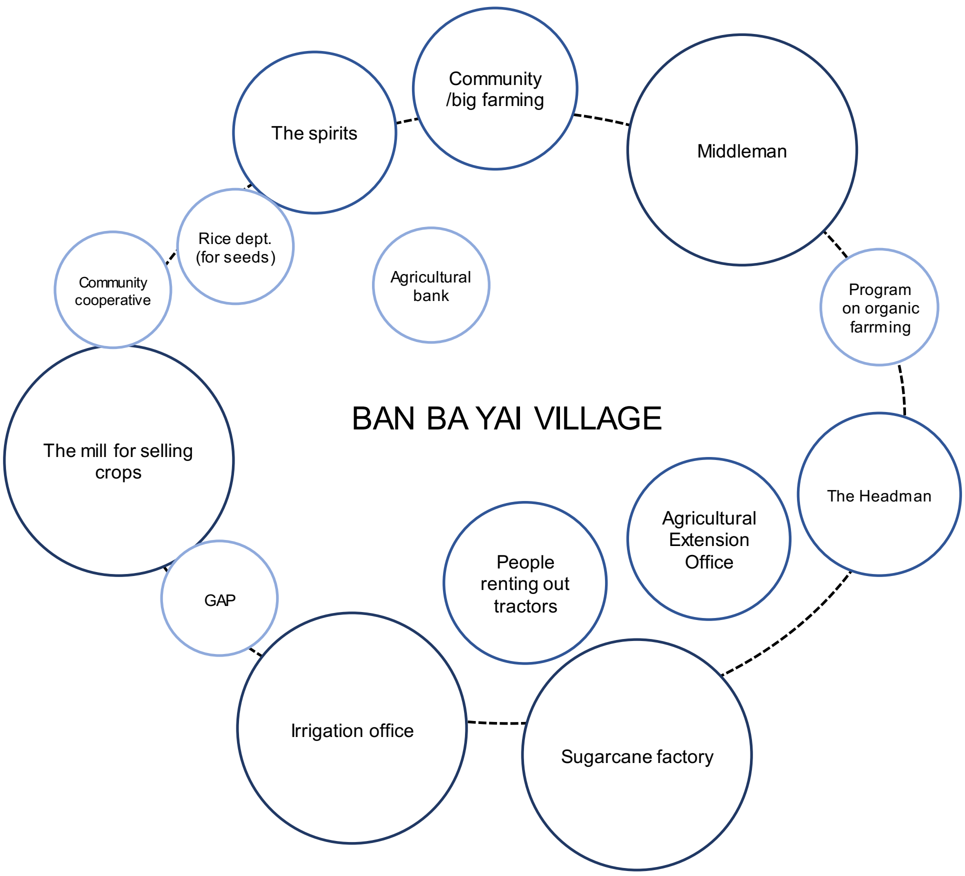


Appendix I

Template for *PRA 4 Institutional Diagram*



Result from *PRA 4*



Appendix J

Results of soil analysis

ID	Description	pH	EC[3] (mS/cm)	Total N (%)	Total C (%)	SOM[4] (%)	Texture
A9-TS[1]	*MO*	5.83	0.058	0.07	0.69	1.19	SiCL
A9-SS[2]	*MO*	5.91	0.057	0.04	0.22	0.38	SiL
A4-TS	*MO*	5.72	0.057	0.05	0.35	0.60	SL
A4-SS	*MO*	6.16	0.057	0.05	0.19	0.33	CL
B7-TS	*MO*	5.87	0.049	0.09	0.84	1.44	C
B7-SS	*MO*	5.83	0.041	0.07	0.52	0.89	CL
B8-TS	*MC*	5.67	0.044	0.09	0.74	1.27	SCL
B8-SS	*MC*	5.64	0.055	0.09	0.76	1.31	SiL
D2-TS	*MC*	5.27	0.093	0.11	0.87	1.50	CL
D2-SS	*MC*	5.32	0.056	0.08	0.50	0.86	SiL
B6-TS	*MC*	5.75	0.072	0.07	0.73	1.26	SiL
B6-SS	*MC*	6.18	0.061	0.05	0.23	0.40	CL

[1] Top soil [2] Sub soil [3] Electrical Conductivity [4] Soil Organic Matter

Appendix K

Effluent Quality Discharged into Irrigation System

Parameter	Unit	Standard (Range or Maximum Permitted Values)
1. pH Value	-	6.5-8.5
2. Conductivity	μMole/cm	2,000
3. Total Dissolved Solids (TDS)	mg/l	1,300
4. Biochemical Oxygen Demand (BOD_5)	mg/l	20
5. Suspended solids (SS)	mg/l	30
6. Sulfide (as H_2S)	mg/l	1
7. Cyanide (as HCN)	mg/l	0.2
8. Fat, Oil and Grease	mg/l	5
9. Formaldehyde	mg/l	1
10. Phenol & Cresols	mg/l	1
11. Free chlorine	mg/l	1
12. Pesticides	mg/l	None
13. Radioactivity	Bacquerel/l	None
14. Color and Odor	-	Not objectionable
15. Tar	-	None
16. Temperature	°C	40
17. Total Kjeidahl Nitrogen (TKN)	mg/l	35
18. Dissolved Oxygen (DO)	mg/l	100
19. Chemical Oxygen Demand (COD)	mg/l	100
20. Heavy metals		
- Zinc (Zn)	mg/l	5.0
- Chromium (Cr)	mg/l	0.3
- Arsenic (As)	mg/l	0.25
- Copper (Cu)	mg/l	1.0
- Mercury (Hg)	mg/l	0.005
- Cadmium (Cd)	mg/l	0.03
- Barium (Ba)	mg/l	1.0
- Selenium (Se)	mg/l	0.02
- Lead (Pb)	mg/l	0.1
- Nickel (Ni)	mg/l	0.2
- Manganese (Mn)	mg/l	5.0

Source : Royal Irrigation Department Order No.73/2554 (2011) dated April 1, B.E.2554 (2011).

Appendix L

Regression model output (reader friendly summary)

```
. regress CHfer edu_hhh inc_agr b1.INC_av i.crop rai gov_train, robust

Linear regression                               Number of obs     =         54
                                                F(9, 44)          =       4.09
                                                Prob > F          =     0.0007
                                                R-squared         =     0.3520
                                                Root MSE          =     29.707

------------------------------------------------------------------------------
             |               Robust
       CHfer |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     edu_hhh |    2.12533   1.526807     1.39   0.171    -.9517468    5.202407
     inc_agr |   -12.4252   4.161729    -2.99   0.005    -20.81262    -4.03779
             |
      INC_av |
          0  |   11.42341   11.03152     1.04   0.306    -10.80916    33.65597
          2  |  -49.91469   16.55115    -3.02   0.004    -83.27134   -16.55803
             |
        crop |
          1  |   26.83947   12.82675     2.09   0.042     .9888548    52.69009
          2  |  -8.577337   11.85354    -0.72   0.473    -32.46659    15.31191
          3  |  -15.44362   13.14239    -1.18   0.246    -41.93036    11.04313
             |
         rai |   .1058199   .1253245     0.84   0.403    -.1467551    .3583949
   gov_train |   4.083705   8.153324     0.50   0.619    -12.34824    20.51565
       _cons |    65.2509   14.92831     4.37   0.000     35.16487    95.33693
------------------------------------------------------------------------------
```

Appendix M

SYNOPSIS

Ban Ba Yai Village

High-chemical input agriculture

Thematic Course: Interdisciplinary Land Use and Natural Resource Management

February 23rd, 2018

Anna Sofie Starup Andersen (htv815)
Christina Schwöppe (sqw866)
Emil Borello (fkr508)
Louise Strange (mjw995)
Monica Quevedo (zrm329)
Morten Hørkild Sten (fmw214)

Words: *2553*

CONTENTS

1. Introduction

In Thailand, agriculture has played a significant part in the development of the national economy as well as in raising the general standard of living amongst Thai people. Agriculture today engages approximately 40% of the Thai workforce and has a vast importance in rural livelihoods in relation to personal and household consumption and as a method for generating income (OECD, 2013). Even though agricultural products constitute only 10 % of the Gross Domestic Product, Thailand is one of the world's leading exporters of rice. Approximately half of the country's cultivated land is devoted to rice production (Loftus, 2017).

In the 1960s Thailand adopted ideas and techniques from the Green Revolution, which promoted the use of agrochemicals, specific crop varieties and technologies to obtain higher yields. This led to higher food production for the rapidly growing population and created surpluses in certain commodities for export. Thus, conventional agriculture has been a popular practice between farmers in Thailand, which is characterized by monocultures and intensive use of agrochemicals (Kasem *et al.*, 2010), but also raised questions of environmental and human health concerns. Excessive use of chemical inputs from agriculture has negative impacts on the environment including biodiversity reduction and water pollution (German *et al.,* 2017). In the past decade, Thailand has completed an approximate increase in pesticide use of 400 % and the Royal Thai Government (RTG) faces the challenge of balancing the reliance of pesticide use on crops and yields versus fulfilling environmental policies and responsibility (Panuwet *et al.*, 2012). RTG has been proactive in managing chemical use for instance by issuing legal frameworks and policies in an attempt to improve food safety, livelihoods and minimize negative effects on the environment (Jourdain, 2017). The impact of such initiatives though, remains insignificant in both quantity and amount of toxins in general pesticide use as well as in compliance with the average farmer (Praneetvatakul *et al.*, 2013).

1.1. Study site area - Ban Ba Yai Village

Our case study takes place in the village Ban Ba Yai, in the sub-district of Udom Sap, in Nakhon Ratchasima Province (see figure 1). The village is located in the northeast region of Thailand, which is known as the rice-basket of Thailand containing the largest area of rice cultivation (Utaranakorn & Yasunobu, 2016). The inhabitants of this province are widely engaged in agricultural activities. Analogously, the villagers of Ban Ba Yai mostly practice either subsistence agriculture, cash crop farming or a combination of the two. Moreover, the majority of the households use high-chemical inputs in their farming systems. In line with national policies, government incentivized households in Ban Ba Yai to change their croppings systems towards more organic and low-chemical input cultivation practices. However, only few households are currently experimenting with low-chemical input farming on part of their agricultural land. In contrast to the general farming practices at our study site, the neighboring village of Huai Phrom, which is located less than ten minutes away, practices low-chemical input farming (SLUSE Thailand Field Description, 2018).

Figure 1. Map of field site and location of Ban Ba Yai village. Source: (ibid).

1.2 Research Question

The aim of our paper is to investigate the rationale and drivers behind the villagers in Ban Ba Yai's high-chemical input farming despite the promotion of sustainable cultivation practices by the government, as well as the contrasting low-chemical input farming in Huai Phrom. Thus our research question is:

> What are the drivers of Ban Ba Yai's apparent high-chemical input agriculture despite of government's incentives and the low-chemical input agriculture used in the neighbouring village of Huai Phrom?

In investigating this, we work with the following sub-questions:

S1. How do the villagers in Ban Ba Yai cultivate land and how has this evolved over time?

S2. What is the villagers of Ban Ba Yai's perception of what constitutes good agricultural practices vs. how are these related to the government incentive program?

S3. What institutions are affecting the choice of agricultural practices in Ban Ba Yai and how?

S4. What are the biophysical conditions in Ban Ba Yai and Huai Phrom and how is this related to the agricultural practice?

Agriculture combines the biophysical, social and economic domains. Answering the questions above will reveal potential societal hierarchies, structures and inequalities across factors such as class, age, ethnicity, religion and gender that might impact choices of agricultural practices in Ban Ba Yai. Cultural norms and practices of agriculture determines farmers' access to natural resources and thereby their living standard (Mackenzie, 2013). Approaching our research question by answering the subquestions will give insights in socio-economic, institutional, and biophysical factors influencing agricultural practices in Ban Ba Yai.

2. Methodology

The aim of this section is to distinguish tools and procedures to answer our research question. Thus, the following section outlines our methodological choices and considerations to achieve our main objective. In section 2.1, we will present the methods to gather historical and current information about the agricultural practices and land use changes in Ban Ba Yai (S1). Section 2.2 focuses on answering S2, which is designed to gather in-depth knowledge of villagers' general perceptions of what constitutes "good agricultural practices" and how these perceptions affect their use of the government incentive program. In section 2.3, we will explain how to generate insights on about institutions effects in households decision-making process and agricultural choices while uncovering barriers, incentives and path dependencies (S3). Finally, in section 2.4, we will address the methods to assess biophysical conditions of farmland soils in Ban Ba Yai (S4).

2.1. Agricultural Practices Currently and Over Time (S1)

One of our main methods is *participant observation* (Bernard, 2006). We intend to observe and join the activities surrounding the daily life in Ban Ba Yai. In this way, we will gather in-depth knowledge of land use changes while taking part in events related to the every-day agricultural practices with local farmers. This will help us get a deeper sense of key events that influence nutrient management over time whilst understanding the relations between villagers and their social, material, and symbolic contexts (Levy & Hollan, 2014).

The first step will be to open a dialogue between villagers and us. Thus, we will use a community meeting tool with the goal to gather all stakeholders, introduce ourselves and inform them about the objectives of this project. This can be done by asking the village head to summon a village assembly. We expect that during such meeting, farmers will understand the goals and procedures that will answer our subquestion S1. At the end of the meeting, we intent to have formed groups for the first Participatory Rural Appraisal session.

A *Participatory Rural Appraisal* (PRA) (Chambers, 1981) is a method that enables local villagers to express and share their knowledge and experiences of living conditions in Ban Ba Yai. For these approaches, we take the role of facilitators and aim to examine farmers previous experience and problems particularly related to land changes. We plan to create a timeline of the agricultural practices and correlate these to key events together with the farmers.

In this way, we aim to establish the contextual and historical setting in relation to land use practices in Ban Ba Yai and define the village boundaries.

The tools used for all PRA sessions will be those that identify problems and causes (Geilfus, 2008). After explaining the objectives of the first PRA session, we will divide farmers into groups where they will be able to draft a seasonal calendar and draw a timeline. At the same time, we plan to get a deeper insight into the community perception of their physical space by preparing a social and resource map.

2.2. "Good Agricultural Practices" in Ban Ba Yai (S2)

Here we want to understand the locals' perception of what constitutes "good agricultural practices" and uncover what farmers do versus what they would actually like to do. We will triangulate data collected from the first PRA session and execute a *questionnaire survey* (Olsen, 2006) and a *semi-structured interview* (Bernard, 2006).

The questionnaire is characterized by predetermined, precise questions and response categories (Olsen, 2006). We plan to acquire data about the local villagers background information and agricultural practices. Thus, we will analyze statistical relations between factors such as for instance gender, age, educational level, income and agricultural management. We will then compare this data with farmers perceptions of "good agricultural practices" obtained from the semi-structured interviews and PRA sessions.

We will randomly distribute the questionnaire within both Ban Ba Yai and Huai Phrom and intend to compare both agricultural systems and agrochemical inputs. An ideal technique is *stratified random sampling* (Shewhart, 2012) as this allows us to collect representative and unbiased data within different stratums such as low-chemical and high-chemical users. It also provides greater reliability for our findings since we aim to compare samples between villages and groups. Another good alternative is *random sampling* as it requires less information about the survey population and allows us to relate results from the sample to the entire population of Ban Ba Yai. The questionnaires will be computed in SurveyXact and distributed using tablets. Additionally, the questionnaire will help us to identify informants for the semi-structured interviews.

The semi-structured interview provides the opportunity to explore themes of our particular interests, making it possible to obtain information in an informal way based on topics set by the interviewer. First, will identify key informants such as farmers and households members, the village headman and potential political players. Secondly, we will determine the sample size and techniques. Finally, we plan to capture farmers perceptions and compared them to factual data later on through a questionnaire.

2.3. Institutional effects on decision making (S3)

To expose the role of institutions in the decision-making process within Ban Ba Yai agricultural practices we will revise literature while triangulating data and analyzing farmers narratives from methods already described. These include participant observation, semi-structured interviews, questionnaires and PRA sessions throughout the fieldwork. In the project we define institutions according to North (1991, p. 97): "*Institutions are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights).*"

However, Czech (2014) argues that institutions do not represent only constraints to our behaviour but also enables possibilities to other actions. Therefore in this project we will take into account both features related to farming activities.

2.4. Diverging Local Practices and Biophysical Conditions (S4)

To assess potential divergence of local practices as a consequence of differing biophysical condition, we will do *soil sampling* (FAO, 2006) on farmland in the village. At the same time, we will use *GPS mapping* to show location of different fields, distribution of crops or soil quality, along with the soil sampling and observations on site. Information gathered in questionnaires can help us identify households of particular interest, in terms of for example crop production systems.

This methodology aims to compare the biophysical properties of high and low chemical content in soils and to understand the local conditions for growing crops in Ban Ba Yai households. We will then distinguish the spatial distribution of different soils quality and strive to identify socio-economic drivers that might influence agricultural practices and preferences of crops in that area. The collected soil data is expected to be triangulated with supplementary sources in order to understand the rationale behind farming behaviors. In this way, we will examine the correlation between soil quality, which is defined by our chosen parameters and the local perceptions of good agricultural practices obtained from the semi-structured interviews.

Particular sampling sites will be decided through a dialogue with the local farmers and through a synergy of various methods such as PRA, semi-structured interviews and questionnaires. Current and historical land use changes (timeline, satellite image and resource/seasonal mapping) will play a crucial role to decide sample locations.

During the fieldwork process, we will frequently use GPS mapping and satellite image in synergy with the other methods mentioned above. The purpose of using GPS in the field, is that we can use it to produce waypoints, tracks and area measurements. Mapping with a GPS along with noting information of particular interest, we can show distributions or locations of different parameters, such as of agricultural crops, field sizes or social division in the study area. This can for example be information about the soil condition and the agricultural fields or specific land use on the location.

2.5. Field access, practicalities, and ethical considerations

We arrive in the field with little knowledge about the conditions and practices in Ban Ba Yai. Due to limitations in communication access it has not been possible in the state of preparation to establish contact with villagers or Thai students and interpreters. To accommodate these conditions and as a method to get acquainted with villagers of the community we will practice *snowballing* (Bernard, 2006). In this approach we will localise and establish contact with informants through their relations. This can for instance be useful in locating the group of people experimenting with low-chemical input methods, if we assume that they share experiences and know each other. Snowballing is effective when gathering data in time-limited project (ibid.). Moreover, the possibility exists that informants will only introduce us to his or her close family relations or people sharing his or her opinion, which can be problematic as it may rectify the answers and perceptions. Thus balancing limited time and the representation of the diversity of the villagers is required for this study.

For gathering different types of data we will take advantage of both the number and the diverging backgrounds of our group members. Our group's size gives us the opportunity to research different field sites simultaneously. Furthermore, many of the activities you can access and attend in the field will be related to gender (Hondagneu-Sotelo, 1988) The fact that our group is gender diverse will then enable us to access a broader spectre of information. Consequently, we will use each other as resources in illuminating our topic thoroughly, challenge each others perspectives and thus examine the field broadly.

In this study there is a possibility that we will talk to a diverse set of villagers with different practices and opinions. In the context of investigating reasons behind high chemical input it is possible as a researcher to fall into the trap of sympathizing with opinions we personally favor, an example could be sympathising more with the villagers using low chemical input do to a smaller impact on the environment. According to anthropologist Helle Bundgaard (2009) it is not the task of social scientists to be: "*morally obligated to one perspective or the other because the interest of the study is of another purpose; an aim to give insights in life as it is lived by people*" (translation by us). Furthermore, as Lotte Buch (2009) points out, it can be impossible at times not to choose sites. She argues that neutral positions are neither possible nor acceptable if you have to understand the objective of your informants - thus you will inevitably be "*morally positioned*" in relation to your field (ibid.). Consequently, we will attempt to address our potential scepticism objectively. Our primary and main obligation is to understand and represent our respondents' perspectives fairly, whatever their opinions might be.

3. References

Bernard, H.R. 2006. *Research methods in anthropology, qualitative and quantitative approaches* 2. ed., Thousand Oaks, Calif: Sage Publications.

Buch, L. 2009. Moralsk Positionering: Feltarbejde i de besatte palæstinensiske områder. In K Hastrup (ed.), *Mellem Mennesker: En grundbog i antropologisk forskningsetik.* Hans Reitzels Forlag, Copenhagen.

Bundgaard, H. 2009. Diskursiv lukning. Etiske dilemmaer i dansk minoritetsforskning. In *Mellem mennesker, en grundbog i antropologisk forskningsetik*, edited by Kirsten Hastrup, 193–206. Hans Reitzels Forlag, Copenhagen.

Chambers, R. 1981. Rapid rural appraisal: Rationale and repertoire. *Public Administration and Development*, 1(2), pp. 95–106.

Czech, S. 2014. *Institutions as enabling constraints. A note on social norms, social change and economic development*. Ekonomia i Prawo. Economics and Law.", Polszakiewicz B., Boehlke J. (ed.), Vol. 13, No. 2/2014, pp. 309-319. DOI: http://dx.doi.org/10.12775/EiP.2014.023.

Dinkins, P. C., Jones, C. and Olson-Rutz, K. 2017. *Soil Sampling Strategies*. [pdf] Montana State University. Available at: http://store.msuextension.org/publications/agandnaturalresources/mt200803ag.pdf [Accessed 16th February 2018]

FAO. 2006. *Guidelines for soil description*. [e-book] Rome: Terme di Caracalla. Available at: http://www.fao.org/docrep/019/a0541e/a0541e.pdf [Accessed 16th February 2018]

Geilfus, F. 2008. *80 Tools for participatory development*. [e-book] San Jose, C.R.: IICA. Available at: http://repiica.iica.int/docs/B1013I/B1013I.pdf [Accessed 21st of February 2018]

German, R. N., C. E. Thompson, and T. G. Benton. 2017. *Relationships among multiple aspects of agriculture's environmental impact and productivity: a meta-analysis to guide sustainable agricultur*e, Biol Rev Camb Philos Soc, 92: 716-38.

Hondagneu-Sotelo, P., 1988, January. Women in the field: Anthropological experiences: edited by Peggy Golde, 397 pages. University of California Press, Berkeley, 1986. price US $12.95 paper. In *Women's Studies International Forum* (Vol. 11, No. 6, p. 611). Pergamon.

Jourdain, D., S. Srisopaporn, S. Perret, and G. Shivakoti. 2017. *'The Role of Information Provision on Public GAP Standard Adoption*. in, Redefining Diversity & Dynamics of Natural Resources Management in Asia, Volume 1.

Kasem, Sukallaya, and Thapa, Gopal B. 2011. Crop Diversification in Thailand: Status, Determinants, and Effects on Income and Use of Inputs.(Report). Land Use Policy 28, no. 3: 618-628.

Levy, R. & Hollan, D. 2014. Person-Centered Interviewing and Observation. In *Handbook of methods in cultural anthropology*, edited by H. Russell Bernard, og H. Russell Gravlee, 296–325.

Loftus, J. (2017). TDRI Quarterly Review, March 2017. Available at: https://tdri.or.th/en/2017/12/tdri-quarterly-review-20173/

Mackenzie, F., 1989. Land and territory: the interface between two systems of land tenure, Murang'a District, Kenya. *Africa*, 59, p.91.

North, D. C. 1991. *Institutions*. The Journal of Economic Perspectives, Vol. 5: pp. 97-112.
OECD. 2013. *STRUCTURAL POLICY COUNTRY NOTES Thailand* [pdf]OECD. Available at: https://www.oecd.org/site/seao/Thailand.pdf [Accessed 19 February 2018]

Olsen, H. (2006). *Guide til gode spørgeskemaer*. København: Socialforskningsinstituttet.

Panuwet, Parinya, Wattasit Siriwong, Tippawan Prapamontol, Ryan, P., Fiedler, N., Robson, M. and Barr, D. 2012. Agricultural Pesticide Management in Thailand: Status and Population Health Risk. Environmental Science & Policy 17: 72-81.

Praneetvatakul, Suwanna et al. 2013. Pesticides, external costs and policy options for Thai agriculture. *Environmental science & policy*, 27, pp.103–113.

Shewhart, W.A., 2012. *Wiley Series in Probability and Statistics*, Hoboken, NJ, USA: John Wiley & Sons, Inc

SLUSE Thailand Field Description. 2018. *THAILAND - DESCRIPTION OF FIELD SITE AND RESEARCH THEMES 2018*. Edited by T. Treue and D. Gonzalo-Ortiz. Received Feb 4th 2018.

Utaranakorn, P., K. Yasunobu. 2016. *Rice Farmers' Attitudes toward Farm Management in Northeastern Thailand*. Journal of Agricultural Science, vol. 8., No. 8. doi:10.5539/jas.v8n8p21.

4. Appendixes

Appendix 1 - Data matrix

Research Question	Sub-Research question	Variables to investigate/ categories	Data required	Methods and tools
What are the drivers of Ban Ba Yai's apparent high-chemical input agriculture despite of government's incentives and the low-chemical input agriculture used in the neighbouring village of Huai Phrom?	How do the villagers in Ban Ba Yai cultivate land and how has this evolved over time?	Agricultural practices (activity over time) in Ban Ba Yai. Time perspective (key events and trends)	Quantitative data (farm and crop size/type) Qualitative data (What they do today vs. what they did earlier, village boundary), covering around 10-20 years. Factual data on historic development of farming practices in the area including including related events (such as climatic events or the introduction of certain policies), covering around 50 years	Questionnaire PRA session 1 (timeline and seasonal calendar; transect walk) Participant observation Satellite images and GPS mapping
	What is the villagers of Ban Ba Yai's perception of what constitutes good agricultural practices vs. how are these related to the government incentive program?	Agricultural practices, opinions and reflections at the household level	Qualitative data (background information, perceptions of soil quality, use of tools and others)	PRA session 2 (community mapping, social and resource map) Semi-structured interview

	What institutions are affecting the choice of agricultural practices in Ban Ba Yai and how?	Government policies Informal Formal Market (Others)	Factual data on government policies and regulations and incentives Qualitative data on formal rules, laws, regulations, legislation etc. As well as on informal rules, regulations, norms, customs, codes of conduct etc. Quantitative data related to government programmes and market behaviour	Semi-structured interview Participant Observation Questionnaire
	What are the biophysical conditions in Ban Ba Yai and Huai Phrom and how is this related to the agricultural practice?	Soil quality Cropping system Agrochemicals	Quantitative data (Soil parameters) Qualitative data Quantitative data (Amount and types)	Soil sampling Questionnaire and SSI

Appendix 2 - Soil description sheet

GUIDELINES FOR
SOIL DESCRIPTION

Date	
Waypoint	
Coordinates	
Profile number	
Slope	
Photo	
Vegetation	
Land use history	
Comments	

Sample ID	Horizon Thickness	Sampling Depth	Colour	Comments

Appendix 3 - Equipment for soil analysis

According to FAO (2006), the equipment recommended is:

- Map of topography (at least 1:25 000) and geology (geomorphology, land use, vegetation)
- 3x cylindrical sampling rings
- Guideline for soil description and classification
- Field book and GPS
- Reading form (Appendix 2)
- Munsell soil color charts
- Shovel, knife, piece of wood and hammer
- Measuring stick

Considerations for the soil analysis:

The number of samples and the practical method of soil sampling will be defined once in the area. The potential sample strategy will be done through a systematic sampling or grid cell sampling (Dinkins *et al.*, 2017) and the potential sites to be examined with different crops and agrochemical input are: rice field, cassava, eucalyptus, sugarcane and maize. The possible soil parameters that can be tested for the field studies are: Permanganate Oxidizable Carbon, Total Nitrogen, Total Organic Carbon, Electrical Conductivity and pH (FAO, 2006) and the estimated sampling time is ~ 3.5 hours/plot.

Appendix 4 - GPS database design

GPS Database design

Sample ID	Date	Waypoint ID	North Y	East X	Elevation Z	Land use/crop	Input	Soil	Photo ID	Comments

Considerations on using GPS and GPS mapping in the field:
A typical GPS that we will use has an accuracy of 5 meters, which is something like the Garmin eTrex 10. For the purpose of our fieldwork, this particular accuracy parameter should not produce any constraints, as we are not making for example an elevation map. With using a GPS accuracy of location is very important. Sources of accuracy errors can be atmospheric particles, for example dusts, that delay the speed of the signals. It can be satellite geometry, i.e. where on the sky satellites are positioned at the specific time, or topographic issues that has the potential to reflect signals.

In our field site, the most likely error could be problems with topography, if we are in hilly areas. However, if most waypoints are being taken in agricultural field or around the village, the sources or error decreases in importance. As mentioned, GPS can be used for different purpose, but one the interesting part is that the data collection that can be presented in GIS-software or on Google Earth (as it is geo-referenced), so we can show distribution or illustrations of land use strategies, farm structure, village sub-divisions of agriculture or social layers, or similar. We have made up a format of a GPS database design that will be used in the field for noting down relevant information when we are making waypoints, tracks, etc.

Appendix 5 - Time schedule

Activity\date	**23.2**	**2.3**	**3.3**	**4.3**	**5.3**	**6.3**	**7.3**	**8.3**	**9.3**	**10.3**	**11.3**
Submission of final synopsis											
Travel to field base camp											
Fieldwork											
Introductory community meeting - Introduction of project objectives and team members to all villagers and counterparts. **Procedure:** Tool 1 community meeting											
1st PRA session **RQ1:** Analyse historical and current land use (+agricultural practices). **Methods:** PRA, Participant observations, transect walk **Procedure:** PRA Tool 1 (matrix ranking), PRA Tool 2 (timeline), PRA Tool 4 (seasonal calendars)											
2nd PRA session **RQ2:** Perceptions and **RQ3:** Institutions **Methods:** PRA, Participant observations **Procedure:** PRA Community mapping tool (social and resource map), transect walk											
Find key ilnformants and identify farmers households for semi-structured interviews and questionnaires											
Interviews and questionnaires Key informants and farmers **RQ1:** land use, **RQ2:** Perceptions and **RQ3:** Institutions **Methods:** Semi-structured interview and Questionnaire **Procedure:** Tool 8 (Interview- agriculture management practices), PEN questionnaire											
Testing and adjusting questions											
Soil sampling **RQ4:** Soil properties **Methods:** Tool 5(Analysing soil fertility management strategies and classifying farms) and Soil Analyses Method Descriptions 2016 (absalon)											
GPS waypoints, tracks, etc.											
Buffer day											
Presentation of data to villagers											
Return to Bangkok											