Assessing the Farming Methods of Local Communities in Nan Province

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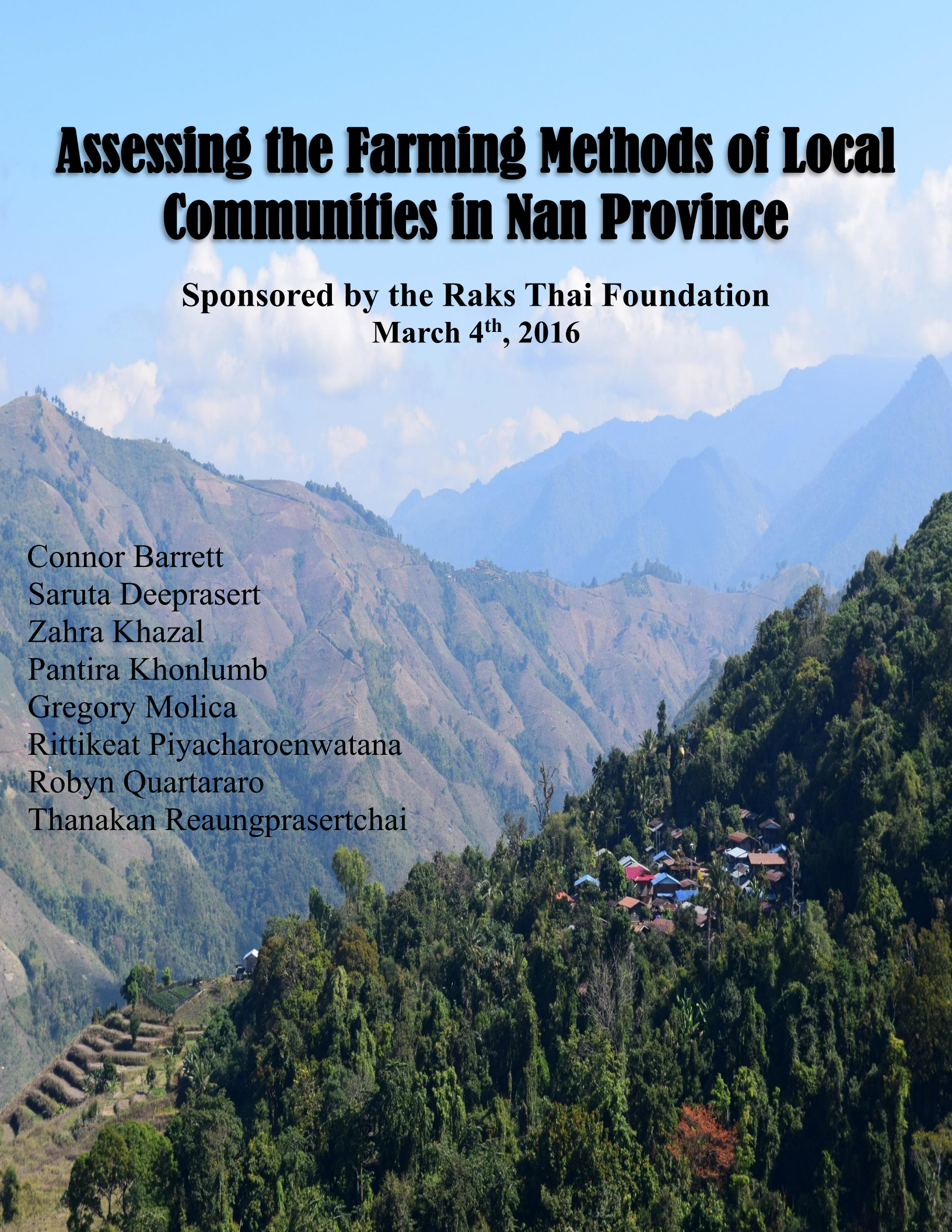

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Assessing the Farming Methods of Local Communities in Nan Province

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Abstract

Our team performed a comparison of crop rotation and integrated terrace farming in highland areas of Nan Province for the Raks Thai Foundation. Farmers have begun to transition from detrimental rotation methods to more sustainable integrated terrace farming, but face barriers such as lack of knowledge about new methods and debt. The comparison is intended to support efforts to persuade farmers to switch farming methods. Our recommendations focused on ways farmers can overcome barriers to adopting integrated terrace farming.

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All members of the project team edited all parts of this IQP

Executive Summary

Introduction

Agricultural communities in Thailand have used crop rotation farming methods for centuries. This method involves growing different crops in successive years that complement each other so that soil quality can be maintained. In the 1970's, however, many crop rotation farmers stopped growing a variety of crops to grow only corn due to the intervention of agricultural companies. For example, in 2005, corn farms covered about 47,000 ha of area in Nan Province, Thailand. However, by 2009, that number increased dramatically to nearly 140,000 ha, causing deforestation and making Nan the second largest corn producing province in Thailand (Balisacan, Chakravorty, & Ravago, 2015). Recently, rotation of the corn crops has become difficult for many farmers due to the reforestation efforts of the Royal Department of Forestry. In many places, crop rotation has been replaced with monoculture methods, which involve repeated planting of one crop every year in the same land (Ongprasert, 2006; Rerkasem, 1998).

Monoculture and the improper rotation of corn crops on the steep hills in northern Thailand has led to soil erosion, loss of biodiversity, and depletion of the soil quality (Chainuvati & Athipanan, 2000). Due to the negative impacts of these practices, there is a need for a transition to more sustainable agricultural methods. One such method is integrated farming which can be practiced on the flat terraces cut into the hillsides. The resulting biodiversity from integrated terrace farming creates a balanced ecosystem that benefits the crops through improved soil structure, nutrient cycling, reduced runoff, and natural pest control (Zhang, Ricketts, Kremen, Carney, & Swinton, 2007).

Organizations such as the Raks Thai Foundation (RTF) and programs like the Royal Project are working to encourage the alternative techniques, like integrated terrace farming, by emphasizing education and conservation (Persson, Henders, & Kastner, 2014). In 2009, the Royal Project started a program to promote integrated agriculture in Nan because it is a very important watershed area (Thailand Sustainable Development Foundation, 2009). Highland villages such as Ban Pang Yang can affect downhill areas when chemicals enter the water supply due to agricultural runoff from heavy rain (Phathomchai & Keawkhammoon). However, there are many limitations that keep farmers from converting to sustainable methods such as land steepness, lack of financial support, and lack of knowledge about how to transition (Horrigan, Lawrence, & Walker, 2002).

The goal of our project was to understand the motivation for and barriers preventing change from rotation farming to integrated terrace farming in the highland areas of Nan Province, and to use the comparison between the two practices to facilitate future transitions to sustainable practices.

Methodology

To achieve our goal we completed five objectives. We used grounded theory to compile large amounts of data and organize it into categories that could then be tied together in order to generate a research question about a particular topic. Our research question was about why some farmers had transitioned to integrated terrace farming as well as how that process could be facilitated. The answer to this question was developed using the following objectives.

1. We documented the current agricultural practices in Ban Pang Yang village

We became familiar with the leaders of Ban Pang Yang village and gained a basic understanding of the agricultural practices in the village. This was accomplished through observation and discussion with the villagers. We learned about the villagers' opinions about terrace farming and crop rotation. The information we obtained helped us to further understand the problem of transition. We also took pictures of the village, farms, terraces, greenhouses, water sources and storage areas. At this point, continuing grounded theory, we began to code our data by separating it into the three main categories of economic, environmental, and social. Establishing the variables was the most important part of this objective

because it determined the baseline for our comparison between crop rotation and integrated terrace farming.

2. We determined what was necessary for the farmers to prosper in Ban Pang Yang

Using these variables for the comparison, we formulated interview questions for the farmers at Ban Pang Yang as well as Huay Muang, a neighboring village. The interview questions are attached in Appendices C and D. We talked to farmers who had transitioned to integrated terrace farming as well as those who have terraces but are not using integrated techniques and those who have not yet transitioned. The interviews were aimed at getting specific information that could be compared such as changes in the amount of fertilizer used and amount of water needed for each practice.

3. We assessed the agricultural strategies used by integrated terrace farmers

While nearly forty families in Ban Pang Yang use terraces for their farming, many do not use integrated techniques even though they can be practiced on the terraces. To gain more data about how integrated farming differs from the corn agriculture, we visited Joko Learning Centre, where the integrated agriculture methods are taught, and Ban Pong Khum, a village that uses the integrated techniques. These visits gave us data on well-managed integrated systems that we could use in our recommendations.

4. We analyzed and compared farming methods to create recommendations for improvement and change

In this step, we analyzed the data we obtained from the interviews in Ban Pang Yang, Huay Muang, Ban Pong Khum, and Joko. We organized the data into two broad categories of crop rotation and integrated terrace farming, and then separated the information further into the categories of economic, environmental, and social. Within these categories, we looked at the data we collected on each variable and compared the two farming methods. We incorporated the opinions and data gained from each type of farmers. We used this analysis in our report to show the changes farmers reported in their lives due to transition. For example, the amount of fertilizer used on slopes versus integrated terraces was very different. Therefore in our report, we highlighted this difference in fertilizer use and its effects of that on soil quality and cost to the farmer.

5. We presented the comparison to the Raks Thai Foundation and made recommendations for assisting farmers to overcome the barriers related to the transition

While our objective was not to tell farmers to change, our analysis included information on the benefits of integrated terrace farming, how the change spread through Ban Pang Yang, and how the RTF could replicate this process. The comparison took the form of a table and a report. The table lists each variable under one of the three categories of economic, environmental, and social factors. The comparison was meant to be used as an example for other villages. Since Ban Pang Yang had already seen change, the RTF wants to use the success there to set an example for villages who have not yet transitioned. Our group did not directly educate the farmers, however, the information we provided could be used in an educational setting.

Results

Our analysis leads to a series of findings about motivations farmers saw for change as well as barriers they faced in the transition.

Finding: Five economic factors play an important role in farmer decisions about using rotational or integrated practices on their land.

The community leaders emphasized the importance of the economic aspects of the farming methods. The farmers are very concerned about the economics because they must have day-to-day expenses. The important factors are as follows:

- **Amount of Income**

The amount of money made by each practice is a large motivation for some people to change. If practiced correctly, integrated terrace farming can be more profitable than selling corn because the alternative crops

such as strawberries. However, we found that farmers are reluctant to completely change at first if they have not directly seen the monetary benefits from a sample crop of their own or from another person in the community.

- **Amount of Debt**

The literature review pointed at amount of debt as a distinguishing factor between the two farming methods. With corn agriculture, the farmers are often loaned the seeds, fertilizer, and machinery for their farms and sometimes cannot repay these loans placing them in debt. The debt is a barrier that prevents some farmers from switching to integrated terrace farming because the change requires an initial investment.

- **Expenses**

Corn farmers have a variety of expenses that integrated terrace farmers do not, which motivates some to transition. The corn rotation farmers must purchase seeds and fertilizer while the integrated terrace farmers own their seeds and do not require additional fertilizers.

- **Stability of Income**

The rotation farmers are incentivized not to transition because the demand for their product is reliable. The middle merchant determines the price so the income does vary, but he will still reliably buy the entire harvest each year. The integrated terrace farmers must find new markets for their products.

- **Additional Water Systems Needed**

Another economic barrier that prevents some farmers from transitioning is the need of an irrigation system with integrated terrace farming. The cost of the PVC pipes can sometimes be too much for farmers who live far away from the water sources.

Finding: Four environmental factors play an important role in farmer decisions about using rotational or integrated practices on their land.

The environmental aspects of each farming method are important to the farmers because in order to maintain the longevity of their farms, the quality of the soil must be preserved. The environmental factors we assessed in the comparison are as follows:

- **Amount of Water Used**

The corn rotation farmers utilize rain to water their crops and do not require irrigation systems. This motivates them to stay with their current practices because the integrated terrace farming require additional water that is stored in ponds.

- **Amount of Fertilizer Used**

Our background research pointed at the amount of fertilizer used as a large difference between the two farming methods. The chemical fertilizer compromises the soil quality and structure over time and therefore farmers are motivated to transition to integrated terrace farming, which does not require chemical inputs. Corn rotation farmers often must use more fertilizer each year to maintain yields.

- **Amount of Runoff from Heavy Rain**

Farming directly on the hillsides makes the fertilizer susceptible to being washed downhill during rain. Each hillside farmer we interviewed said this was an issue. The farmers are motivated to transition to integrated terrace farming because the terraces can hold more water from the rain and prevent runoff.

- **Soil Quality**

The community leaders pointed at soil quality as a key difference in the two farming methods. The corn rotation farmers were concerned with the soil quality and one farmer said that he had transitioned specifically due to the deterioration of his soil. The integrated terrace farms have better soil quality because the creation of a balanced ecosystem helps maintain the soil quality through nutrient cycling.

Finding: Three social factors play an important role in farmer decisions about using rotational or integrated practices on their land.
The social aspects of the transition were harder to measure, however there were social differences that present different barriers or incentives to the farmers. The social variables are as follows:

- **Labor Intensity**

The labor on the hillside farmers is more difficult than the integrated terrace farmers because hillside farmers require weeding and the integrated terraces do not. Also the flatland is easier to work on.

- **Need for Education**

One of the largest barriers to preventing farmers from transitioning is the need of additional education on each aspect of an integrated farm. Without the proper education, the integrated farm could fail to produce the necessary yields for the farmer to make a profit.

- **Access to Education**

Education on corn farming is readily available in the villages from family members. One motivation we found for change was the influence of respected individuals. Some farmers are skeptical of outside influences are more likely to follow the example of a respected person in the community.

Recommendations

From our findings and literature review, our team has generated several recommendations that would help the villages in Nan Province develop lasting integrated terrace farming methods. These recommendations address the barriers that farmers face, which were established in the Results section.

Recommendations to Address Economic Barriers

The economic barriers that we are trying to address are the debt preventing an initial investment, uncertainty in new markets, and uncertainty in the success of alternative crops.

We recommend that the RTF explore a variety of funding options to help farmers begin the transition to integrated terraces. Based on our findings, most of the farmers practicing monoculture cannot afford the initial investment of building terraces. They rely on the income from a single harvest year to year, most of which goes back into their farm. For this reason, many farmers cannot afford the switch to integrated terrace practices. If there was a way for farmers to borrow money with little to no risk, farmers would be more inclined to invest in their farms.

We recommend that the RTF advertise highland farming communities to promote their products. The farmers' independence in their farming methods and income would allow the RTF and the Royal Project to move on and help other communities. We recommend that the RTF helps advertise the villages to attract new markets so they can sell new crops. In addition, advertising farming communities and the products grown in them can attract tourists, who are potential buyers. With more people aware of the communities, they will become more open to tourists, new markets, and therefore more consumers.

We recommend that RTF gather meaningful financial information and success stories from farming communities throughout Nan to show the economic benefits of terrace farming. While many farmers in Nan have heard of integrated terrace farming, many are still unaware of the financial benefits that these practices can lead to. For farmers to be convinced to grow alternative crops they need proof, which can be shown using financial information or by successful examples of community members or neighboring communities. The RTF can utilize the completed comparison of integrated terrace farming and crop rotation to convince the farmers of the benefits of switching as well.

Recommendations to Address Environmental Barriers

The environmental barriers we plan to address are the need for additional water in integrated terrace farming and the lack of proper knowledge on constructing a balanced ecosystem.

We recommend that the RTF provide education about recycling waste and integrating animals on the farms to promote integrated agriculture. Farmers who integrate both crops and animals on their farms will easily be able to compost and reuse extraneous waste products because the waste from animals can also be used as fertilizer, and the animals can help turn agricultural waste into fertilizer as well. Not only is this more beneficial to the environment, but better financially for the farmer. The three animal systems we recommend are pig, chicken and fish systems because the farmers in Ban Pang Yang already own them.

We recommend the RTF educates farmers about efficient ways to use and store water so they can continue to grow crops in the dry season. With proper irrigation systems and proper planning, farmers can maintain healthy crops without depletion of water during the dry system. Year round growth of crops would allow farmers to grow larger amounts of healthy crops. In addition, the RTF suggesting alternative crops that require less water would be beneficial for the farmers.

Recommendations to Address Social Barriers

The social barriers are related to the education of the farmers. Two barriers farmers face are that currently, it is difficult to gain a complete education on integrated farming and some farmers may be skeptical of outside voices trying to influence their transition.

We recommend that the Raks Thai Foundation focus on convincing people such as community leaders to adopt integrated terrace farming practices. Large groups of the farmers learned about terrace farming from Lung Pan in Ban Pang Yang, and the leader of the community supported the change. The farmers that had the ability to switch to this method of farming trusted and respected his suggestion, which turned out to be successful. If the Raks Thai Foundation uses the comparison developed in our report, it will be a strong incentive that may further convince the leaders to bring integrated terrace farming to their communities.

We recommend that the RTF takes our recommendations about education and integrates them into their plan for the learning center in Ban Pang Yang. The goal of the learning center is to educate farmers about the benefits of integrated terrace farming. We believe that the learning center can go beyond this goal, and teach farmers about how they can switch, adopt new crops, efficiently use resources, and more. By doing this, the Raks Thai Foundation can help farmers become more independent.

Conclusion

The goal of our project was to compare integrated terrace farming and crop rotation and provide recommendations based on our comparison. Overall, our results show that there are many farmers willing to implement integrated terrace farming on their land. There are barriers that prevent some from completing this transition, but there are also support systems that can be used to aid the farmers at the beginning of their transition. Some of the barriers include lack of education, lack of access to a water source, insufficient product marketing and market access, and financial constraints. The organizations that exist to support the farmers are the Raks Thai Foundation and the Royal Project, in addition to organizations such as Joko, that teach farmers about a sustainable way of life. The comparison between rotation farming and integrated terrace farming is intended to ultimately convince farming communities that integrated methods are more beneficial for them and the surrounding environment over the long term. In addition, we have given the Raks Thai Foundation a series of recommendations they can consider when convincing and helping highland communities to change. Our work was intended to help make farmers and their communities more independent from outside assistance after switching to integrated terrace farming. In this way, the Raks Thai Foundation can aid a larger community of farmers in Nan Province, who are looking to change, to transition to better practices.

1 Introduction

The world population doubled between 1970 and 2010, raising concerns of growing food consumption. "Projections show that feeding a world population of 9.1 billion people in 2050 would require raising overall food production by some 70 percent between 2005-2007 and 2050" (Hoe, 2009). Recognizing an opportunity to make a profit from the growing demand for food, agricultural businesses began hiring farmers to produce high yield cash crops (Barker, 2007). An example of this industrial transition is in Thailand, where agricultural output has increased by more than 3% per year since the 1960s due to industrial agriculture techniques (Leturque & Wiggins, 2011).

Agricultural communities in Thailand have used crop rotation farms for centuries. This method involves growing a variety of crops that complement each other in successive years to maintain soil quality. In the 1970's, however, many crop rotation farmers began transitioning to growing only corn due to the intervention of agricultural companies. For example, in 2005, corn farms covered about 47,000 ha of area in Nan Province, Thailand. However, by 2009, that number increased dramatically to nearly 140,000, causing deforestation and ranking Nan as the second largest corn producing province in Thailand (Balisacan et al., 2015). As the farmers lost land to the reforestation efforts of the Royal Department of Forestry, crop rotation was replaced with monoculture, which is an agricultural practice that involves repeated planting of a single crop on the same land every year (Ongprasert, 2006; Rerkasem, 1998). These practices on the steep hills in northern Thailand lead to soil erosion, lack of biodiversity, and depletion of the soil quality (Chainuvati & Athipanan, 2000).

Due to the negative impacts of monoculture and improper rotation, there is a need for a transition to more sustainable methods. Integrated farming, an agricultural method that emphasizes harmony between all aspects of the farm, can be practiced on flat terraces cut into the hillside. The resulting biodiversity from integrated terrace farming creates a balanced ecosystem that benefits the crops through improved soil structure, nutrient cycling, and natural pest control (Zhang et al., 2007).

Organizations such as the Raks Thai Foundation (RTF) and programs like the Royal Project are working to encourage the transition to alternative techniques such as integrated terrace farming in the region, with an emphasis on education and environmental preservation (Persson et al., 2014). In 2009, the Royal Project started a program to promote integrated agriculture in Nan because it is a very important watershed area (Balisacan et al., 2015; Thailand Sustainable Development Foundation, 2009). Highland villages such as Ban Pang Yang affect downhill areas when chemicals enter the water supply due to agricultural runoff from heavy rain (Phathomchai & Keawkhammoon). However, there are many limitations that keep farmers from converting to sustainable methods such as land steepness, lack of financial support, and lack of knowledge about how to transition (Horrigan et al., 2002).

The goal of our project was to understand the motivation for and barriers preventing change from rotation farming to integrated terrace farming in the highland areas of Nan Province, and to use the comparison of the two practices to facilitate future transitions to sustainable practices. To complete the comparison, we interviewed crop rotation, monoculture and integrated terrace farmers to gather information about the agricultural techniques. We summarized our comparison in a report that showed the differences between crop rotation and integrated terrace methods based on variables categorized into economic, environmental, and social factors. We determined the categories through our literature review and interviews with the villagers. The comparison and report were meant to highlight the motivation farmers had to transition. We also included recommendations for the RTF on how they can help farmers overcome the transitional barriers. Overall, the project was meant to help facilitate change to integrated terrace farming throughout the Nan highland villages by demonstrating why and how farmers have transitioned.

2 Literature Review

This chapter provides an introduction to crop rotation and integrated terrace farming and the differences between them, which was obtained from our research. To develop this comparison, we describe the agricultural movement from crop rotation into monoculture, and then to integrated and terrace farming practices, using Ban Pang Yang as a model in this change. First, we explain the advantages and disadvantages of crop rotation. Then we detail how monoculture became popular and some of the negative effects of monoculture that encourage farmers to transition to integrated terrace farming. Next, we discuss the benefits and challenges agricultural communities experienced with integrated farming thus far. Finally, we introduce some of the organizations that support the villagers in Nan Province.

Agricultural communities in Nan Province, Thailand experience short growing seasons, high labor costs, and difficult topography (di Mambro, 2015). These factors limit the variety of crops that can be grown. Due to the mountainous terrain, villagers tend to grow cash crops, such as corn, which can be grown on steep hills, but also drains the soil of nutrients (Rueankeaw, 2008). Some villages, such as Ban Pang Yang, have found other ways to farm in the highlands, which has given them the ability to grow a larger variety of crops with more yield (Keawsrinual, 2012).

2.1 Advantages and Disadvantages of Crop Rotation

In this section we discuss the advantages and disadvantages of crop rotation. While crop rotation can be a successful and sustainable farming practice, limited land and lack of knowledge on proper techniques are problems that keep farmers from practicing it correctly (Robson, 2013). Crop rotation is a farming practice in which multiple fields are used to grow a variety of crops on rotation every 1-3 years to prevent soil degradation. Farmers sometimes leave one of the fields that was already used fallow to maintain nutrients in the soil (PAN Germany).

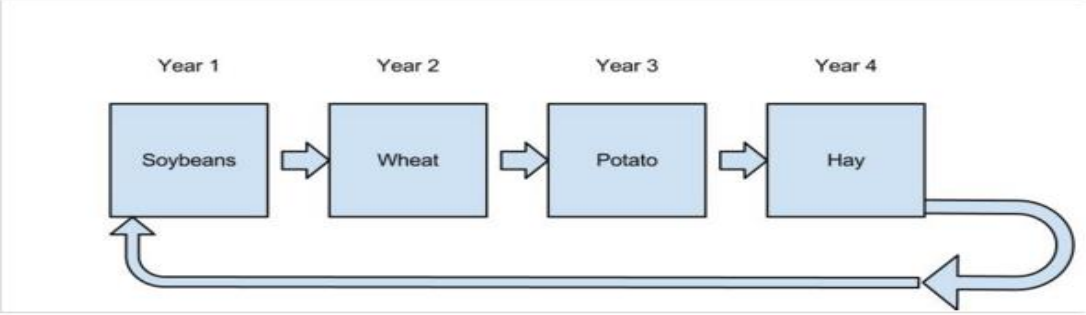


Figure 1: An example of a crop rotation plan

There are advantages to crop rotation when farmers practice it properly. The annually rotated crops complement each other and allow the nutrients in the soil to regenerate, leading to reduction of soil erosion and runoff on fields, prevention of invasive plants and animals, and a decrease in the use of chemicals on the crops (Higgs, Peterson, & Paulson, 1990). Since the availability of nutrients in the soil changes over each rotation of a new crop, it becomes more difficult for weeds to grow and for insects to infect a specific crop. As a result, correct execution of this agricultural method does not require much use of chemical fertilizers, pesticides, and herbicides (Wongwichit, Siriwong, & Robson, 2012).

While there are benefits to crop rotation, there are some disadvantages to this farming practice. Lower profitability, decreased crop flexibility, and high initial investment are a few of the downfalls of this farming method. Crop rotation can be less profitable than monoculture because farmers are unable to grow more of their most profitable crop. In addition, farmers have to pick crops that complement each other to keep the soil quality high, but some of these complementary crops naturally have lower yields than others. Crop rotation also requires more land than other farming practices and therefore requires a large initial investment from farmers to buy plenty of land for rotating (Robson, 2013). The large amount

of land used also requires a lot of work with minimal profits, leading farmers to cut corners by transitioning to alternative farming techniques. These alternative techniques can degrade the soil instead of improving it. For example, when the villagers in Ban Pang Yang practiced rotation farming, corn was their only cash crop, which meant only corn was being rotated on the fields. Practicing crop rotation in this fashion only slows down soil degradation, instead of preventing it (PAN Germany). This way of practicing crop rotation has become widespread in many farming communities in Nan to help their financial situations. While crop rotation has some benefits, the disadvantages outweigh the advantages, motivating many farmers to find new agricultural practices.

2.2 Transition from Crop Rotation to Monoculture

Monoculture is an agricultural technique that utilizes all of the farmland owned by a farmer to grow the same plant every year. The abundance of rotation farms in Thailand declined and was replaced with monoculture farms between 1960 and 1980 (Rerkasem, 1998). One of the main reasons farmers stopped crop rotation techniques in Nan was because of an intervention by the Royal Forest Department (RFD) in the mid-1960's. In the past 50 years, the RFD has declared 59% of the forestland in Thailand nationally conserved forests, making it illegal to cut down trees in the conserved areas (Ongprasert, 2006). The RFD utilizes a variety of approaches to prevent deforestation and protect the conserved forests such as law enforcement, reforesting certain areas, encouraging forest management in local communities, managing the use of forestland through issuing permits, and providing education plans to raise awareness about deforestation. In exchange for villagers reforesting their land, the RFD supports them in terms of budget, technical assistance, and forestland education. Those who do not give up their land are arrested or fined depending on the amount of land they own. Between 2000 and 2006, about 473,400 hectares of land was involved in the Royal Forest Department's forest management projects (Ongprasert, 2006). The program resulted in a large loss of land for many farmers, which forced many of them to convert from crop rotation to monoculture techniques to maximize the use of existing land. In addition, farmland is passed down from generation to generation, meaning siblings must share the land owned previously by their parents, further complicating the land issue (Rueankeaw, 2008).

For the farmers, monoculture was initially thought to be the best option to adapt to the new land restrictions because it produced short term high yields, provided good income, and had moderate work intensity (Khumpian, 2015). Monoculture, however, causes soil erosion, nutrient degradation, and forces farmers into a cycle of debt (Darlington, 1998). The loss of biodiversity that comes from planting one crop continuously in the same area leads to the reduction of soil fertility and degradation of the land. As the soil degrades, it requires greater amounts of fertilizer, loses its structural integrity, and is more susceptible to landslides and chemical runoff during rainfall (Krishna Bahadur, 2008). Both of these effects have the potential to decrease production yield for farmers over time. If crop yield is less than expected, farmers will need to borrow money to purchase more fertilizers, pesticides, and seeds for the next growing season. Since the soil quality is decreasing, the yield will never be as high as it was the first year, and the farmers are caught in a cycle of borrowing money and not raising enough income from the yield to pay it back. For this reason, farmers are once again ready to make a switch to a new agricultural practice that will improve their livelihoods.

2.3 Integrated Terrace Farming

An alternative to crop rotation and monoculture in the highland areas of Nan is integrated terrace farming. Integrated farming is most effective in flat areas with high water retention, such as terraces. In integrated farming, the environment is recognized as a vital source of biodiversity, which is a necessity for a healthy, sustainable farm. With this farming method, a variety of crops are grown to feed the farmer and a plan based on water use, soil management, crop nutrition, crop health, livestock welfare, nature preservation, waste management, air quality, and energy efficiency is devised by the farmer for each agricultural situation (EISA, 2012). This method of agriculture addresses impacts that the previous methods usually cause, such as soil degradation (Al-Kaisi Mahdi, 2000). While integrated terrace farming is still not

widely used in Nan, villages such as Ban Pang Yang have improved their financial situation as well as the surrounding environment through adopting these new farming techniques (Vogel, 1987).

Farmers who switch to integrated terrace methods benefit from their farms much more than in crop rotation and monoculture. Terrace farming prevents soil erosion and allows farmland to capture more rainfall, allowing the soil to retain nutrients and decreasing the amount of fertilizer used. For example, corn yields improved up to 15% with terrace farming compared to conventional hillside practices. Additionally, restoration and adoption of terrace farms in the Philippines lead to a 150% increase in a variety of crops grown in upland regions (Jeffrey Hays, 2008). The resulting surplus of crops helps farmers financially, as they can sell additional crops in the market. To improve the terrace farming system, adopting integrated practices can further increase crop yields and improve soil quality. Integrated farming also creates an environment that is unlivable for invasive plants and insects, which decreases the use of pesticides and herbicides (EISA, 2012). This system allows the crop to thrive as naturally as possible. A simple integrated system is outlined in Figure 2 (Luu, 1992).

Another important aspect of integrated terrace farming is water. Water usage on the farm is closely monitored, ensuring that the source is not overused, leading to a deficiency (EISA, 2012). This is important because the highland region of Nan experiences droughts during the dry season and water is needed on terraces all year long to continue growing crops (Balisacan et al., 2015). Overall, integrated farming systems are based on a comprehensive understanding of cause and effect. Each action taken by the farmer affects the entire system, so the correct course of action may not be readily apparent. For instance, if a new chemical would increase yields, its usage may be encouraged in nonintegrated farms. However, in an integrated system, the chemical's effects on the environment, the water quality, and the soil would be closely examined before it was introduced (EISA, 2012).

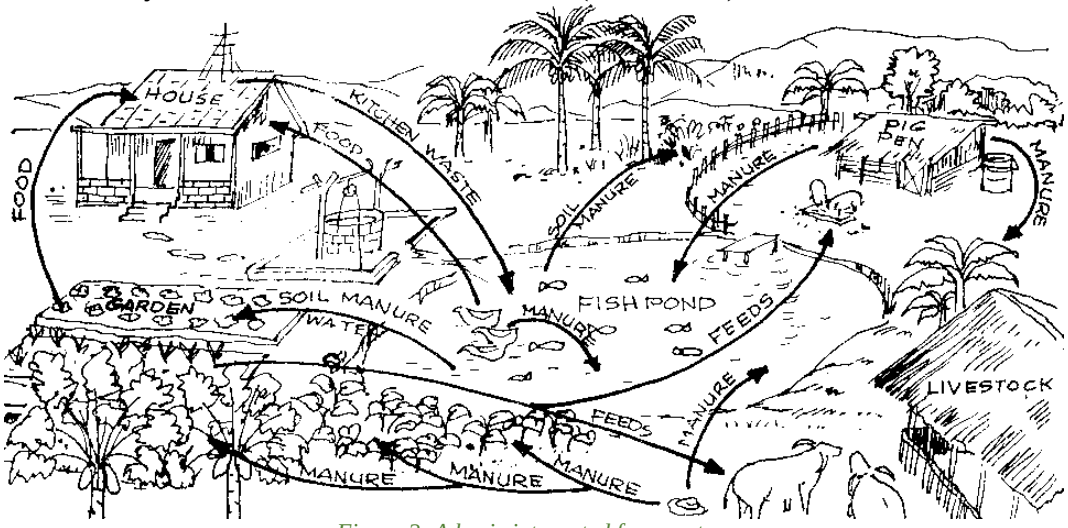


Figure 2: A basic integrated farm system

2.3.1 Challenges with Transition to Integrated Methods and Terrace Farming

A few barriers preventing some farmers from building terraces are lack of relevant knowledge, support from organizations on financial and adequate water management systems. Terraces require more water when rice paddies and high-water-intake crops such as fruit are grown. The mountainous terrain of northern Thailand makes it challenging to transport water to farms without proper water transportation systems. In order for farmers to actually build more durable water management systems such as PVC piping, they need education and financial assistance. Villages like Ban Pang Yang have received a lot of support from the Royal Project and the Raks Thai Foundation in dealing with the financial and environmental issues. However, entire irrigation systems are very costly to implement, so farmers need to purchase some of their own materials (Dorren & Rey, 2005). Even building the actual terraces requires

knowledge on proper construction techniques. For example, farmers must determine natural runoff paths and patterns prior to construction. To prevent erosion of the constructed terraces, paths need to be dug to allow for excess water to flow out of the terrace based on following natural drainage paths. If a farmer is unaware of proper irrigation, the terrace system will not function to its highest capacity, if at all (Dorren & Rey, 2005). While terrace farms and integrated practices can be beneficial, they require a certain level of expertise that some farming communities in Nan lack, which prevents many farmers from transitioning to the practice.

While there are issues with terrace farming that can be combated, there are some unavoidable downsides. One of these downsides is an average of 20% area loss due to construction of terraces. For some farmers, this is enough of a reason to shy away from the idea of terrace farming because it will decrease the farmers' yield and income. The income loss can, however, be reduced by growing a second crop during the dry season (Branca, Lipper, McCarthy, & Jolejole, 2013). Another downside is the time it takes to construct terraces. To do it properly, bench terraces and waterways can take up to four months to build. A report stated that if a family farm worked steadily throughout a dry season, they could finish the new farm style in 3-3.5 months, which is enough time before the rainy season starts again (Kitchaicharoen, Suebpongsang, Sangchyoswat, & Promburom, 2015). This time could additionally be cut with proper machinery (Suebsang).

2.4 Support to Overcome Transition Challenges

There are many external organizations with the goal of improving the environment and quality of life in agricultural communities. In northern Thailand, two of the organizations with this purpose are the Thailand Royal Project and the Raks Thai Foundation (RTF). Both organizations are non-governmental and share the desire to aid highland farmers and conserve the mountainous environment they live in.

The largest support system working in Nan Province now is the Royal Project, which was created by King Rama IX in 1969. The "Pid Thong Lung Phra" Royal Project works on providing Nan with a model on integrated, area-based and issue-based development. The Royal Project mainly focuses on addressing deforestation and poverty issues by providing farmers with suggestions on growing alternative crops and supplying some materials for the farmers (Highland Research and Development Institutes). The Royal Project collaborates with Doi Tung Development focusing on upstream areas, to address problems that occur in Nan province such as land ownership, deforestation caused by corn production, and standard of living of local communities (Thailand Sustainable Development Foundation, 2009).

Another organization that has supported villages in Nan is the Raks Thai Foundation. The RTF is a member of CARE International and started as a CARE facility, but became its own entity in 1997 (Raks Thai Foundation, 2008). The mission of the organization is to empower people who are physically, economically, or environmentally disadvantaged. They do not simply solve the problems, but rather instill useful knowledge that can be used in the future by the communities to switch to more sustainable practices than crop rotation and monoculture (Raks Thai Foundation, 2008). In northern Thailand, the RTF projects provide education and conserve the forest that many indigenous populations rely on for sustenance and income. To help combat deforestation for agricultural activities, the RTF facilitates agreements between communities to monitor the land usage and deforestation of shared areas. The program gives control to the affected communities, meaning they have an active role in the course of project rather than being spectators (Raks Thai Foundation, 2008).

2.5 Summary

The research in this chapter focuses on rotational farming and integrated terrace farming in the mountainous region of Nan Province in order to see the advantages and disadvantages of each technique and determine how they shape the future of farming in surrounding villages. Our project seeks to further understand the incentives and barriers the village of Ban Pang Yang faces during its transition to

integrated terrace farming by comparing rotation agriculture and integrated terrace farming. Knowing these barriers and incentives, the RTF can better assist other villages surrounding Ban Pang Yang to begin adopting more sustainable practices. In addition, the knowledge gained about each farming method helped our team to write our methodology, develop the variables for our comparison, and create a series of recommendations for our sponsor.

3 Methodology

Ban Pang Yang is one village in Nan Province that has adopted terrace farming methods, in addition to some integrated farming techniques. The goal of our project was to understand the motivation for and barriers preventing change from rotation farming to integrated terrace farming in the highland areas of Nan Province, and to use the comparison between the two practices to facilitate future transitions to sustainable practices. Our team provided the RTF with a comparison of crop rotation and integrated terrace farming to show what incentivized farmers in Ban Pang Yang to switch, what barriers they faced, and what benefits they saw from the transition. We developed the variables in our comparison by using our background research to guide discussion with community leaders to determine which variables were most important to the farmers. We focused on the barriers that burden farmers who want to transition towards integrated terrace farming. By highlighting the barriers, we were able to present recommendations on how to overcome them using information we gathered from the people who had transitioned and from support systems that made the transition possible.

We used grounded theory to compile large amounts of data and organize it into categories that could then be tied together in order to generate a research question about a particular topic (Scott, 2009). Our research question was about why some farmers had transitioned to integrated terrace farming as well as how that process could be facilitated. Data from our first two visits to Ban Pang Yang and our literature review was analyzed using open coding, which also helped us develop the variables that we used to compare crop rotation and integrated terrace farming. We spent ten days in Nan Province and were able to visit Ban Pang Yang four times as well as Joko, Ban Pong Khum and Huay Muang once. The answer to our research question was developed using the following objectives.

3.1 We documented the current agricultural practices in Ban Pang Yang village

We used our background research to guide the discussion on our first two days in the village and determined the most important factors to the farmers and the barriers they had experienced during the transition to integrated terrace farming. The purpose of our first day in the village was to become familiar with the community leaders and to gain a basic understanding of the agricultural practices there through observation and discussion. We spent the day in the village leader's house and spoke with him, his assistants, and some farmers. By exploring some of the barriers, we were able to derive questions that looked at why barriers existed and how they were overcome. We also asked about what farmers expected and did not expect from the transition. During our second day in Ban Pang Yang, we took a tour of the community and were able to talk with more farmers. The observations were used to understand the practices that are being used by the farmers in Ban Pang Yang. The specific things we observed and inquired about are listed in Appendix B.

We analyzed our notes from the first two visits to the village by creating a list of the variables that were mentioned by the farmers and that we found in our background research. At this point, continuing grounded theory, we began to code our data by separating it into economic, environmental, and social factors to find variables that we could later assess in our interviews. The organization of our initial categories and variables can be seen in Appendix C. Determining our variables was the most important part of the first objective because it helped determine the base of our comparison between crop rotation and integrated terrace farming.

3.2 We determined what was necessary for the farmers to prosper in Ban Pang Yang

Using the variables we determined from our first objective, we formulated interview questions aimed at collecting data about each variable. The interview questions can be seen in Appendix D. The entire group started the interviews on January 29th in Ban Pang Yang. On the 30th, we split into two groups, with one group going to Ban Pang Yang and the other going to Huay Muang, a neighboring village. The purpose of the interviews from Huay Muang was to provide us with information about rotation farming methods and reasons for lack of transition to terrace farming, as well as to obtain different perspectives of the farmers from a different village. We wanted to find the advantages and disadvantages of both methods to truly understand why some farmers had switched and others had not. A more in depth description of the interview process can be found in Appendix K.

3.3 We assessed the agriculture strategies used by integrated terrace farmers

While nearly forty families in Ban Pang Yang use terraces for their farming, many do not use integrated techniques even though they can be practiced on the terraces. To gain more insight about integrated farming, we visited Joko Learning Centre, where the integrated agriculture methods are taught, and Ban Pong Khum, a village that uses the integrated techniques.

The questions asked at Joko are listed in Appendix E. Khun Samruay, Joko's founder, explained the benefits of integrated farming as well as the strategies they used to influence the change from monoculture. The group then traveled to the village of Ban Pong Khum to observe the integrated practices there. The monk there, Phra Somkit, had convinced the entire village to change and shared with us how he convinced them and the techniques he utilizes on his farm. This information was important in creating recommendations for the RTF to convince other villages to switch to integrated terrace farming. The same questions that were asked at Joko were also asked at Ban Pong Khum.

3.4 We analyzed and compared farming methods to create recommendations for improvement or change

In this step we analyzed the data we obtained from the interviews in Ban Pang Yang, Huay Muang, Ban Pong Khum, and Joko. We organized the data into two broad categories of crop rotation and integrated terrace farming, then separated the information further into the categories of economic, environmental, and social. Within these categories, we looked at the data we collected on each variable and compared the two farming methods. For example, the amount of fertilizer used on slopes versus integrated terraces was very different. Therefore in our report, we highlighted this difference in fertilizer use and its effects such as on soil quality and cost to the farmer. While our objective was not to tell farmers to change, our analysis included information on how the change spread through Ban Pang Yang and how that process could be replicated. This process is outlined in Appendix K.

3.5 We presented the comparison to the Raks Thai Foundation and made recommendations for assisting farmers to overcome the barriers related to the transition

Our analysis of the interview results included information on the benefits of integrated terrace farming, how the change spread through Ban Pang Yang, and how the RTF could replicate this process. The comparison took the form of a report and a table. Since Ban Pang Yang had already seen change, the RTF wanted to use their success as an example for villages that have not yet transitioned. Our group did not directly educate the farmers, however, the information we provided could be used in an educational setting.

To encourage the farmers to switch, we provided information on possible crops the RTF could introduce. The harvest from corn farms is completely purchased by the agribusinesses who also provide the seeds and fertilizer. This was attractive to the farmers because it was a reliable market for their single product.

By switching to integrated terrace farming, the farmers will have a bigger variety of crops that would provide them with a reliable income. We also provided recommendations on strategies for the spread of integrated farming. To overcome the initial cost of the investments we assessed various ways the farmers could obtain financial support. We showed the RTF the specific reasons why people had switched to hopefully help them replicate the situation in Ban Pang Yang in other similar villages. The report was meant to be applicable to many villages, leaving the scale of distribution at the discretion of the RTF.

4 Variables of the Comparison

The main goal of our project was to develop a comparison between crop rotation and integrated terrace farming to understand the barriers farming communities face with adopting better agricultural techniques. Between our literature review and the data collected during our visit to Nan Province, our team came up with a list of variables in the three main categories of economic, environmental and social factors that were highlighted by our background research and interviews. In this chapter, we identify these variables and explain their significance in our comparison. All of the interviews quoted in this section can be found in Appendices F, G and H.

4.1 Economic Variables

The most important economic variables highlighted by our literature review and our interviews with the farmers are their income, the stability of their income, amount of debt, ownership of their seeds, expenses, and the need for an irrigation system.

Annual Income/earnings: Within our literature review, we identified annual income to be a key issue (Darlington, 1998). We found that farmers deal with fluctuating incomes based on market demands for crops in a given year, and the actual quality of the crop. This is applicable to both rotation and integrated farming. All of the farmers we interviewed from Ban Pang Yang indicated that their stable income mainly came from corn rotation farming because there is a middle merchant that goes to the village to buy their products. On the other hand, one of the first farmers who started integrated terrace farming mentioned that "now, crops grown on terraces are for personal consumption but not for sell."

Stability of Income: Stability of income was identified as an important variable for all farmers because with crop rotation, the value of their crop fluctuates each year (Robson, 2013). Lack of financial stability is a major barrier for many farmers considering switching to integrated practices. In addition, we found that financial stability is sometimes an incentive for farmers to switch to new methods of agriculture and increase their crop variety. The village leader says that, "these fruits are now in their experimental process for most of the villagers and those who already succeeded are now selling their product to the Royal Project," which means they are earning more income.

Amount of Debt: In our literature review we found that many farmers who practice crop rotation farming and monoculture often find themselves in a cycle of debt (Darlington, 1998). The amount of debt of farmers who practice crop rotation farming is higher due to a variety of additional expenses they have such as fertilizers. In the short term, farmers who switch to terrace farming are pushed into debt from initial expenses. Some of the farmers we interviewed discussed amounts of debt with us as well, voicing it as a major concern for them. One farmer stated, "I have no money for my children's education so I have no choice and signed the contract with the middle merchant to buy and sell everything from the middle merchant to feed my family". This farmer is one of the many farmers stuck in a difficult financial situation due to monoculture crop rotation practices. Even though all materials are provided, corn can be grown only once a year, which is a not enough income for the farmer. The corn can be profitable at first but one farmer explained that "As [he] continuously grows corn in the same area, the soil quality is getting worse so [he] needs to buy more and more fertilizers every growing period." As there is an increasing in the amount of expenses on crop rotation farming and corn farming, farmers find themselves

further in debt every year. On the other hand, integrated terrace farming requires less fertilizer since a variety of crops were grown. Many farmers unfortunately cannot afford to adopt terrace farming practices such as Farmer 3 who stated, "I wanted to change to terraces but I did not have enough money to buy the PVC pipe or construct the terraces". This means that due to economic issues, farmers are unable to switch to terraces since they require upfront cost to buy PVC pipes and hired labor to build terraces.

Seed Ownership: In our interviews we found that corporations play a large role in seed ownership. Farmers who practice crop rotation farming do not own the seeds they grow and have to pay for seeds annually. Those who practice terrace farming do own their seeds. In Ban Pang Yang, the royal project supplies farmers with seeds for no charge. Seed ownership reduces expenses and puts less financial stress on farmers compared to those who must pay for seeds every year from middle merchants.

Access to Additional Water: Proper irrigation systems are expensive due to large amounts of piping required to get water from brooks to farms. We found water management to be a concern after visiting Ban Pang Yang, and was something we did not find in our literature review. This is an important variable because lack of water is a barrier for farmers that want to switch to integrated terrace farming practices. A farmer in Ban Pang Yang, stated, "Some of the PVC pipes were given by the Royal Project but I don't have enough money to afford the rest... My farming area is above the water area." So while the Royal Project and other organizations can supply PVC piping, some farmers are simply too far away from a water source to even practice terrace farming. We found this to be one of the most common barriers with farmers switching to integrated terrace farming.

Water Storage for Dry Season: During the dry season, water storage is required for farmers to grow crops on terraces (Dorren & Rey, 2005). This is an important variable because crop rotation farms can rely solely on rainfall, while integrated terraces require a steady supply of water. Some farmers, such as Farmer 7 have created ponds to supply water for their terraces during the dry season "I stored water in my pond located on top of the terraces."

4.2 Environmental Variables

The most important environmental variables highlighted by our literature review and our interviews with the farmers are their amount of water and fertilizer used, amount of runoff from heavy rain, and soil quality.

Amount of Water Used: We found this variable to be important to consider as some villages only have rainwater to water their crops. We found that terrace farming requires water management systems, unlike crop rotation. Depending on proximity to brooks, terrace farming can either be easy to adapt to or extremely difficult. Typically crop rotation farming only uses rainwater, which makes it easy for farmers who practice, but also leads to less stable crop yields. If there is a bad season for rain, crop yields are low and farmers make less income. While terrace farming requires more water, putting in water management systems is better anyways because it leads to more stable crop yields. Farmer 8 said, "I don't have to store any water for my corns because I used only rain water but for terraces I have to dig a pond to store water. For the terraces, I have to connect the pipes from the brook to my farming area. Some of the pipe was provided by the Royal Project and he bought the rest." Since doing this, however, Farmer 8 has been able to grow crops year round, which has loved.

Amount of Fertilizer Used: This variable addresses what kinds of fertilizers are used and how they impact the surrounding environment. From literature we discovered the effects of fertilizers on the environment. Overall, fertilizers should be avoided as they lead to imbalances of chemicals in the soil (Al-Kaisi Mahdi, 2000). We also learned from the farmers how certain fertilizers are used between different practices and their effects on overall crops yield. For example, terrace farming requires less

fertilizer use than crop rotation farming as Farmer 9 said "I used about two bags of fertilizer per rai for corn farming and about one bag for terraces." Farmer 4, another terrace farmer in Ban Pang Yang, compared the yields of both practices stating "I used less fertilizer on terraces due to its higher production yield, and I also reused corn cobs as organic fertilizers."

Amount of Runoff from Heavy Rain: Terraces help address the problem of runoff due to rain. Between literature and our own observations, we found runoff to be a common issue with uphill crop rotation farming (Al-Kaisi Mahdi, 2000). In addition, farmers explained why crop rotation farming requires more fertilizer. Farmer 5 said, "For hillside, I need to re-fertilize all of the area if it rains, but on terraces the fertilizers will remain on the steps." Terrace farming reduces runoff, which helps the surrounding environment and helps financially as farmers don't have to use as much fertilizer.

Soil Quality: In addition to less runoff, terrace farming helps improve soil quality. From literature we learned that crop rotation, if practiced correctly, works well and helps maintain the environment. However, hillside farming limits farmers to what they can grow, and corn makes them the most money so farmers in Nan switched to these practices. These practices have caused widespread soil degradation (Krishna Bahadur, 2008). Farmers such as Farmer 10 are aware of the damage and have begun to adopt terrace farming practices, saying, "The soil quality is getting worse each year from corn farming. But when I've switched to terraces, the soil quality slowly improved." Between runoff and decreasing soil quality, farmers who practice crop rotation must increase the amount of fertilizer used each year. Farmer 9 says "the soil is getting worse each year so I need to use more and more fertilizers each year if I want to maintain the soil."

4.3 Social Variables

The most important social variables highlighted by our literature review and our interviews with the farmers are the labor intensity on the farms and education sources. Each variable is compared between rotation farming and integrated terrace farming in Table 3.

Labor Intensity: Our results from the interviews showed that crop rotation required a lot more work than terrace farming. For this reason, farmers often have to work harder and hire additional labor to complete the work. Terrace farming has allowed farmers to have more time, such as Farmer 9, who "uses less labor for terraces which means that the other labor will be able to do something else such as gathering mushrooms for food." Farmers have also said it's easier to farm terraces than hillsides, which has been better for their joints. A lot of farmers praised lower working intensity as one of the best benefits of terrace farming and is an incentive for many farmers looking to make the switch.

Need for/Access to Education: Ban Pang Yang has been so successful in adopting terrace farming that the Raks Thai Foundation has plans on creating a learning center from it. Farmer 9 said "Ban Pang Yang is now becoming a model but if we were not invited by the other village it is not our job to convince anybody to change. But if they want to learn from us we are happy to teach them because there is no point of wasting our time explaining to those who don't care about it." While many villages such as Huay Muang want to change, they feel that they can't without the significant assistance of support groups such as the Royal Project. We also learned that many of the farmers followed the example of two respected men in the village, Lung Pan and the community leader. The person that the idea for change is coming from has a significant effect on whether people will change or not, because not as many people trust outside influences as they do their leader.

5 Results

This section takes our determined variables from the previous section to develop our comparison between crop rotation and integrated terrace farming. In addition, this section discusses other important findings that helped us develop recommendations for the Raks Thai Foundation. The questions that we asked the farmers gave us information about their past techniques and how they compared to the new techniques, if integrated terrace farming is being used. Using the variables that were highlighted as the most important, we interviewed farmers at Ban Pang Yang and Huay Muang, as well as Khun Samruay, the Chief Executive of Mueng Jung's Sub-district Administrative Organization and founder of Joko Community Learning Center, and Phra Somkit, a monk practicing integrated terrace farming at Wat Pong Khum for demonstration. These interviews presented a series of findings that included trends that about what convinced farmers to change, and barriers that prevented or deterred the farmers from transitioning to the integrated terrace farming techniques. The barriers are very important because they showed us what can be improved by the Raks Thai Foundation to help farmers transition. The key barriers were financial constraints, lack of marketing and market access, location, and education. We focused on understanding how the farmers had transitioned and how they overcame the barriers.

5.1 Economic Variables of the Transition

After compiling all of our data and analyzing it, we found that the financial situation of the farmer is one of the main motivators and one of the main barriers to the farmers' transition. If the farmers have money to invest in their farms and convert their land to terraces, then they are very willing to do so. The investment is also motivated by the financial success that integrated terrace farming brings, which is proven by the farmers in Ban Pang Yang who have already switched. However, farmers are often limited by their financial situation. One farmer stated that he wants to change to terrace farming because his family will "have a better life, but [he does] not have enough money to support [his] family and build the terraces". Building terraces and growing new crops requires an initial investment and ability to sell the products of the farm, so if farmers cannot afford it they are unable to move away from crop rotation or monoculture. Table 1 is a summarized table containing the answers from the farmers about the economic variables used to compare rotation farming and integrated terrace farming.

Economic Variables	**Rotation Farming**	**Integrated Terrace Farming**
Money/year	Traditional rotation was for food but **corn rotation** produces a cash crop that is sold for **7-8 Baht/kilo**	Traditional varieties of **rice** can bring around **5 Baht/kilo more than GMO ric**e. Fruit and local vegetables can also be **more profitable**
Amount of debt	**More debt** for corn, seeds can be borrowed as well as fertilizer to be paid back at the harvest.	**Little to none** debt since the farmer controls the seeds and does not borrow fertilizer
Seed ownership	Farmers **do not own** the seeds	Farmers **own** the seed
Stability of income	Corn price **determined by the middle** merchant but the crops are **consistently purchased**	Price determined by **new markets**, income depends on if the farmer can find a buyer
Expenses	**More** cost on seeds, fertilizers	**Lower cost on fertilizer (** but Upfront cost to transition
Additional water system required	**None needed** (Rain water only)	**PVC pipe** must be purchased for an irrigation system

Table 1: Economic Variables

Debt due to the transition to monoculture prevents farmers from investing in their farms
The transition to monoculture of corn created debt in the region of Nan. Prior to the corn-based economy, farmers owned the seeds that they planted. However, when the companies came to Nan and loaned the farmers corn seeds to grow and work for them, the ownership of seeds was lost. The corn companies loaned the seeds to make it as easy as possible for farmers to transition to the monoculture of corn. Even if the farmers did not have the money to transition, the middle merchant would lend them everything they needed. The farmers stated that "all the seeds and machineries were provided by the middle merchant." This initial loan started the debt that is now seen in the region as farmers fight to make enough income to payback their loans. At Joko, there is a focus on returning to the traditional seed varieties that were used before genetically modified crops became prevalent. Growing the traditional varieties also allows the farmers to regain ownership over their seeds. Integrated farming on flat land or terraces eliminates the need for loans from large corporations. These current loans, however, sometimes prevent farmers from transitioning away from monoculture.

Transition is particularly difficult for farmers who are in debt to the agricultural companies or from other purchases such as vehicles. Since the transition to integrated terrace farming requires an initial investment to create the terraces and irrigation systems, the upfront cost can be difficult to overcome if the farmer already owes the company for the seeds, fertilizer, and machinery. The farmers often get assistance from the Royal Project for the PVC pipes in the irrigation system, but must buy additional pipes with their own money. Farmer 4 said that the loans he had received for seeds had prevented him from starting a new agricultural practice without outside assistance because the money made from corn was not enough to pay for his family's expenses. The farmers are incentivized to stay with the current farming methods because it gives them quick, guaranteed money.

To help with this barrier, the Joko Learning Center has set up a micro-financing system. They give small loans to farmers so that they can invest in their own farms to make the transition to integrated farming and can be paid back once the benefits of the integrated techniques are seen. This system of micro-financing has been very successful in the areas where Joko works. Other villages, such as Huay Muang have a small bank that gives out loans in order for the families to purchase seeds and fertilizers, which they must pay back once they make a profit from their crops. While not directly used for transitioning to integrated terrace farming, cooperatives can be used to help lower the initial individual cost of transitioning. However, farmers without access to aid systems such as Joko are left to come up with the money for the transition on their own. Very few farmers can do the transition by themselves. The support systems such as Joko's loans are vital in the spread of integrated farming practices.

Uncertainty about new markets discourages farmers from transitioning
The corn farmers in Ban Pang Yang discussed that the corn price was determined by the middleman and therefore was unstable. The price fluctuated between 7 and 8 Baht/kilogram. While many acknowledge that there are benefits to alternative products, they do not want to risk the transition because they have a guaranteed market for their product. These farmers have to look out for themselves and their family, which means avoiding unnecessary risks. The farmers can consistently sell their products to the middle merchant every year. Khun Samruay emphasized that the reliability of the current market and the uncertainty around finding a new market is preventing people from switching to integrated farming. The uncertainty aspect was shown in Ban Pang Yang where Farmer 5 said the biggest surprise from growing avocados was that the merchant came to the village to buy her produce. She was uncertain about this market source but was pleasantly surprised with the result. Khun Samruay explained that some farmers live too far from the available market sources. This distance discourages them from growing alternative crops because the corn merchant will come directly to the village. This finding highlighted a lack of marketing for the farmers. Their products are not well known enough for the farmers to feel comfortable transitioning to alternative crops.

Farmers transition after seeing the financial success of growing alternative crops
Many farmers in Ban Pang Yang have transitioned to terraces and some to integrated terrace farming, therefore, the benefits can be seen by other farmers in the community. When the farmers saw people like Lung Pan make increased profits with their new crops, some of the apprehension of switching was alleviated. At Wat Pong Khum, we saw a vegetable system that focused on crops with short life cycles. The plants grew fast so they could be harvested multiple times over a period of months. Phra Somkit explained that the initial reaction to those crops is that they would not generate enough money. However, farmers did not realize that they could get multiple harvests per year and thus make a profit. Like the villagers in Ban Pang Yang that observed Lung Pan, the benefits had to be seen before they were accepted.

The majority of the terrace farmers' income in Ban Pang Yang comes from growing corn on hillsides. Most of the farmers mainly use terraces to grow rice and other fruits and vegetables for personal consumption and they sometimes sell the excess. However, some of them recently started to grow avocados, grapes, and strawberries based on the recommendations of the Royal Project who also provided them with seeds. One of the farmers we interviewed also owns greenhouses to grow grapes and strawberries.

While terraces require an initial investment, once the soil has regenerated its nutrients and the farmer is harvesting crops, they cost less to maintain than hillside farms. Most of the farmers we interviewed in Ban Pang Yang used little to no fertilizer on their terraces. Khun Samruay displayed the integrated farm where there was no fertilizer used. Therefore, not only do the products such as grapes and strawberries sell for more money, they cost less to grow once the terrace system is in place. Fertilizer and seeds are the two main costs for farmers who grow corn and both of these costs are reduced or eliminated when they transition to integrated terrace farming.

Overall, integrated terrace farming is economically beneficial in the long term. However, the taking of initial steps to become an integrated terrace farmer can be difficult for the farmers. The initial cost to transition inhibits some farmers, especially those who are debt. The farmers are also apprehensive about the transition because they do not know if they will be able to sell their products. When the farmers are able to observe the success of others, they are more easily convinced of the benefits of transitioning.

5.2 Environmental Variables of the Transition
We interviewed a number of farmers in Ban Pang Yang about the different environmental factors that they experience in rotation farming and integrated terrace farming. Most of the farmers that we interviewed said that they do not need much water for rotation farming because corn requires only a small amount. Farmer 6 mentioned that practicing integrated terrace farming requires a lot more water because of crops like farmed rice. Also, one or more ponds need to be built around farms to store water. In addition, the amount of fertilizer used is higher in rotation farming practices than terraces because growing corn leads to the soil degradation. Farmer 9 indicated that "corn is the cause of soil erosion. If [they] keep doing it for many years, all soil in this area will be degraded." We also asked about the difference that runoff made between the hillside farming and terraces. The farmers told us that when there was a heavy rain, it washed away all of the chemicals and fertilizers on the hillside farms. In addition, the longer corn is grown on the land, the worse the soil quality gets as it destroys the soil surface on the hillside. Growing a variety of plants makes the soil quality better due to the mutuality of complementary inputs from different plants leading to the more nutrients that soil can gain. The summary of farmers' responses to our environmental variables is included in Table 2.

Environmental Variables	Rotation Farming	Integrated Terrace farming
Amount of water used	**Less** water (requires rain water only [No pond]	**More** water (requires additional water directly from reliable source)[1-2 ponds per terrace]
Amount of fertilizer used	**More** fertilizers (Both organic and chemical fertilizers	**Less** fertilizer (Fertilizer can be used to replenish the soil quality initially but when the terraces are built, fertilizer use is lower)
Amount of runoff from heavy rain	Heavy rain washes **more** chemicals and fertilizer down the hill	**Less** fertilizer is washed down the hill (terraces capture more water)
Soil quality	**Bad** soil quality	Fewer chemical inputs lead to **better** soil quality

Table 2: Environmental Variables

Chemical fertilizers are affecting the soil quality in Nan Province

The use of chemical fertilizer degrades the soil, which adversely affects the crop quality and yields. The farmers in Nan province, such as Ban Pang Yang, are aware of this effect and tried different methods to prevent degradation. Farmer 7 had previously practiced corn crop rotation but switched to integrated terrace farming because of the noticeable degradation he saw in his soil. According to Farmer 6, fertilizers cost him around 120 Baht per rai. If the soil degrades, the farmers are forced to increase the amount of fertilizers they use to maintain yields. The increase in fertilizer further degrades the soil and raises the costs for the farmer.

Integrated terrace farming, however, does not require the use of fertilizer. Khun Samruay explained that the traditional varieties of the local vegetables and other crops are naturally resistant to many pests. Farmer 7 in Ban Pang Yang stated that the transition to integrated terrace farming has allowed him to stop using fertilizer. Also, the connection of plants and animals in an integrated system eliminates the need to weed crops. Therefore, if an integrated system is designed and maintained properly, there is no need for any chemical inputs.

Runoff leads to the transition between hillside and terrace farming

On hillside farms, heavy rain increases the risk of runoff. This is a problem because the fertilizer is washed down the mountain leaving the crops unfertilized. Therefore, the farmers must re-fertilize their land which costs them more money, more time, and also exposes them to the chemicals longer. Every farmer who farmed corn on the hills expressed the runoff as a problem. The runoff also leads into larger water sources causing water pollution.

Runoff on is prevented, however, with the use of terrace farms. The farmers who had switched to terraces explained that the heavy rainfall was actually good for the quality of their crops. Farmer 8 explained that during periods of heavy rain, the fertilizer remains in the terraces. The terraces can hold more water and if there is runoff, it goes to the lower terraces rather than down the hill. The terraces farmers who still used fertilizer said that they did not need to re-fertilize their crops after the rainfall.

Monoculture does not have a completely balanced ecosystem, which requires chemical inputs

Due to the unbalanced ecosystem in monoculture, many farmers face environmental problems. The proper use of animal systems helps create the necessary ecosystem for an integrated farm. Livestock offer a wide variety of benefits in integrated systems that are not seen in monoculture. Khun Samruay showed a

particularly beneficial system of raising pigs called “Mhuu Lhum” which means “pig in the hole”. The fertilizer created by waste from this process can be used on crops and sold to other farmers. A hole is dug in the middle of the pigpen and filled with a mixture of corncobs, rice byproducts, sawdust, soil, and sea salt. As the pigs grow, they produce a lot of waste that adds nutrients to the mixture. The integration of pigs is not only applicable in an integrated farming system but was absent in the rotation and monoculture systems we observed. Khun Samruay explained that in the past with rotation farming, some farms had livestock but they were not integrated into different aspects of the farm. They were simply raised for personal consumption. Systems like Mhuu Lhum, however, can add more value to the animals making them a more attractive option to the farmers.

A particular system we observed in Ban Pang Yang was one of aquaculture. The flat land on terraces enables farmers to build storage ponds for water in the dry season to aid them in their agricultural practices. All farmers who use terrace farming in Ban Pang Yang have ponds and seven out of the eight we interviewed also farm fish in these ponds for personal consumption. The fish, like pigs, add value to the farming system.

Integrated terrace farming requires more water than rotation farming

The terrace farmers need to build ponds because the terrace farming methods require more water than the hillside farms. To be most effective, the terraces need a lot of water and the alternative crops that can be grown in an integrated terrace farm also require more water than corn to thrive. Therefore, a reliable water source must be available to transition away from growing corn. The water source was one of the main issues we observed with people who had not yet built terraces but wanted to switch from their current farming methods.

The system used to transport water in Ban Pang Yang and Huay Muang consisted of large PVC pipes from the water source and smaller pipes to distribute the water to the crops. The PVC pipes had replaced the previous method of using bamboo, which required replacement each year due to rotting. There are, however, more complex systems that can greatly benefit the farmers. We were introduced to another method of water management during the visit with Joko called a syphon water system. The system consists of a dam at the water source and then piping to the smaller ponds throughout the village or for 600 rai area. While the system would be beneficial, it could not be constructed without the outside help of Joko. This system also required a very specific location where a dam would not completely disrupt the ecosystem.

Location of some farmers has prevented them from transitioning

For some farmers, it is simply not possible for them to switch due to their location. Two farmers interviewed in Ban Pang Yang and another in Huay Muang, while close to the brook, are located above it. The farmers and the Royal Project or the Raks Thai Foundation often do not have the resources to install a water management system that can transport water uphill. So for this group of farmers, switching to terrace farming will not be possible as their location is unsuitable for it. The farmer in Huay Muang, however, did utilize a small pump to get additional water to his crops but it was not enough to sustain an integrated terrace system.

Another location-related issue that prevents the farmers from converting to terraces is the land steepness. When the land is too steep, terraces cannot be built because they cut out too much of the land. This would reduce the amount of land they can farm on, and for the farmers less land equates to less money. In addition, terraces built on very steep terrain require more maintenance and other materials such as stones or lumber to keep the terraces from eroding too quickly. While the Royal Project and Raks Thai Foundation do offer some support, the farmers know the location of their land makes terrace farming and integrated practices more difficult than in the lower farmland areas.

Overall, the farmers are concerned with the environmental effects of the repeated growing of corn on the hillsides and we found that they understood the soil degradation caused by the chemical fertilizer and had already seen the detrimental effects. Many of our environmental findings revolve around the use of chemical fertilizers, which further degrades the soil especially in repeated growing of corn with improper or no rotation. This degradation causes the farmer to use more fertilizer to keep yields as high as possible. The chemical fertilizer also washes down the hills in periods of heavy rain. The runoff and over usage of fertilizer is prevented in integrated terrace farming. The integrated farms require less fertilizer due to the creation of an ecosystem that naturally resists weeds and pests. The closed-loop ecosystem, however, requires additional water to maintain which is difficult for some farmers because of the location of their farms.

5.3 Social Variables of the Transition

The social aspects of the transition from rotation farming to integrated terrace farming are more difficult to observe in the farming communities. The difficulty made it harder to directly compare rotation farming between integrated terrace farming methods. However, there were several social aspects that have been barriers to farmers who seek to change agricultural methods. There are certain social requirements that need to be met to be a successful integrated farmer, but not a rotation farmer. These requirements are the main differences between the two methods. The social variables we interviewed farmers about and their summarized responses are included in Table 3.

Social Variables	**Rotation Farming**	**Integrated Terrace Farming**
Labor intensity	Weeding done by hand **Harder** to work on due to land steepness	No weeding necessary **Easier** to work on due to flat land
Need for education	**Does not require training course** (Method has been passed down for generations)	**Required training course**
Access to education	Farmers **taught by family members**	Farmers follow the **example of a respected individual**

Table 3: Social Variables

Labor intensity is lower on terraces than on hillsides

One variable that was comparable was the difference in labor intensity between the two farming methods. Once the integrated terrace farming system is put in place and maintained, not only do profits rise but the work intensity also goes down. The farmers in Ban Pang Yang explained that the amount of work required was lowered after the terraces were built. The transition to terraces does, however, require work. The terraces can take months to build and the irrigation system can take another month to set up. After the transition period, however, the terraces are relatively low maintenance. Every terrace farmer that we interviewed in Ban Pang Yang stated that the hillside corn crops needed to be weeded by hand while the terraces did not require weeding. This statement was confirmed at Joko where it was explained that the integrated systems do not need to be weeded because the ecosystem naturally resists invasive plants. Also, one farmer expressed that the flat land of the terraces was easier to work on for him because of an issue with his legs. The hillside farming can be very steep at times, which presents problems for some of the older farmers. Additionally, Farmer 7 explained that as the work difficulty goes down, they can save money by hiring fewer laborers.

Communities follow the example of respected individuals that successfully adopt the new practices
One thing we wanted to explore in Ban Pang Yang was the order that people transitioned to terrace and integrated terrace farming in and if there was a pattern or trend. Lung Pan, the first person to build terraces, told us that when he first started practicing terrace farming, the other community members did not welcome the idea (Appendix A). However, as time went by, the villagers started to notice some benefits of terrace farming and started to practice it. Of the farmers we interviewed, Farmers 4, 5, and 7 all transitioned after seeing the success of Lung Pan. Other farmers switched because they either heard from other respected villagers about the benefits of terrace farming or learned about it from the Royal Project and the Raks Thai Foundation. Lung Pan is the uncle of the village leader and therefore was in a position of respect. This respect helped him encourage other farmers to transition. Phra Somkit at Wat Pong Khum, also used his respected position to facilitate the change. As a monk, the community was much more receptive to what he was saying and believed that he was there to help. The communities sometimes feel that outside organizations are offering help for the organization's own benefit. However, if they have a community leader or respected individual such as a monk teach them the alternative methods, they are more likely to follow. Therefore, when trying to initiate change in a village, most of the focus should be on the respected individuals.

Education of every aspect of an integrated terrace farm is necessary and there are currently gaps in the education
The education on the proper integrated techniques was emphasized by Khun Samruay as the most important aspect of the transition to integrated farming. Joko has made the spread of useful knowledge about integrated farming the priority of their programs. They have set up Farmer Field Schools to spread information on sustainability, planting diverse crops, and using less chemical inputs. They work with farmers to adopt the integrated farming practices and the process of transition inevitably starts with the education. Khun Samruay underscored that integrated farming was not easy to start or maintain. For an integrated system to be efficient, there must be a detailed plan that is understood and followed. Therefore, the farmers require training on proper water management, how to best utilize their livestock, and possibly how to maintain a fish pond. Also, some villages require large infrastructure supports such as dams to get water to all of their farms. Therefore, the farmers need the necessary education to use and maintain these systems. They cannot rely on organizations like Joko, who assist them with planning and construction, to fix every small issue they may have. If the farmers do not have the relevant information on integrated farming, their crops are more likely to fail. They may lose money and be forced to return to their previous, less sustainable methods.

Another large part of the balance in an integrated farming system is the water management. Joko began to focus specifically on water five years ago because it is vitally important to the success of integrated systems. The education on water management must be thorough so that the crop yields are maintained while conserving the water source. While Joko has disseminated this education program on all aspects of integrated farming, they cannot reach all of the farmers.

The crop rotation methods or monoculture do not require in-depth education. The corn farmers that we interviewed had learned their techniques from relatives and parents who had practiced them for decades before that. Each terrace farmer in Ban Pang Yang was a first generation terrace farmer that had to learn the new methods after gaining an understanding of the corn farming throughout their life. The new education is a requirement for integrated terrace farming and can present a challenge for farmers who are comfortable with the farming methods they have used for decades.

Obtaining a thorough education or enough support can be difficult due to a lack of cohesion between education sources

The support systems and organizations currently in place to help the farmers are beneficial in many ways, but they do not collaborate which presents further challenges to the farmers. In the region, there are various support systems available such as the Department of Forestry and the Royal Project. Khun Samruay explained that the shortcoming of these programs is how widespread their accessibility is. The Royal Project only works in villages where there is a good water source to ensure the highest success rate possible. Also, the Department of Forestry and the Royal Project, at times, disagree on policy. Khun Samruay told of an example of a Royal Project representative being arrested by the Department of Forestry. This conflict prevents some villages from getting the best possible assistance because if the Department of Forestry is in a certain village, the Royal Project will often not go there. Therefore, there are gaps in the education of the farmers on certain aspects of sustainable farming.

If the farmers do not have a resource such as Joko's Farmer Field School, gaining all of the information on how to properly maintain an integrated farm can be very difficult. The lack of compilation of all the relevant information is a barrier for some farmers without the time or access to transportation for travel. If all the information and experts were available in one location, as it is in Joko, the farmers have an easier time getting their education on the integrated techniques. The lack of a centralized learning environment for the farmers leads to gaps in their understanding, For example, Farmer 4 grows avocados that he got from the Royal Project, but there are multiple types of avocado seeds that they supply. When he got his seeds, he did not know about the different species of avocado so he received seeds that produce less valuable fruits. This farmer made the necessary steps to start growing an alternative crop yet was held back by a lack of understanding about crop varieties and their respective yields.

On the other hand, education on corn farming is very easy to obtain for the farmers. When the farmers initially transitioned to corn rotation farming, the corn companies sent agents to the villages to train the farmers. Training on how to grow alternative crops should be just as available.

Education needs to help farmers become independent

While Joko has had a widespread impact in Nan, Khun Samruay also explained some of the difficulties that that the organization has seen. One of the main issues is experienced before any construction on a project starts. He explained that the negotiations with farmers where he tries to convince them to take part in the program often take extended periods of time. The particular syphon water system Khun Samruay was showing had only taken three weeks to construct. However, the negotiations to get enough farmers to agree to be a part of the project took half a year. While this half-year of meetings took valuable time away from the project, it was entirely necessary. In order for the projects to succeed, the complete cooperation of as many farmers as possible is needed. Khun Samruay wants the farmers to take an active role in the projects.

In order to take this active role, the education aspect of the project must also be well structured and thorough. Therefore, training and education takes an extended period of time to ensure the projects are well maintained and used to the full potential. Khun Samruay explained that if the farmers are properly educated about the projects, they feel ownership over the project, which encourages them to maintain whatever system Joko assists them with building. If Joko simply came to the village and constructed a dam for a syphon water system, the farmers may use the system but it would be seen as Joko's dam. Khun Samruay pointed out that a lack of a sense of ownership would also lead them not to feel responsible for the system.

6 Recommendations

From our findings and literature review, our team has determined several recommendations that would help the agricultural villages in Nan Province develop lasting integrated terrace farming methods. The three main categories of the comparison established in our Results section were economic, environmental and social variables. By evaluating each of these key variables, we extracted several essential findings, which were discussed in the results section. The findings are organized in the same order as in the results section with their respective recommendations.

6.1 Recommendations to Address Economic Barriers

The adoption of integrated terrace farming requires the purchase of proper water management systems, fertilizers, and seeds, while farmers face potential loss of income during terrace construction. Farmers also depend on middle merchants to sell their products, so the uncertainty in finding new markets discourages farmers from transitioning. In addition, farmers in Nan have heard of integrated terrace farming, but many are still unaware of the financial benefits that these practices can lead to. For farmers to be convinced to grow alternative crops they need proof of success, which can be gained from significant financial data or shown by example.

We recommend that the Raks Thai Foundation explore a variety of funding options to help farmers begin the transition to integrated terraces.

Based on our findings, most of the farmers practicing monoculture cannot afford the initial investment of building terraces. If there were a way for farmers to borrow money with little to no risk, farmers would be more inclined to invest in their farms. We recommend that the Raks Thai Foundation explore a system similar to the cooperative bank at Joko utilizing micro financing.

We recommend the advertisement of highland farming communities to promote their products.

Integrated farming in Ban Pang Yang village is an important technique that could improve the financial stability of the farmers living there. Based on our findings, upland farmers in Nan Province have very limited market access since they depend on the middle merchant to sell their crops. If a high supply of agricultural products from each household is released out at the same time, the farmers will face difficulties in distributing the products and finding other consumers who are willing to buy their crops. This is a risk for farmers who rely solely on the income from their agriculture, which keeps some from transitioning.

Becoming independent from middle merchants and agricultural companies would allow the Raks Thai Foundation and the Royal Project to move on and help other communities. Therefore, we recommend that the RTF help introduce the village to new markets. This can be done by advertising Ban Pang Yang and the products that come from the area. With more people aware of the community, it would open up to tourists, new markets, and therefore more consumers.

Our team recommends that RTF gather meaningful financial information and success stories from farming communities throughout Nan to show the economic benefits of terrace farming.

For farmers to be convinced to grow alternative crops they need proof, which can be shown using significant financial information or by example. One farmer in Ban Pang Yang told us that she ordered 300 strawberry seeds and saw economic success from them, so she ordered 3,000 more. Success stories like this are an example of what convince farmers to change. Our team recommends that the RTF gather meaningful financial data by conducting surveys in farming communities all throughout Nan Province. They should also collect and share success stories from upland farmers in Nan to show the economic benefits of terrace farming. The RTF can utilize the completed comparison of integrated terrace farming and crop rotation to convince the farmers of the benefits of switching as well.

6.2 Recommendations to Address Environmental Barriers

Some farmers we interviewed in Ban Pang Yang use both chemical and organic fertilizers. Other farmers recycle their corncobs and use them as fertilizers. Animals can also be used to help clean up agricultural waste and create natural fertilizer. Spreading these practices would benefit the farmers because it would give them a way to recycle their agricultural waste and earn extra income. Education about efficient ways to use and store water would also be helpful for the farmers so that they can continue to grow crops in the dry season.

We recommend the RTF provide education about recycling waste and integrating animals on the farms to promote integrated agriculture.

When we discovered that some farmers reuse agricultural waste, we decided to expand upon this and recommend that more people recycle as much as they can after their harvests. One farmer told us that he turns his leftover corncobs into fertilizer, and therefore spends less money on other chemical or organic fertilizers. This recycling method also works well with integrated farming methods. Farmers who integrate both crops and animals on their farms will easily be able to compost and reuse extraneous waste products because the waste from animals can also be used as fertilizer. This helps to support the transition to integrated terrace farming by showing that there are less expenses involved in maintaining the farm than with rotation farming.

During our trip to Joko, we learned about the importance of animal systems in integrated farms. Integrated farms benefit immensely from animal systems in completing the integrated farm cycle. Animals provide additional income, fertilizer, and food. We chose three animal systems to present to the Raks Thai Foundation that they can help introduce to the agricultural communities in Nan. The three systems that were chosen are pigs, chickens, and fish, because the villagers in Ban Pang Yang already have all of these animals.

In integrated farming, ponds are considered the main area to store water. However, from our findings, some farmers are not using those ponds to their highest potential. Aquaculture development is a way for villagers in Ban Pang Yang to increase their income and resource stability. Currently, people in Ban Pang Yang cultivate catfish in ponds around their farms for personal consumption. However, there are several other fish species that can be easily grown in the mountainous environment that can be beneficial to the farmers. Fish that are popular in Thailand and have high product yields are grass carp, silver barb, common carp, and seven-striped barb. Since Ban Pang Yang village is located on the mountain area, they can farm those types of fish for personal consumption and also for sale to earn a higher income.

Another animal system that we would like to recommend is the pig system. Raising pigs for food, sale, and making fertilizer helps the farmer decrease spending and earn more income. Pig farming requires an initial investment to start up, but it is possible to loan pigs from other farmers to start a pig system. This works by one farmer giving another farmer three piglets to be raised and used for breeding. Once the piglets grow up and begin breeding, the farmer would repay the loan with three piglets. Once a farmer has several pigs, the system can be sustained. Education is required for the farmers to learn how to care for the pigs and create the fertilizer that comes from this system, but is beneficial to the farmers over the long term. It is beneficial because pigs produce around 10 tons of waste/livestock annually, which can later be use as a fertilizer in the farm. Waste from Mhuu Lum, the pig system, is not only from pig's waste but also agricultural waste, such as corncobs, that is used to fill the pig pen. Using this system, the farmer doesn't have to spend a lot of money on fertilizer because the pigs produce it.

The third farming system we recommend is the chicken system. Using chickens for egg production is not widely practiced in most villages in Nan because the farmers believe there is a high expense associated

with buying animal feed. However, instead of buying the animal feed, farmers can easily find it in forests surrounding the village or use agricultural waste such as banana stalk or broken milled rice. Moreover, chicken can be farmed in an open farming system that doesn't require a large budget. The chicken system would provide a small extra income for the farmers. There is a high demand for eggs and meat produced on organic chicken farms. Even if the farms are not organic, the products from chickens can be sold or consumed. To summarize the recommendation to introduce animal systems to agricultural communities, the pros and cons of the three proposed systems are in Table 4.

Animal System	PROS	CONS
Fish	1. Low expenses: waste generated from agricultural activities and animals can be used to feed fish 2. Pond mud can be used as fertilizer as it contains animal feeds leftovers 3. For personal consumption and excess for sell	1. There must be certain number of fish in the pond for them to grow well 2. If the number of fish is not balanced with the amount of animal feed, waste will remain in the pond and will lead to water pollution 3. Possibility of chemicals entering the pond due to runoff of chemical fertilizers
Pig	1. Low expenses: pig feed comes from agricultural waste 2. Pig waste can be use as fertilizer for farmland or for sell which increases the farmer's income	1. It might take a longer time to raise pigs if agricultural waste is not enough to feed the pigs 2. The amount of microbial fermented water has to be accurate
Chicken	1. Organic chickens have longer egg production cycle 2. Chicken feed can easily be found in nature 3. Chicken waste can be used to feed fish also as a fertilizer 4. Chickens can be raised for both personal consumption and for sell to increase farmers' income 5. Hens can produce eggs daily which provides more income to the farmers	1. High number of chickens must be raised in order for the farmers to earn higher income

Table 4: Summary of Animal Systems

We recommend education about efficient ways to use and store water so farmers can continue to grow crops in the dry season.

Through our observations of Ban Pang Yang, background research, and interviews with the farmers, we found that integrated terrace farming requires a lot of water. Most farmers who were able to switch either built an irrigation system, which requires buying PVC piping, or were close to water sources. However, for other farmers, their farm location prevents them from switching. This is a challenge because access to water makes the transition to terraces easier and allows farmers to grow crops in the dry season. To minimize the need for large amounts of water, we recommend that the Raks Thai Foundation introduce the farmers to crops that require less water. The RTF should also educate them on strategies for storing and transporting water efficiently.

6.3 Recommendations to Address Social Barriers

From our results, we found that many farmers will follow the lead of individuals they respect in their community. In other words, if someone in the community tries a new farming method and shows success, more people are likely to switch to this method. For this reason, we suggest the Raks Thai Foundation first focuses their efforts on convincing people such as community leaders to adopt integrated terrace farming practices. We also became aware of the Raks Thai Foundation's desire to create a learning opportunity in Ban Pang Yang. While the initial plan of the RTF was to educate visitors from other communities, a learning center would also benefit the farmers in Ban Pang Yang by creating educational workshops about useful topics such as short cycle crops and animal systems.

We recommend the Raks Thai Foundation first focuses their efforts on convincing people such as community leaders to adopt integrated terrace farming practices.

As mentioned in the Results, a large group of the farmers learned about terrace farming from Lung Pan in Ban Pang Yang, and the leader of the community supported the change. The farmers that had the ability to switch to this method of farming trusted and respected his suggestion, which turned out to be successful. Based on our literature review, there are two justifications to this finding.

The first justification is from a Harvard Business Review article where the author discusses how people tend to follow the lead of others whom they respect or are figures of authority (Cialdini, 2001). In farming communities, the people who will have the most influence in convincing farmers to change are the leaders of these communities.

The other justification of the spread of integrated terrace farming methods is an example of diffusion of innovation (Rogers, 1983). This concept is extremely important for our recommendations because it is the process in which the majority of a village could eventually adopt the integrated terrace farming techniques. The process starts with the early innovators that take a risk and begin to use the new methods. The first people in a village who try the new farming methods are not certain what the results will be and therefore are taking a large risk by moving away from the reliable corn-based income. The next step in the diffusion of innovation includes a small group of early adopters and then the majority follows after. To get the early adopters, the innovators need to have seen a benefit from their initial innovation. If people see that there is not as high of a risk than they originally thought, they will have less doubt in the transition. Also, if they can see the clear benefits from switching to integrated terrace farming, they will be encouraged to switch to improve their own situation. Therefore, to best start the transition of a village to integrated terrace farming, the change must start with the village leaders and other respected individuals. In Ban Pang Yang, we talked with the first person that switched to integrated terrace farming, Lung Pan. Lung Pan is the uncle of Ban Pang Yang's leader and a well-respected member in the community. He learned the techniques from a friend in a different village and decided to take the risk and be an innovator. We learned from our interviews that many of the people who had transitioned to terrace farming learned the method from Lung Pan. Some had help from outside organizations but many were able to transition based off of Lung Pan's example. As more people saw the benefits of the terrace and integrated farming, the techniques spread further. In Ban Pang Yang, terrace farming has reached the highest amount of families who are able to switch. Integrated farming is still being spread throughout the village because diffusion of innovation is a gradual process.

If the leaders take the risk of switching their methods and training the farmers, the people following them will most likely change as well if the benefits are realized. Khun Samruay outlined the process that Joko uses to encourage change in the communities they work in. His recommendation was to use group learning. Since Joko has seen success with this method, we recommend the RTF to introduce the integrated terrace farming methods in a group setting to community leaders. Training from the inside of the community would also make the village feel like the project is their own. The goal is to have the

community members be the driving force behind the change instead of an outside entity. If an outside organization forces the change, there would be no sense of ownership from the farmers. When they work on it themselves with guidance, they truly learn the techniques, which gives them a higher chance of success. Also, if they succeed, after some time, they would be able to spread the information themselves.

We recommend RTF takes our recommendations and integrates them into their plan for the learning center in Ban Pang Yang.

The Raks Thai Foundation had a plan to make Ban Pang Yang a model of integrated terrace farming with a learning center for other farming communities before we went to the village. This learning center would be extremely beneficial to both outside communities and the farmers within Ban Pang Yang. It would help the farmers further improve their farming methods and their livelihoods because the Raks Thai Foundation would provide educational support to help the farmers become independent and financially stable. Some of the subjects that can be taught at the learning center include alternative crops that require little water, efficient water use and storage, how to create animal systems, and access to various product markets. There could also be education on how to recycle or reuse agricultural waste such as corn cobs and compost. The learning center could be used to help spread useful economic related information such as the micro financing system to help farmers with the initial investment to build terraces. The advantage of supplying the farmers with a broad education on these topics is that they can become independent in their farming practices. If they are able to sustain themselves without the help of external organizations, the organizations will then be able to help other communities.

6.4 Summary of Recommendations

Overall, the purpose of our recommendations is to make it easier for farmers to transition to integrated terrace farming and to convince them to change. We recommended increasing market exposure of the village, alternative crops, and animal integration in order to increase the income of farmers. To alleviate some of the pressure from the initial investment to change, we recommend aiding the farmers financially by introducing a cooperative bank or micro financing institution. In order to aid the Raks Thai Foundation in convincing people to change, we recommended proving the financial success of integrated farming and teaching community leaders to spread integrated farming methods. Adoption of these recommendations will benefit highland farmers in Nan and the Raks Thai Foundation.

7 Conclusion

The goal of this project was to understand the motivation for and barriers preventing change from rotation farming to integrated terrace farming, and to use the comparison between the two practices in Nan Province to facilitate future transitions to sustainable practices. Overall, our research and results showed us that there are many farmers willing to implement integrated terrace farming on their land. There are barriers that prevent some from completing this transition, but there are also support systems that can be used to aid the farmers at the beginning of their transition. Some of the barriers include lack of education and land rights for the farmers, insufficient marketing and market access, location and financial constraints. The organizations that exist to support the farmers through the barriers are the Raks Thai Foundation and the Royal Project, in addition to organizations such as Joko, that teach farmers about a sustainable way of life. The comparison between rotation farming and integrated terrace farming is intended for the end goal of convincing farming communities that integrated methods are more beneficial for the farmers and the surrounding environment over the long term.

During the course of our project we were faced with a few limitations. Our team was not able to interview as many farmers as planned. The Raks Thai Foundation was looking to obtain significant financial information that would support our conclusions, but due to the small sample size the numerical data obtained would not be representative of the population. However, our qualitative data allows us to recommend ways to facilitate the transition from monoculture and thus to empower the farmers. The steps

towards the farmers becoming more independent will take time and effort, but will be a long-term improvement as agriculture transitions from the “monoculture era” to the “integrated era”. These steps require education to promote lasting change, and the aid of the Raks Thai Foundation will empower the farmers to adopt the integrated methods and adapt them to individual situations.

References

Al-Kaisi Mahdi. (2000). Soil erosion: An agricultural production challenge | integrated crop management. Retrieved from http://www.ipm.iastate.edu/ipm/icm/2000/7-24-2000/erosion.html

Balisacan, A., Chakravorty, U., & Ravago, M. (2015). *Sustainable economic development: Resources, environment, and institutions* Academic Press.

Barker, D. (2007). *The rise and predictable fall of globalized industrial agriculture.* ().

Branca, G., Lipper, L., McCarthy, N., & Jolejole, M. (2013). Food security, climate change, and sustainable land management. A review. *Agronomy for Sustainable Development, 33*(4), 635-650. doi:10.1007/s13593-013-0133-1

Chainuvati, C., & Athipanan, W. (2000). *CROP DIVERSIFICATION IN THAILAND - chavalvut chainuvati* and withaya athipanan**.* ().

Cialdini, R. B. (2001). Harnessing the science of persuasion. *Harvard Business Review, 79*(9), 72-81.

Darlington, S. M. (1998). The ordination of a tree: The buddhist ecology movement in thailand. *Ethnology, 37*(1), 1-15. Retrieved from http://www.jstor.org/stable/3773845?seq=1#page_scan_tab_contents

di Mambro, A. (2015). Farming in mountainous areas: A fragile balance. Retrieved from http://www.euractiv.com/sections/can-new-cap-deliver-sustainability/farming-mountainous-areas-fragile-balance-317711

Dorren, L., & Rey, F. (2005). A review of the effect of terracing on erosion. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.484.7280

EISA. (2012). *Sustainable agriculture.* (). Berlin, Germany: EISA.

Higgs, R. L., Peterson, A. E., & Paulson, W. H. (1990). Crop rotations sustainable and profitable. *Journal of Soil and Water Conservation, 45*(1), 68-70.

Highland Research and Development Institutes.Thailand's royal project. Retrieved from http://www.hrdi.or.th/en/who_we_are/page/Thailand-Royal-Project

Hoe. (2009, Global agriculture towards 2050. *How to Feed the World 2050,* Retrieved from http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf

Horrigan, L., Lawrence, R. S., & Walker, P. (2002). How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental Health Perspective,* (110), 445-456. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240832/pdf/ehp0110-000445.pdf

Jeffrey Hays. (2008). DEFORESTATION AND ILLEGAL LOGGING IN THAILAND | facts and details. Retrieved from http://factsanddetails.com/southeast-asia/Thailand/sub5_8h/entry-3327.html

Keawsrinual, S. (2012). *The baan pang yang community.* (). The Center for People and Forests, Thailand: The Center for People and Forests, Thailand. Retrieved from http://www.recoftc.org/sites/default/files/uploaded_files/reports/11 Pangyang_N.pdf

Khumpian, P. (2015). *Study of cost and return for cultivation of animal corn tambon sila, amphoe lom-kao phetchabun province.* (). Retrieved from http://research.pcru.ac.th/rdb/pro_data/files/5701025.pdf

Kitchaicharoen, J., Suebpongsang, P., Sangchyoswat, C., & Promburom, P. (2015). *Situational analysis in support of the development of integrated agricultural systems in the upland areas of nan province, thailand.* (). Retrieved from http://humidtropics.cgiar.org/wp-content/uploads/downloads/2015/10/Situational-Analysis-Nan-Thailand-EV.pdf?d542d0

Krishna Bahadur. (2008). Mapping soil erosion susceptibility using remote sensing and GIS: A case of the upper nam wa watershed, nan province, thailand. *Environmental Geology, 57*(3), 695-705. Retrieved from http://link.springer.com/10.1007/s00254-008-1348-3http://www.springerlink.com/index/pdf/10.1007/s00254-008-1348-3

Leturque, H., & Wiggins, S. (2011). *Thailand's progress in agriculture* Overseas Development Institute.

Luu, L. T. (1992). The V.A.C. system in northern vietnam. Retrieved from http://collections.infocollections.org/ukedu/en/d/Jii23we/5.3.html

Ongprasert, P. (2006). *Forest management in thailand.* (). Retrieved from http://www.forest.go.th/foreign/images/stories/FOREST MANAGEMENT IN THAILAND.pdf

PAN Germany.Crop rotation. Retrieved from http://www.oisat.org/control_methods/cultural__practices/crop_rotation.html

Persson, M., Henders, S., & Kastner, T. (2014). Trading forests: Quantifying the contribution of global commodity markets to emissions from tropical deforestation. *Center for Global Development: Climate and Forest Paper*

Series, (8), 1-60. Retrieved from http://www.cgdev.org/sites/default/files/CGD-Climate-Forest-Series-8-persson-et-al-trading-forests_0.pdf
Phathomchai, V., & Keawkhammoon, C.*General information on royal project in ban pang yang, pua district, nan province.* (). Retrieved from http://eherb.hrdi.or.th/pdf/phukha.pdf
Raks Thai Foundation. (2008). *Raks thai foundation annual report.* (). 2008: Raks Thai Foundation.
Rerkasem, K.Shifting cultivation in thailand: Land use changes in the context of national development. 54-63.
Robson, I. (2013,). Crop rotation definition and benefits. Retrieved from http://myfarmeducation.ca/farming/crop-rotation-definition-and-benefits/
Rogers, E. M. (1983). *Diffusion of innovations.* (). New York: The Free Press.
Rueankeaw, S. (2008,). Hill tribes of thailand, the lua tribe. Retrieved from https://sopa2006.wordpress.com/%e0%b8%82%e0%b9%89%e0%b8%ad%e0%b8%a1%e0%b8%b9%e0%b8%a5%e0%b8%8a%e0%b8%b2%e0%b8%a7%e0%b9%80%e0%b8%82%e0%b8%b2%e0%b9%80%e0%b8%9c%e0%b9%88%e0%b8%b2%e0%b8%95%e0%b9%88%e0%b8%b2%e0%b8%87%e0%b9%86/%e0%b8%8a%e0%b8%99%e0%b9%80%e0%b8%9c%e0%b9%88%e0%b8%b2%e0%b8%a5%e0%b8%b1%e0%b8%a7%e0%b8%b0/%e0%b8%8a%e0%b8%99%e0%b9%80%e0%b8%9c%e0%b9%88%e0%b8%b2%e0%b9%83%e0%b8%99%e0%b8%9b%e0%b8%a3%e0%b8%b0%e0%b9%80%e0%b8%97%e0%b8%a8%e0%b9%84%e0%b8%97%e0%b8%a2-%e0%b8%8a%e0%b8%99%e0%b9%80%e0%b8%9c%e0%b9%88/
Scott, H. (2009). What is grounded theory? Retrieved from http://www.groundedtheoryonline.com/what-is-grounded-theory
Suebsang, N.How to adopt terrace farming techniques.*6* Retrieved from http://r07.ldd.go.th/Web/15_KM/Km5.pdf
Thailand Sustainable Development Foundation. (2009). Nan province royal development project. Retrieved from http://www.tsdf.or.th/en/royally-initiated-projects/10162-nan-province-royal-development-project/
Vogel, H. (1987). Terrace farming in yemen. *Journal of Soil and Water Conservation*, *42*(1), 18-21. Retrieved from http://www.jswconline.org/content/42/1/18.extract
Wongwichit, D., Siriwong, W., & Robson, M. (2012). Herbicide exposure to maize farmers in northern thailand: Knowledge, attitude, and practices. *Journal of Medicine and Medical Sciences, 3(1)*, 038. Retrieved from http://www.interesjournals.org/full-articles/herbicide-exposure-to-maize-farmers-in-northern-thailand-knowledge-attitude-and-practices.pdf?view=inline
Zhang, W., Ricketts, T. H., Kremen, C., Carney, K., & Swinton, S. M. (2007). Ecosystem services and dis-services to agriculture. *Ecological Economics*, *64*(2), 253-260. Retrieved from http://www.sciencedirect.com/science/article/pii/S0921800907001462

Appendix A: Raks Thai Foundation Phone Interview Questions

The following questions were asked during the phone interview with the representative from the Raks Thai Foundation.

Logistical Questions:

- When would the first trip be? and how ?
- Where would we live during the visiting period?
- How would we get to the village?

Project-Related Questions:

- Confirmed the objective of the project and determined deliverables.
- The basic geographical information of the village.
- What kind of farming did the villagers practice in the specific area?
- Why did the Raks Thai Foundation need our help?
- What kind of support could the RTF provide us?

The following answers were obtained from our first interview with the Raks Thai Foundation. The representative we spoke with is Khun Ravee.

1. The objectives of the project were find the differences and compare integrated farming with corn farming in terms of cost, income, labor, and long term effects. The Raks Thai Foundation wanted us to provide numbers and statistics to help convince the farmers in Ban Pang Yang to change. They said we could compare multiple kinds of crops that could be grown in the village and whether or not they would be able to increase yield and income for the farmers.
2. Ban Pang Yang village, is populated by the Lua hill tribe. There are currently 57 families, and so far 5 of them have converted to integrated terrace farming. The rest of the village is resistant to the change. There is also another Lua village nearby that has zero families using terrace farming.
3. What kind of farming that the villagers practice in the specific area? The villagers in the Pua district have been practicing crop rotation for about 5-6 years. This is not the most effective way to use the land because only one section of the land can be used at a time. Some villagers started moving down to the flat land, and they brought terrace farming back to the village with them. This created the ability for the farmers to grow various flat land crops such as rice, strawberries, and avocados, which help increase their income. This method decreases corn farming as well. The Raks Thai Foundation thinks that if we can convince more farmers that terrace farming is beneficial to them, and then more people would be willing to change.
4. The Raks Thai Foundation would like to use the results of the project to support the villagers and help them improve their agricultural practices.
5. The Raks Thai Foundation was in Nan from January 11th to January 17th, and from January 25th to January 31st. Their visits in February have not yet been planned. We then flew into to Nan, and took a van supplied by the Raks Thai Foundation as close to the village as possible. Ban Pang Yang is removed from the paved roads by a dirt road that we must travel on by ATVs. This trip is in total, about 2 hours away from Nan city. The first time we traveled into the village, we planned to go with the Raks Thai Foundation. Our second option was asking our contact to help provide us with transportation.
6. Representatives from the Raks Thai Foundation arranged accommodations for us within the village of Ban Pang Yang so that we didn't need to make the two-hour trip each day. We stayed in the village for a few days to obtain our data, and returned to Nan city to analyze it. We then went back to the village for more research and observations.
7. The problem that the Raks Thai Foundation is facing is changing the local communities' traditional farming methods. Their industrial methods have been passed down for generations, so

they do not want to lose this culture. They are also not willing to change because it will require labor and money to create terraces for farming, in addition to limited access to resources such as trucks or machines to help build the terraces.

Appendix B: Outline of Desired Observations in Ban Pang Yang

1. Geographical observations:
    - Hill steepness that can have terraces
    - Hill height
    - Community forest system
    - Location of water sources
    - Soil appearance of both farming methods
2. Observe both forms of agriculture
    - Gain information on how prevalent each practice is in the village
    - Observe the variety of crops used by each type of farmer
3. Information gained through informal conversation with farmers
    - Machines used
    - Farmers' opinions on the industrial farming such as overall satisfaction
    - Farmers' opinions on transitioning to integrated terrace farming
    - Barriers that the farmers who had transitioned experienced
    1. Determine possible sample size for the subsequent interviews

Appendix C: Variables for Comparison

Variables split into three main categories

- Economic
    - income per year/value of crops
    - amount of debt
    - stability of income and yields
    - expenses
    - access to additional water
    - storage method for water during the dry season
- Environmental
    - amount of water used
    - fertilizer (amount, price)
    - runoff effects
    - soil quality
    - land use (how large are the fields, are they rotation or terraces?)
- Social
    - labor difficulty (maintenance of fields, amount of workers)
    - use of machines
    - stress level (concerns of the farmer)
    - source of education (traditional methods

Appendix D: Questions for Industrial Farmers

<u>Agricultural Methods</u>

- What is your opinion about your current farming method?
    - What do you like?
    - What do you dislike?
- What is your opinion about terrace farming?

        - Have you ever heard of it? (If not, explain what it is in an unbiased way)
        - What do you think of it?
    - How many rai is your farm?

Work Intensity

- How long do you work per day on your crops?
- How long have you been working with corn?
- What machines do you use on your farm, if any?
- What are the struggles of industrial agriculture?

Economic

- Where do you get your seeds and fertilizer?
- How much seed did you get from the Royal Project or a corporation this season? (if from there)
- What was your yield this past year?
- How much do you pay for the fertilizer?
- Who buys your crops?
- Do you have an irrigation system? How did you build and pay for it?
- Do you have a water storage system?

Environmental

- Are you aware of soil erosion?
- What fertilizer do you use and how much?
- How much water do your crops require?
- What do you believe the chemical fertilizer's effect on the environment and the soil is?
- Are you concerned about landslides happening on your farm?
- Have you noticed a change in the quality of your soil over time?

Transition

- Have you considered switching to terrace farming?
- Have you ever received aid from NGOs or the government for the transition to integrated terrace farming? Was it beneficial?
- Would you switch growing corn for a different crop? Why or why not?
- Would demonstrations of integrated terrace farming interest you? Why or why not?

Appendix E: Questions for Joko and Terrace Farmers

Questions for Joko

Transition

- How difficult is the switch from industrial farming to integrated farming?
- Generally, how hard is it to convince farmers to switch their practices?
- What barriers do farmers face when they are looking to transition from farming only corn?
- What factors are most important to the farmers that convince them to switch?
- What strategies best work in persuading farmers to transition?

Work

- Is working on integrated farms more or less difficult than maintaining industrial farms?
- How long do you work per day on your crops?
- What machines do you use on your farm, if any?

Agricultural Methods

- What is your opinion of rotation agriculture practices?
    - How does the repeated growing of corn affect the soil?
    - How does rotation cropping affect the environment? Deforestation? Runoff?
- What is your opinion of integrated terrace farming?
    - How does it address the problems of rotation/industrial agriculture
- What are the struggles of integrated agriculture? Struggles of integrated terrace farming?

Economic

- Do integrated farmers typical make more or less than industrial farmers?
- How much money is typically needed to transition to integrated farming?
- How much money is typically needed to maintain an integrated farm?
- Do you receive any aid from NGOs or the government?

Questions for Terrace Farmers

Agricultural Methods

- What is your opinion of industrial agriculture?
- What is your opinion of terrace farming?
- What crops do you grow?
- How long have you been farming on terraces?
- What fertilizers do you use? How much?
- How much water do you use per year?
- How many rai is your farm?

Transition

- What convinced you to switch to terrace farming?
- How difficult was the process of switching?
- Would you recommend other farmers to switch from corn to integrated terrace farming?
- Did you have assistance in your transition?

Work

- How difficult is it to work on the terraces?
- How is your farming process/work different from industrial farms?
- What machines do you use on your farms, if any?
- What difficulties have you faced as a terrace farmer?

Economic

- How much seed did you get from the Royal Project or a corporation this season?
- What was your yield this past year?
- Do you have an irrigation system? How did you build and pay for it?
- Do you have a water storage system?
- What products do you sell from the crops?
- How much do you pay for fertilizers?
- Who buys your products?

Appendix F: Ban Pang Yang Interviews, Jan 26 and Jan 28

Appendix F includes the translated interviews from Ban Pang Yang on January 26th and January 28, 2016.

Present: Khun Samut, Lung Pun

- Reasons why farmer decided to switch from crop rotation to monoculture :
    - family size:
        - more money are needed to feed the family and corn farming has been introduced to the farmer as a crop that can gives them more income
        - land must be split to each children which makes it more difficult for the farmer to rotate around
- Transition process
    - Rotation farming -> Corn farming + Rotation farming -> Corn farming (monoculture)-> Terrace farming + monoculture

    - Even though the farmer decided to switch to terrace farming or integrated terrace farming, corns are still their main income so it is impossible to switch completely in a short period of time.
    - Corn production yield decreases each year because corns was grown continuously at the same area which increases soil erosion.
- Rice grown are mainly for their own consumption so they didn't considered about selling rice at the market
- There are two types of rice which are farmed rice and upland rice.
    - steep land: upland rice only
    - terraces: both upland and farmed rice can be grown
- The Expansion Royal Project brought avocado, strawberry, and grape seeds into the village as alternative crops that are now very popular and can give them high income. So now there are 3 families growing grapes, 12 trees in total, as their experimental product and it gives them around 25,000 baht income.
    - If the production yield from these fruits is high, they will plants more of these fruits and decreases the amount of corn.
- Terrace: (32 families out of 50 are now doing terrace farming)
    - Steepness should be no more than 45 degree
    - Crops such as rice grown on terraces are mainly for consumption not for sell
    - Fruits on terrace are both for food and for sell

Variables	Monoculture (30 years)	Terrace farming
Soil quality	<	>
Fertiliser	>	<
Pesticide	>	<
Expenses	>	<
Amount of seeds per field	10 kg	
Profit	lower each year	-

- Cost of fertilizers:
    - 1,200- 1,500 baht per bag
- Cost of corn seeds:
    - 600 baht per 5kg bag
- Income from corns:
    - P Samut: 70,000- 80,000 baht (Profit: 30,000 baht) for 30kg of seeds
    - Lung Pun: 10000 baht profit

Present: Leader of Ban Pang Yang village

- Uncle Pun is the first person that started terrace farming because the terrace farming gave him a better result.
- Water system : use PVC pipes
- There are ponds with fish in terrace farming
- If the landscape is too steep (more than 45 degree), cannot create the terraces. It can grow only corn.
- Each step of terrace height 2 meters.

- Should grow grass to cover the soil surface or tree that has deep root to hold the soil in order to prevent the soil collapse.
- Avocado took 3 years to get the product
- Assume that there are 3 fields, one of three is used to grow alternative crop and then sell to merchant without convert that product. The rest is used to grow corn. Because the alternative crop took long time to get the products.
- Rotation farming: adjust the balance of soil.
- Integrated : Fruit tree and backyard garden
- Terrace: require fertilizer
- 10 kg of corn require 100 kg of fertilizer (use a lot of fertilizer)
- 1 rai require 500-600 of fertilizer/pesticide
- Corn 1 rai gave 3,000baht
- Upland rice requires 10-20 bags of fertilizer per 1 rai and also herbicide.
- Farmed rice requires a lot of water.
- Fruit tree needs herbicide
- 38-39 out of 57 families changes to terrace farming (287 people in this village)
- Some of the villagers cannot start doing the terrace because their land is too steep. So, they would end up with growing corn for sell and upland rice for themselves on steep land. And also fruit tree but not much.
- They started did the terrace farming 20 years ago
- Total areas is 2000 rai
- They grow melon (from RP), strawberry, avocado, and grape. They can grow on steep land.
- Product per rai: They sell the fruit to RP and get 100,000 but fruit require longer time to grow and this price is not stable. While, they sell corn to middle merchant and get 1,000baht. The farmer can get the money 100% (3,000baht) from middle merchant. And growing corn requires shorter time to grow.
- In winter and raining season: It's better because the fruit is stimulated for flower and get better product.

Present: Lung Pun, Khun Tun (Leader's Assistant)
Topic: History of Ban Pang Yang

- Ban Pang Yang is 140 years old
- Two to three families from Ban Sakat, Ban Phalai, Ban Porp, Ban Toey migrated to this area and form a new village called Ban Pang Yang. They chose this area because it was surrounded by water source and other resources.
- At that time they grow rice and hunt for their own consumption without going to the market.
- There was no school so when the children is around 7 to 8 years old, they start going out to the farmland to help their parent.
- As time passes by, their relative from the 4 villages start to move in which increased the amount of families in this village.
- When middle merchant came in, lahung trees were introduced as their first industrial farming product. The farmer sell lahung's seeds to middle merchant to extract the oil.
- In 1985-86, the middle merchant brought varieties of corn into the village and the farmer starts to grow this cash crop.
    - After the farmer harvested the corns, middle merchant brings in the machine to process the corn and transport it down to the company. Therefore, the farmer don't have to transport the corn down by themselve and they don't know which company the middle merchant are sending those corn to.
- In 1996, the villagers have more access to education, Ban Pang Yang School were built in this area.

Topic: Culture and Religious belief:

- Some families still believe in “Phi Ban Phi Ruen” or known as local spirits.
- Gin Hap Ceremony (July)
    - Once a year
    - After every family harvested their crops, they will bring some of their products such as rice and potatoes together with flowers and candle for the local spirits to say thank you because they believe that the local spirit protects them and their crops.
    - After the ceremony, they will chose the sharmen by letting one person from each family to come and pick up three piles of rice. If all of the piles have even number of rice, that person will be selected as the next two shamans (known as “Khao Jum”). They belief that Khao Jum is chosen by the local spirit
- Shaman:
    - There are 2 Khao Jum (Shamans)
    - The shamen will be the leader for each ceremony in the village.
    - Shamen will choose the day that the farmer should grow and harvest the rice
    - If they go to the doctor but the doctor cannot help them, they will come to the shaman
    - they sharman helps them with the production yield
- They will have a holiday every 10 days, they believe that on this day it is not appropriate to go out to the farm. This belief was passed from their ancestors.

Present: Khun Sin – Royal Project Staff, Khun Tanawat – department of local area administration, Khun Phat – assistant of the leader of the village

Variables	Crop rotation	Terrace farming
Labors	>	<
Seed	>	<
Fertilizers	>	<
Land	>	<
Pesticides	>	<
Yields	>	>
Profits	<	<
Costs	>	<
Rice (amount of rice requires per field)	1 bag= 15kg	½ bag=7.5kg
Burning agricultural waste	✓	✓
Water required	<	>
Farmed rice	X	✓
Upland rice	✓	✓

Appendix G: Ban Pang Yang Interviews, Jan 29 and Jan 30

Appendix G includes the interviews from Ban Pang Yang on January 29th and January 30th, 2016. Farmer 1 through Farmer 3 are strictly corn farmers with no terraces. The rest of the farmers have both terraces and hillside corn farms.

Farmer 1	Hillside	Terrace
WATER MANAGEMENT	corn-rice rotation farming	Zero Terraces
amt water	Very little water	
proximity to water	less than 100m from brook, but located above it so it's hard to transport the water up.	
irrigation	Not enough PVC from royal project	
storage	1 soil pond with fish, used to eat not sell	
ECONOMY		
money/year	7 baht per kilo, but changes with middle merchant. They rely on the income from one corn harvest per year	
debt		
stability	yield and price not stable. only 2 people work the farm, and it takes 1 month to harvest everything. If it rains before they get to some of the crop, it cannot be used.	
expenses	LOTS of fertilizer	
SOCIAL		
labor, weeding	weed all 50 rai by hand	
machines	machine used for seeding the corn	
stress		
traditions	cannot change due to the location	
autonomy		
ENVIRONMENT		
fertilizer	must re-fertilize every time it rains: 5 bags of fertilizer per field	
runoff	if they the corns are still small there is a possibility for the corns to be washed down	
soil quality	-	
land use	5-field rotation. 10 rai per field (50 rai total).steep land, located above the brook. Use all 5, but switch corn and rice each year, burning them in between	
Additional Notes: *raks thai and Royal Project provide education and recommendations for farming but their land is not suitable *it is good to fertillize the corn after it rains		

Farmer 2	Hillside
WATER MANAGEMENT	ONLY corn
amt water	Rain water **ONLY**
proximity to water	located uphill above the river source which means that it is difficult for them to transport the water up
irrigation	-
storage	-
ECONOMY	
money/year	1kg of corn = 6baht
debt	borrow from relative: 1% of interest per month vs. 5% (from somehwere else): buying fertillizers because the soil quality is getting worse as they continuously grow corn in the same area, for their nepthew education, not enough money for the whole family if the production yields is low.
stability	not stable : depending on the yield they get each year
expenses	1 bag= 1500-1600baht (the more fertilizer, the better the yield)
seeds	use 20 kg corn seeds/ rai
SOCIAL	
labor, weeding	2 people (Khun Lorm and her husband)
machines	from middle merchant
stress	
traditions	cannot change
autonomy	she wants to change to terrace farming but its landscape, location is not suitable to make a terraces. Also she didn't have enough money to do that.
ENVIRONMENT	
fertilizer	Corn 10KG = 1-2 Bags of fertillizer
runoff	wash down all fertillizer
soil quality	the soil is getting worst each year
land use	Corn only

Additional Notes:
if someone in the family passed away, they are not allow to work for 10 days
*Corn farming **ONLY**
reason of not changing :
land steepness
not enough money to buy any additional PVC or hired any labor
above river source
not enough land
Doesn't gorw avocado due to the difficulty of transportation
it takes time to build terraces

Farmer 3	Hillside
WATER MANAGEMENT	Only Corn
water/year	only rain use
proximity to water	too far from water source
irrigation	no piping
storage	
ECONOMY	
money/year	enough to support herself, remain indepedent
debt	
stability	prices change depending on middleman
expenses	middleman
SOCIAL	
labor, weeding	weeds her crops
machines	all by hand
stress	
traditions	mother's generation started rotation
autonomy	grows corn for middleman, he buys
ENVIRONMENT	
fertilizer	was using chem + org but transitioned to only org
runoff	
soil quality	chemicals destroyed the surface
land use	
Additional Notes: Why hasnt she switched? Not enough water/don't have the piping to reach their farm, also areas are too steep Would she want help to transition? She does not want the help of outside organizations because she wants to remain independent	

Farmer 4	Hillside	Terrace (6-7 years)
WATER MANAGEMENT	Rotation farming - corn	
amt water	corn only, so not much water necessary	water an issue. requires more water because of rice farming on terrace
proximity to water	further from water	1km from brook, too far from water tank
irrigation	PVC pipe - some given by royal project, bought the rest	
storage	Brook. too far from tank. Also 1 soil pond, 1 cement pond, both with fish. Fish for personal consumption	
ECONOMY		
money/year	7 baht per kilo, but changes depending on middle merchant price	rice for food only
debt		
stability	not stable price or yield	
expenses	less fertilizer so less cost	
SOCIAL		
labor, weeding	more weeding. by hand.	tills with machine
machines	Corn machine from middle merchant	
stress		
traditions	switched because of Raks Thai and Uncle Pan	
autonomy		
ENVIRONMENT		
fertilizer	Less fertilizer on terraces because yield is good. Also uses corn cobs as fertilizer, so spends less $$ on fertilizer	
runoff	must re-fertilize after rain because it washes down	
soil quality		Better with terraces, but it takes time
land use	Uses hillside for corn farming to sell (has two separate plots of land, corn is uphill)	Uses for personal crops (terraces are lower on the mountain). The bigger the terrace the better

Additional Notes:

*Raks Thai Foundation helped build the terraces, he built some by himself and they built some

*on terraces, he grows corn, rice, avocado, and durian, but does not sell these crops. He will sell the avocado if he has extra but usually does not. Planning to start strawberries and seedless grapes next year.

*He had to wait 1-3 years before he could use the terraces

*started growing avocado 3-5 years ago, but does not have enough seeds. Everyone wants avocado seeds so there are not enough for everyone.

*There are multiple types of avocado but he did not know this when he got his seeds, so he got normal ones instead of the more valuable avocado seeds.

*heard from lung Pun (1st person who starts terrace farming in this village) and Raks Thai Foundation

Farmer 5	Hillside	Terrace (Start 2548)
WATER MANAGEMENT		
amt water	less on hillsides	more
proximity to water		close to water source
irrigation	uses rain	PVC (From Royal Project and bought the rest)
storage	n/a	There are 3-4 ponds with fish.
ECONOMY		
money/year	Main income from corn	grow rice for themselve only (no selling)
debt	yes	Yes from education
stability		
expenses	higher expenses due to fertilizer	less due to more efficient use of fertilizer (1 bag = 50kg)
SOCIAL		
Labor, Weeding	her and her husband weed	no weeding, except on the perimeter
machines	none	none
stress		
traditions	corn farming passed down many generations	1. 1st generation of terrace farming 2. learned from uncle Pun 3. she didn't want to take risks of burning off neighbor farms
buyer	middle merchant, comes to town	merchant who comes to town
ENVIRONMENT		
fertilizer	upland rice requires more fertilizer	farmed rice does not need much fertilizer
runoff	heavy rain washes the fertilizer down so she has to refertilize	fertilizer stays on the terraces
soil quality	similar due to rotation	similar because she grows vegetables on off seasons to regen soil quality
land use		5 rai for corn, rice, fruit

Additional Notes:
*1st women that do terraces in Ban Pang Yang
- Know about terrace from Lung Pun
- Take 1 year to got the result
Why did she change? She did not like burning the fields and putting other people's farms at risk if the fire got out of control
6-7 month for **Upland Rice** - Require less water (Use much more Fertilizer)
3-4 month for **Farmed Rice** - Require more water (Use not much fertilizer)
Upland Rice and Farmed Rice grow once a year
Avocado, Gwava, Lime, mango, Grape and Strawsberry
Duck and Chicken
First switch : some prople disagree
Is she happy with the switch? Yes, very happy with results

Farmer 6	Hillside	Terrace	Greenhouse
WATER MANAGEMENT	Corn	Upland rice	Grape
amt water	Only Rain water	More for rice	Require much more water only for small grape
proximity to water	Quite far from the brook		
irrigation	PVC (from Royal project only the main line of water and bought for personal) for side line pipes, they cost 60 Baht (small) and 100-300 baht (big)		
storage	There is one pond near the greenhouse with fish for personal consumption		
ECONOMY			
money/year			1 box of grape (half kg) = 100฿
debt			less
stability	depending on the middle merchant and weather		
expenses	Fertilizer	Personal PVC pipe	
SOCIAL			
labor, weeding	Hire 10 people (150฿ per head)	No weed	No need to hire
machines	from middle merchant	Buy themself (15,000฿)	No need to use
stress			
traditions	-	-	Need more income
Buyer	Middle merchant	Not for sell	
ENVIRONMENT			
fertilizer	Require more fertilizer	Use less fertilizer (given by Royal Project)	Use fertiizer and 'GA' (plant hormone) to stimulate the growth.
runoff	wash down all fertilizer	Fertilizer remain in the next step	
soil quality	Getting worst in each year		-
land use	Only corn	Rice	Grape
Pestcides	use pesticides twice/yr. buy them for 120Baht/liter, 1L/rai		

Additional Notes:

Adv.	Requires less water Makes good income (the main income) Requires less thinking about finding alternative Have support from Royal Project	Requires less care Costs less Can grow alternative crops Use less water
Dis.	Requires more care High cost risk of natural disaster such as landslide	Hard to make at 1st Issues w/ invasive insects (rice) Requires more water

*1st person that grown grape in the Greenhouse
- The organization provide for only the main line of water pipe.
- The price of PVC pipe depending on their size

Farmer 7	Hillside	Terrace
WATER MANAGEMENT		
water/year	More for rice on hillsides	less for the rice once the terraces were built due to water storage. The fruits require a lot more water because if they are not watered properly, there is no product
proximity to water		50m from brook
irrigation		some pvc provided by the RP, bought the rest
storage		1 soil pond with fish
ECONOMY		
money/year	corn still main profit	little profit, only sells what he doesnt eat
debt		
stability	not stable, price changes depending on middleman	
expenses	more	less
buyer	middle merchant	most for self but sells small excess
SOCIAL		
labor, weeding	weeding by hand	easier to walk on, no weeding
machines		only on bigger terraces
stress		
traditions	corn farming passed down generation after generation	first generation of terrace farming, 3 yrs now, heard from uncle Pun and Khun Daen
autonomy		
ENVIRONMENT		
fertilizer	15 bags of fertilizer still could not produce the yields he needed (20 bags of fertillizers per year)	self fertilizers the land from tilling, 1/4 bags of fer
runoff	when there wes heavy rain, the nutrients and fertilizer would be washed down and he would have to re fertilize	no runoff
soil quality	repeated planting destroyed the soil	
land use		each step varies from 4x8m to 4x12m

Additional Notes:
*Advantages include: easy to walk, more income, more production yield, less fertilizer so less expense, nutrients will remain in soil without being washed down
*corn is their main income while terraces were use to grown products for food
*integrated, rotation and terraces farming
*Why did he change? The soil quality was noticably decreasing and he wanted to save the longevity of his land
*What problems did he face in the change? Bamboo as piping was a hassle because it needed to be replaced every year due to rotting and it also wasnt straight. PVC solved this issue
*What does he farm? Rice, cabbages, backyard garden, rambuton, avocado in integrated farm
*Where did he learn terrace farming? Lung Pan, Lung Dang, Lung Uang
*Is he happy with the switch? He prefers the terrace farming, but some of his land is too steep for terraces. He started to transition to grapes from the RP on these steeper lands.
*Other product: cabbage, garlic (backyard garden)
*decided to switch from bamboo to PVC because it is more convenient, they don't have to go into the forest to cut them. Moreover, PVC is more durable compare to bamboo that have to change every year.
*most of the product are for food first before they sell it

Farmer 8	Hillside	Terrace
WATER MANAGEMENT		
water/year	less	more
proximity to water		1km from brook
irrigation	rain	RP gave all PVC - took them one month to make a irrigation system
storage	none	1 cement, 1 soil, no fish
ECONOMY		
money/year	main income, 6-7Baht/kg	terraces for food
debt		
stability	unstable, depends on middle merchant	unstable as well, depends on the year for rice
expenses	buy seeds, fertilizer	fertilizer
SOCIAL		
labor, weeding	weeding by hand	no weeding
machines		mechines to make terraces but harvest by hand
stress	stress about whole farm	
traditions	corn farming passed down for generations	only for 3 years
autonomy		
ENVIRONMENT		
fertilizer	chem + org, 2 bags of fert to 1 bag of corn	chem + org, same amount
runoff	some landslides,	fertilizer stays in the terraces
soil quality	reduces over time, especially without rotation. They do rotate the type of corn that they grow depending on the soil quality of that year	maintains nutrients
land use	corn around terraces	2 rai of terraces

Additional Notes:

Farms both rice and corn, rice on terraces. Not enough land currently to rotate crops.

Why can't they grow other crops? 3 year period on avocados big factor because they need all the land each year, also they do not have enough space on the terraces to grow other RP fruits

Are you happy with the switch? It is better and she is happy with the results

What made her change? She saw other farmers doing the terraces and followed their example

RTF showed how to grow crops, RP gave grape seeds + education

Not enough space to expand the terrace area

Farmer 9	Hillside	Terrace (3 years)
WATER MANAGEMENT	Corn	Rice and ~6 avocado trees
amt water		
proximity to water		200m from brook
irrigation	Only rainwater	paid for all PVC by themselves
storage	Brook, and 2 soil ponds with fish for food, not selling	
ECONOMY		
money/year	7 baht per kilo from middle merchant, some people have cars to transport themselves and get 8 baht per kilo	
debt		
stability	Crop and price not stable	Doesn't grow other crops around the rice on terraces becasue the rice yield would be lower
expenses	If people have their own cars, they can transport crops themselves	
SOCIAL		
labor, weeding	by hand, 4 people	no weeding, took 1 year to make terraces
machines	middle merchant machine	tilling machine
stress		
traditions	switched to terraces because of conserved forest. they were not able to rotate anymore so terraces were easier. Also they saw what Lung Pan did	
autonomy		
ENVIRONMENT		
fertilizer	2 bags per rai on rotation	1 bag per rai. less fertilizer used for rice on terraces
runoff		
soil quality	worse every year with corn so he has to use more fertilizer	
land use	sometimes rice. corn on rotation.	grows corn around terraces. sometimes rice. 2-5 rai of terraces at a time. 3 separate plots of terraces total (rotates)

Additional Notes:
*didn't get enough help from royal project
*sometimes burns cobs, sometimes the merchant buys them
*about 2-3 years to get to success on terraces
*if terraces are too close to the brook, the water is too cold and decreases production. a little further down and sun warms the water a little
What has RTF and RP done to help? Could they do more? *RP gave some breeds of fish, but not enough so they had to buy more. *some recommendations from RTF but did not actually help with anything. *RP recommends avocado, use a little.
Are you happy with your transition? Were there any unexpected benefits or downfalls? *more income. *more production yield compared to upland rice.

Farmer 10	Hillside	Terrace (integrated, 4 years)
WATER MANAGEMENT	corn	rice, avocado, grapes
amt water	use plenty of water but sometimes too steep for terraces	leave fruit without water, rice needs a lot from pipes
proximity to water		2km from brook
irrigation	rainwater	PVC, but not enough pipes
storage	3 soil ponds with fish for eating	
ECONOMY		
money/year	6-7 baht per kilo	only for food
debt		
stability	stable yield, not price	grows strawberries - 300 seeds and success last year - ordered 3000 more.
expenses	fertilizer. 800 - 900 baht for a 15 kilo bag	
SOCIAL		
labor, weeding	hand. 10 family members.	no weeding
machines	middle merchant	
stress		
traditions	used to have upland rice and corn. upland rice takes 6 months to grow.	
autonomy		
ENVIRONMENT		
fertilizer	2 bags per rai	less fertilizer, and royal project pays for fertilizer used on terraces
runoff	must add fertilizer after rain	fertilizer stays
soil quality	gets worse and worse	improved when they changed
land use	15 rai	3 rai

Additional Notes:
*before royal project, they had to buy their own PVC
*cobs: sells cobs in 50lb bag for 4 baht per bag
What has RTF and RP done to help? Could they do more? *RP recommended the terraces, so that's why she tried them. *RP checks soil quality to see if it is suitable for terraces. *RTF provides recommendations and durian, but the durian does not work. *RP: avocado, strawbs, grapes, fertilizer, limes, and bamboo, but must be grown on terraces/flat land.
Are you happy with your transition? Were there any unexpected benefits or downfalls? *good results from strawberries. *there are more tourists, so more opportunity to sell fruit. *last year they began growing avocado, grapes, and strawberries. *didn't expect there to be insects on the rice. upland rice didn't have the insects but farmed rice does. farmed rice takes less time to grow (2-3 months) and they harvest once a year.

Appendix H: Huay Muang Interviews, Jan 30

Appendix H contains the interview charts with the corn farmers from Huay Muang on January 30th, 2016.

Farmer 11	crop rotation	hill side	Opinion about terrace farming
WATER MANAGEMENT	upland rice	Corn (10 years ago) , rice	more crop variety and yield
amt water			needs plenty of water
proximity to water	far from water resources	he has a water pump that brings the water up	he is higher up than most and away from the brook so water management would be too difficult
irrigation	Wait for rain	Small dam	using PVC pipes
storage	Brook	Small dam	
ECONOMY			
money/year	grow for personal consumption	30,000 baht; 6,000 baht from his rice and the rest from maize and rubber crops	
debt			
stability			
expenses			less
SOCIAL			
labor, weeding	volunteers from the other villagers	About 60 volunteers from the other villagers which, finished all harvaest for 7 rye in 3-4 hours	About 5 families which has 2-3 people for each families
machines	Only hand	600 baht rent	
stress			
traditions			
autonomy	Personal consumption		
ENVIRONMENT			
fertilizer	no fettilizers needed till he started to grow corns	He would apply crushed limestone to the soil every three years, which helped protect the soil	less
runoff			fertilizer stays
soil quality	don't need to use fertillizers to grow crops due to good soil quality	decreased due to the use of herbisides in corn farms	
land use	Only rice upland	Of the 30 rye he has, 7 rye is used to grow corn, which he says is very easy to manage especially in his age	
chemical use	Don't use due to good soil quality	herbisides cost 480-520 baht per 5 liters. 1 Liter of herbicide is put into 700L of water. he adds herbicides to the water and sprays his entire field down	
Additional Notes: Som is a 70 year old farmer who has been doing farm since he was about 21-22 years old. He was the one that started deforestation to build his farming. he has been using lime to protect soil sucfaces from the soil erosion. he actually wants to make the terraces but lacks of knowledge and supports from any organization			

4 Huay Muang Villagers	Hillside	opinions about terrace farming
WATER MANAGEMENT		The Dept. of Forestry gave recommendations to use terrace farming. They provided an educational program about terrace farming for farmers who were interested; 5 farmers went to the program which was only for 1 day
amt water	use less water for corns but plenty water for farmland rice	The reason they want to change to terrace is because it requires less work and less fertilizers and they can grow a variety of crops
proximity to water	They get their water from the brooks around the village	They have small dam close to their farmland
irrigation	Some people cannot afford the PVC pipes, so they just wait for the rain water	PVC piping
storage	Small dam and brook	
		One went to Ban Pang Yang and liked the idea of terrace farming because even though they have steep land, they still make better income
ECONOMY		
money/year	Main income is mostly from corn, they grow it for selling. The average income is 50,000 baht/year including expenses	Get more
debt	The borrow money from the village bank one/ye every year because the money they earn is not enough for the family so cannot save any of it, but they pay them back after they earn the farming profit	
stability	corns can grow only in rain season	Variety of crop in every season
expenses	fuel of the machines(husking), 0.5 baht/kg	
SOCIAL		
labor, weeding	30 volunteers in one farm However, if they don't have time, they will hire laborers	less labor (2-3 people)
machines	husk corns; harvest by hand	
traditions	They help each other to do the farm	
autonomy	The merchant decides the price of the crops but they have to sell it to him to earn income whether the price is high or low	
ENVIRONMENT		
fertilizer	For each 10 kg of corn, they use 50 kg of fertilizers	Less fertilizer
runoff	the fertilizers need to be added before the rain season. Otherwise, the water from the rain will flow all fertilizers away	Fertilizer still remain in the soil, even in the rain season
soil quality	Herbicides make the soil quality worse	
land use	One of them is growing lychee fruit, rubber tree, and lambutan Only 5 families grow tobacco They also grow longan They used to only grow upland rice for personal consumption They 1st started to grow corn 20 years ago, the other farmer started to grow corn 3 years ago.	
chemical	use a lot of herbisides to kill roots of grass before growing corns. For rice they only use 200 liters of pesticides. They use pesticides for corn twice/year (200 liters/rai) = 400 liter total They use pesticides for corn twice/year (200 liters/rai) = 400 liter total For rice they only use 200 liters of pesticides	

Additional Notes:

One the farmers grow lychee fruit, rubber tree and lambutan
Only 5 families grow tobacco
They also grow longan
They used to only grow upland rice for personal consumption
They 1st started to grow corn 20 years ago, the other farmer started to grow corn 3 years ago.
Before corn, they used to be hired as laborers for other villagers. Now, the only do this during the dry season
Before, they used to go and collect fruit, mushroom, or hunt and sell them
There is a project the Dept. of Forestry that just started but none of the farmers have decided to participate yet. They will make 1 rai of farmland for the farmers, but in return they want 3 rai of corn farm from them. The farmers however think it is worth it to participate in the project because they can grow variety of crops in the farmland
They want to build a terrace farming but, don't have any organization to support them.
Due to their do not have enough money.
Herbicides make the soil quality worse
They use a lot of herbicides in the field before they grow corn to kill the roots of the grass and also to save time and energy of labor
They only receive support from the Dept. of Forestry
When they first started growing corn, they didn't use any machines. However, the merchant gave them machines later
The reason they started to grow corn was because they heard from other villages that it makes good income

Issues of upland rice farming	Distance – far away from the villagers' houses Unstable yield→ depends on rainwater. If there not enough rain then the rice will die. During the dry season, they use the water from the brook. Sometimes, there is not enough water in the brook neither.

Appendix I: Information from Joko and Wat Pong Khum

Appendix I contains the information supplied by Khun Samruay and other staff at Joko Community Learning Center, and interview with the monk, Somkit, at Wat Pong Khum on February 3rd, 2016.

Khun Samruay:	Chief executive of the Sub-district Administrative organization
Joko:	meaning small hill
	Jobs: 1. Reforest 2. Select seeds 3. Educate people on farming, product, maketing Problems: way to spread news
History - present	
- Starts 25 years ago - Starts from seed because at that time there were a lot of monoculture activities - Starts from farmer field school - 10 years ago: start water management - 7 years ago: safety food network - now: sell seeds to farmers inside and outside the province	
Work	
- work with 14 provinces - now: sell seeds to farmers inside and outside the province - persuade farmer to save money within the group - collect diversity of material from traditional technique to present - starts farmer field school : to make the farmer involve and learn more - invented syfron (water tube) - require less electricity. - no pump needed - covers 400 rai	
Challenges of farmer	
- Debt - Knowledge + technology transfer - Market + income - Land right	
Why farmer wants to change	
- health problems caused by inhaling too much chemicals - Debt - in the cycle of debt - loan money, seeds, fertillizers - Ecological balance: not balance anymore	
Foundation in Nan Province	
1. Royal Project	
2. Expansion Royal Project	
3. Pid Thong Lung Phra	
4. Princess Sirinthorn	
5. Raks Thai Foundation - @ Doi Phua, Manipluek, Ban Sawang, Ban Pang Yang	
- Co- management with: Government, Communities and Other sectors	
6. National Park	
7. Reservative forest	

Topic: Timeline of Farming techniques: from the chief executive of the Sub-district Administrative Organization (SAO), Khun Samruay.

- Traditional Rotational farming
    - 40 years ago

    - farming for food, rice with a garden of vegetables
    - rotate crops to regenerate soil nutrients
    - every part of farm is separate - crops, animals not integrated
    - farmers controlled the seeds
- Monoculture
    - farming for profit
    - only corn for animal feed, not food for farmers
    - current 'era'
    - created a corn-based economy in Nan
    - puts the watershed area at risk because of chemical inputs
    - mindset evolved, money was the main force
    - big company controls the seeds- CP, Monsanto, Cigna
    - seeds are designed to have a single purpose/resistant but they lose the many other genes that traditional varieties gained over thousands of years
- Integrated/Alternative
    - The next 'era'
    - farming for sustenance + some for sale
    - protects the environment with biodiversity
    - uses traditional seed varieties for natural pest management
    - rotation is unnecessary if there is enough water

Present: Monk Somkit (Wat Pong Khum)

- He use integrated terrace farming demonstration farm to convince farmers to switching
- Started integrated farming since 2006
- He thinks that the main problems are
    - environment:
        - The government introduced cash crop to the local communities. As a result, the amount of natural resources decreases each year.
        - More deforestation
    - social:
        - debt
        - villagers move out to find new job
    - health:
        - cancer
        - asthma
        - high blood pressure
        - respiratory system
- The government tries to solve the problems but they didn't tackle the right area, they are solving the problem without looking at the cause of the problem.
- It is very important to solve the problem from its starting point that are mainly caused by deforestation.
- Deforestation decreases the amount of water and rainfall. As a result, the production yield decreases.
- Growing cash crop is not bad, but it is very important to create a balance in it
- He came up with the project called "Suam Muak Hai Phukao, Suam Rorng Tao Hai Teen Doi" which means wear a hat to the mountain and put a shoe on the foothill.
- He made comparisons between monoculture and integrated terrace farming on its expenses, income, amount of fertiliser to show the overall profit per day to show the farmers.

Topic: Suam Muak Hai Phukao, Suam Rorng Tao Hai Teen Doi

- Followed 50-30-20 ratio:
    - 50% of the mountain should be reforest and leave it untouched. (hat)
        - In order to do this he showed the farmer how important the forest is by allowing the trees to grow naturally back to normal in the area that used to be corn farming.
    - 30% of the mountain: grow plants and trees for consumption and excess for sell
    - 20% (shoe) : change steep landscape into terraces for rice farming, growing plants and fruits for personal consumption and excess for sell
        - Got PVC pipes from the government
        - Advantages terraces:
            - prevent runoff
            - prevent small brooks from soil deposit
            - get frequent income from growing short live crops that require less water
            - decrease health problems such as cancer, high blood pressure, bond problem and respiratory system because monoculture require lots of chemicals
    - Disadvantages of terraces:
        - In order to make terraces, soil will be dig out leaving the area with new soil which gives them lower production yield
        - it takes time for the new soil to gain nutrient, therefore fertilizer are needed to add more nutrients into soil (6 months)
- This project able to:
    - solve rice problem
    - use the area more wisely
    - minimize agricultural area
    - start integrated terrace farming
- Problem:
    - argument between farmer who agree and disagree about the changes
    - getting a small profit at a time from terraces might be too slow for some farmer because in corn farming, farmer be able to get more income at a time.

Appendix J: Deliverables for Raks Thai Foundation

Appendix J contains the deliverables for the Raks Thai Foundation.

1. Recycling agricultural waste

From our findings, we learned that most farmers burn off the excess waste from their harvests, such as corn cobs. Recycling the agricultural waste, like turning the corn cobs into fertilizer, can help in turning the waste into something more useful and decreases the farmer's expenses on fertiliser. This recycling method is the most efficient way for integrated farmers to use extraneous waste products from crops and animals. Moreover, it reduces the amount of chemical fertilizer use and utilizes integrated techniques.

1.1 Corncob fertilizer

Components
1 ton of corn cobs
1 pack of super LDD 1 microbial activator
20L of water

Instructions

1. Dissolve super LDD 1 microbial activator into 20L of water
2. Pour water onto the corn cobs
3. Cover corn cobs with rubber sheet
4. Turn over the corn cobs every 15-20 days for 3 months
5. Cobs can now be used as an organic fertilizer

2. Integrate animals onto the farms

Integrated farming is an agricultural technique that entails utilizing at least two agricultural activities in the same area. For example, combining various crops in the same area to complement each other, or allowing animals to roam the fields to help naturally degrade the agricultural waste. This technique uses the advantages of each activity to support the others, allowing the farmer to farm in a more sustainable way. It mainly focuses on the availability of resources in the area and how farmers can use the resources more effectively. It allows farmers to improve their income stability and their quality of life. The chart below lists the advantages and disadvantages of integrated farming. The points are in no particular order.

Advantages	Disadvantages
Reduces invasive species of pests and animals.	Requires suitable land
Increases efficiency of land use	Takes 1-3 years to see results
Supplies enough food for personal consumption throughout the year.	Requires planning and resource management within the farm
Provides the farmer with autonomy	Requires proper marketing system in accordance with local and regional level.
Suitable for small farmers and larger production	High initial investment

Animal systems play a crucial role in balancing the ecosystem within the farm. For example, animal waste can be used as an organic fertilizer to decrease chemical use and increase production yield. Agricultural waste can be used to nourish animals inside the farm, so the animals do not cost the farmer additional money for care. We recommend the following animal systems that can be used as options for the farmers to choose from.

2.1 Chicken farming

Chickens used for egg production are not widely considered in the village because farmers think they have to go down to the city to buy animal feed. In fact, animal feed can easily be found in the forest near the village. Examples of such products that can be turned into animal feed are banana stalks or broken milled rice. Moreover, chickens can be raised in an open farming system.

Chicken farms are a popular market because there is a high demand for eggs and meat. In general, one hen can produce one to two eggs per day. If the chickens are raised in colder conditions, they will be able to produce bigger eggs, and if they are organic they can be sold for 8-9 ฿ per egg or more, while regular

eggs can be sold for only 3฿ . In one year, one hen can produce approximately 250 eggs after it reaches maturity at 22 months old. An organic farm hen is able to produce eggs for two years, and a normal farming hen can produce eggs for one year. In addition, chickens can be sold for consumption within 8 months of age or at a weight of 2 kg.

2.1.1 Income

- Eggs
  - For 300 hens, around 250 eggs are produced per day
  - 1 egg for 4 ฿ = 1000 ฿/day = 30,000 ฿/ month (for wholesale)
  - 1 egg for 8 ฿ = 2000฿/day = 60,000 ฿/ month (for direct sale)
- Meat
  - Live Chicken: 38-40 ฿/kg

2.1.2 How to start a chicken farm?

1. The farmer can either buy chicks and wait until they grow or buy hens that are 18-20 months old. Different breeds of chicken are recommended for different purposes:

- Best chicken breed for egg production (hen):
  - Red Rhode Island
  - Plymouth Rock
- Best chicken breed for meat production (broiler):
  - Cornish Rock
  - Jersey Giant

2. Food: Natural feed that can be produced from natural material found in the forest can be used to feed the chickens because it is fresh and contains more nutrients than processed animal feed that may contain chemicals.

Ingredients:

- 30 kg of banana stalk
- 10 kg of rice
- 10 kg of rice bran
- 1.5 kg of broken milled rice
- 1kg of brown sugar
- 200 g of salt
- cow waste 4 kg (optional)
- 2 kg of soil

Chicken should be fed constantly (120 g of food per chicken)

2.1.3 Farming technique

Free range farming, a chicken farming technique that reduces stress of the hen and leads to a longer egg production as well as better meat quality.

The farm consists of two areas:

1. Chicken coops- for the chicken to sleep, eat and produce eggs
   (Chicken coops can be built by using bamboo found in the village)
2. Field areas- for the hen to roam and find their own food such as grass and insects

(3 hens should have 1 square meter of space)

2.1.4 How to improve meat/egg production of the chicken by using organic supplementary food

Some farmers face problems such as small eggs or limited meat production. Fresh agricultural products and agricultural waste can be used to feed chickens to improve the quality of animal products without leaving any chemicals behind. Raising the chickens organically increases the price of the product, which increases the farmer's income. The following are ingredients that can be added to chicken feed to enhance the quality.

1. Grass: consists of protein, vitamin A, calcium and fiber which helps with their excretory system, growth and improves the eggs quality.
2. Sataeba and gourd: makes the egg bigger and helps in meat production
3. Banana stalk and papaya: improve the egg yolk colour (dark orange egg yolk) and meat production

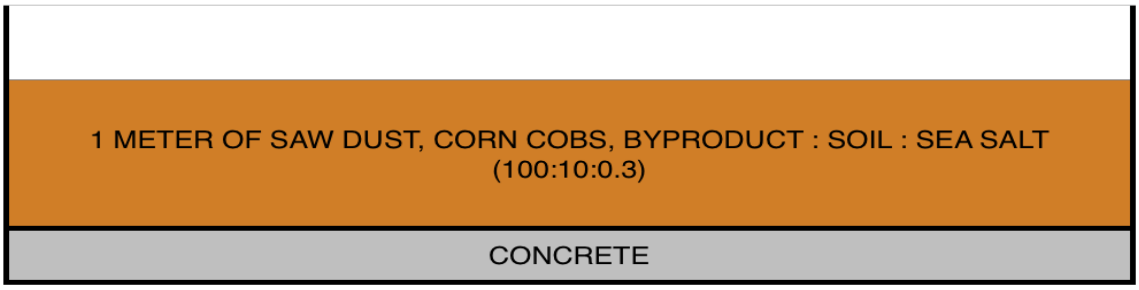
2.1.5 Expenses

- 33฿ per chick
- 60-70 ฿ per chicken that are 18-20 months old
- Chicken coop (depending on the material used)
    - 60 sqr m for 15,000 ฿
- Equipment for 4,500฿
- Chicken food: 5 ฿ per kg

2.2. Pig system

Nowadays, farmers are raising pigs for personal consumption without considering how they can make it more productive in order to earn more income. Also, farmers who sell pigs are facing financial problems caused by increasing cost of maintaining the pig farm. Mhuu Lum, the pig farming system used at Joko, emphasizes the use of organic and local materials in integrated farms. A system that utilizes pigs to their full potential can be very profitable and useful for integrated farmers. The pig pen is layered with corn cobs, rice byproduct, and sawdust, and then the pigs' waste adds nutrients to the mix to create rich fertilizers (Figure 1). This mutualism is inexpensive for integrated farming to reduce the amount of agricultural waste which decreases the farmers' expenses for fertilizers and animal feeds. Integrated farming with pigs allows farmers to farm in a more efficient way and helps to balance the farm ecosystem. The system is good for the environment and avoids chemicals in the process, which makes the pigs and crops safe for the farmer and consumers to eat. Therefore, in an integrated farm, the pig system not only helps in reducing fertilizer usage and increasing crop yields but also has potential to make the farmer money.

Figure 1: Layering of pig pen



2.2.1 Income

- The piglets can be sold for 1500 Baht
- Fertilizer can be sold

2.2.2 How to start Mhuu Lum

1. Raising the pig:
- breeder pig for 6500 ฿ (to produce piglets)
- piglet can be sell for 1500฿

2. Build a pen and dig the center layering it with organic material to capture pig's waste
3. It takes about four months to cure to form an organic fertiliser (up to 6 tonnes of fertiliser per year)

* Each pig birth can have a maximum of ten piglets and one breeder pig can have a maximum of seven birth cycles.

2.2.3 Farming technique

How to build the pen?

1. Each side of pen should be far away for pillar for 30 cm and dig down, around 70-90 cm.
2. Separate all of the border into half then, dig it in deep around 30 cm into "L" shape.
3. Use brick to lay all of the "L" shape or use concrete to lay in all of the border to avoid pig to use their mouth dig into the border and break it.
4. Poured concrete along every side of the wall.
5. Keep the soil that was dug out to mix with other organic material then put it back into the hole.
6. Dig a hole with 70cm depth
7. Add layers of organic material:(for 3x3 size with 70cm depth)
    - 1st layer: 400 kg of sawdust, husk or by product that can decompose into the hole for 35cm height or half of the hole.
    - 2nd layer: 40 kg laterite or digged soil
    - 3rd layer: 40kg of charcoal(The size of charcoal should be as small as possible)
    - 4th layer: 4 kg of sea salt
    - 5th layer: fill up the hole with sawdust, husk or by product that can decompose
8. Mix natural microbial fermented water with white fungus (2 tablespoons per 10 liters of water mixed)
9. Leave it for 4 days
10. Use this mixture to feed and clean the pig
11. Manage the environment and pen into airy and well ventilated

How to manage the farm?

The piglet that bring to feed should have the average weight around 15-20 kg

1. During the first month, use diet pills.
2. When it grows to a teen pig (weight 30-40 kg), feed it with the fermented food which contains silage, rice bran and broken-milled rice.
3. For pig drinking, use the fermented water from herb and fruit in the ratio of 2 spoons tables per 10 litres water.
4. Use the fermented water to pour around the pig's pen to decrease the bad smell.
5. If the dust collapsing or dose does not cover all of the hole surface, always fill it to fit the hole.

2.2.3 The recipe for Mhuu Lhum's food

Raw material

1. Green plants or fruit 100 kg
2. Brown sugar 4 kg
3. Salt 1 kg

Instructions

1. Mince the fruit or green vegetable wastes from household or agricultural crops, such as banana stalk, green vegetables or vegetable scraps.
2. Sprinkle brown sugar and sea salts into the mixtures.
3. Put down the mixtures into one-third of a composting tank. Then, cover the tank with paper with dot holes to let some air in and out.
4. Ferment the mixtures for seven days, or five days if the weather is hot.

Advantages of Mhuu Lum

- Decrease the expense up to 70%
- Decrease the burden to clean up the pen floor
- Less pollution from bad smell and no fly
- Can feed in community (such as near house)
- Can use natural material which is easy to find and cheap
- Avoid chemical use
- Can use compost as organic fertilizer
- Can sell pig for money
- Part of sustainable farming
- Pigs can eat more and grow faster
- Pigs will be more healthy

Three Factors to success

- Good breed
- Good food that fit to each age of pig
- Good farm management method

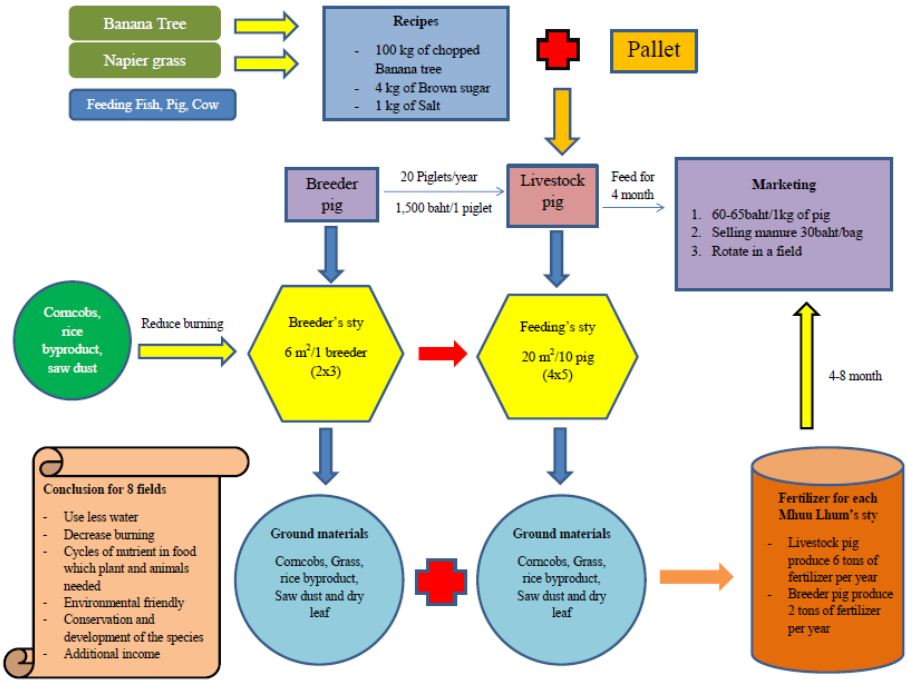


Figure 2: a flowchart representation of a successful pig system on an integrated farm.

Expense

- 6500 ฿ per breeder pig

- 1500 ฿ per piglet

*This price is expensive because a full grown pig weighs around 100 kilograms but the money saved on fertilizer or from selling fertilizer offsets this cost.

2.3 Aquaculture

The aquaculture development is a recommendation for villagers in Ban Pang Yang in order to increase and stabilize their income. Currently, farmers have many ponds around their farms to store water from the brooks and cultivate catfish for personal consumption. However, if other fish species, that can be easily grown and are more reproductive are introduced, the villagers can gain more income by exporting them to the market, instead of cultivating only for personal consumption. Moreover, cultivating varieties of fish in integrated farm allows farmer to reuse agricultural waste and get rid of unfavoured living organism that may destroy the farmers' crops. Examples of fish that can be found in Thailand and have a high yield are Black or red tilapia, Silver Barbs, and Naked catfish.

2.3.1 Income:

- The price of the fish depends mainly on the species:
    - Black/red tilapia: 85฿/kg
    - Silver Barbs: 74฿/kg
    - Naked catfish: 200฿/kg

2.3.2 How to start fish farming

- **Choose fish species can easily be found in thailand that is profitable:**
    - Black tilapia/Red Tilapia
    - Silver Barbs
    - Naked catfish

(Habitat: ponds, lakes, rivers, tanks with fresh water)

- **Food:**
    - Natural feed: aquatic weeds, by-products from grain processing, snails, mussels, crayfish and death plant parts, spawn in weedy area, pellets, aquatic weeds
    - Agricultural waste: Chicken waste
    - Household waste

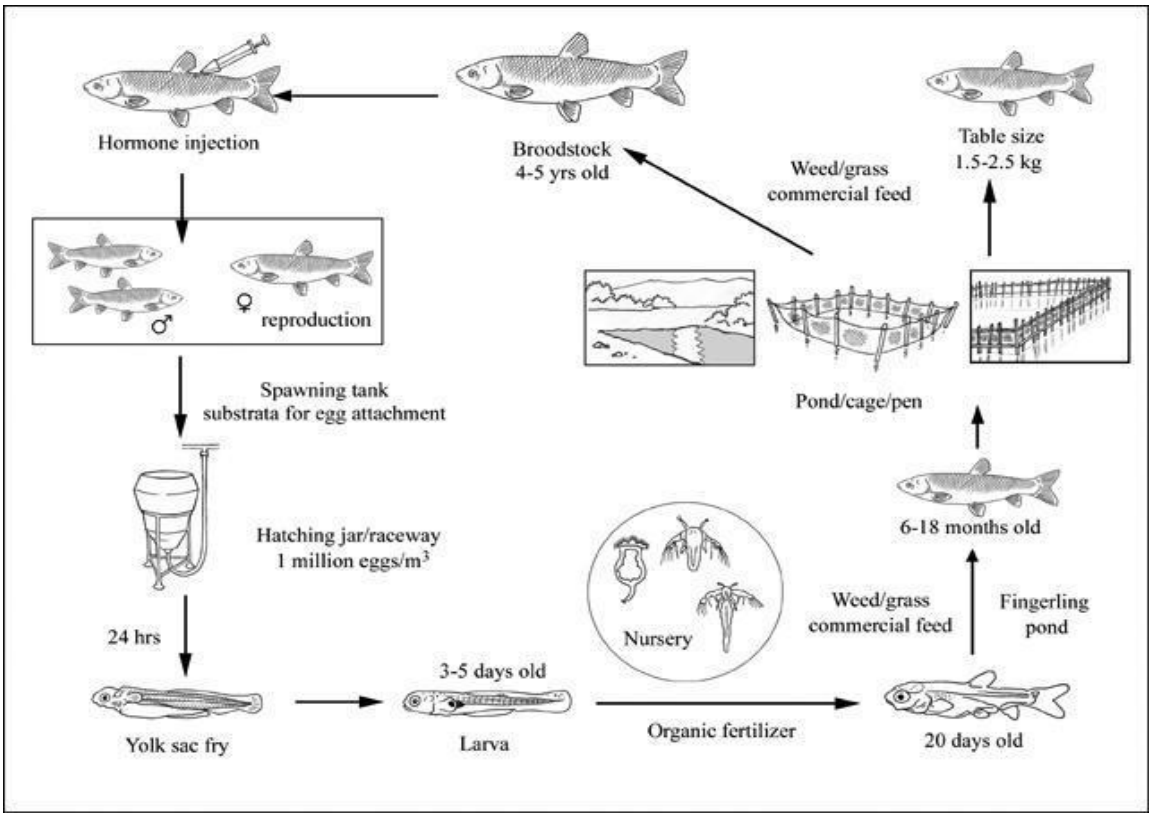


Figure 3: The process for farming grass fish

2.3.3 Expenses

2-3 cm: 0.10฿
3-5 cm: 0.20 ฿
5-7 cm: 0.30 ฿

3. Alternative crops

Alternative crops allow farmer to earn more income throughout the year since those crops can be grown during off season instead of leaving the land fallow. These crops require less water and have short life cycle which helps the farmer earn more income during off seasons. These crops can be grown on integrated farms to balance the soil nutrients. Since each crop requires different nutrients, it results in constant change in nutrients in the soil, making it difficult for weeds to grow. Also, integrated farming consists of different kinds of crops growing at the same time so these alternative crops can be used as a suggestion for farmer to grow in the future. Moreover, waste produced from these crops can then be used to feed animals such as chickens, pigs, and fish on the farm. The following list contains some examples of alternative crops to corn.

Dragon fruits

- Harvesting period: 45 days
- Water requirement: water flow system
- Growing season:
    - white and red dragon fruits: April-October (summer only)
- Production yield: 50 kg/tree
- Price: 20-25฿/kg

Beans

- Types: snap bean,
- Harvesting period: 2 weeks
- Water requirement: rain water
- Growing season: December- January
- Grown period
    - snap bean: 50-55 days bush, 50-67 days pole
    - scarlet runner beans: 60 days green, 90 days dry
    - lima beans: 75 days bush, 85 days pole.
    - yard-long beans: 80 days.
    - tepary beans: 80 to 90 days.
- Price:19฿/kg

Pumpkins

- Types: vine, bush
- Harvesting period:
    - bush→ 25-60 days
    - vine→ 120-180 days
- Growing season: February- March, September- October, November- February
- Soil quality requirement: can be grown on any soil quality
- Water requirement: furrow system
- Production yield per rai: 15-20 tonnes/rai
- Price: 20฿/kg

Sunflowers

- Types: hybrid species
- Harvesting period: 90-100 days
- Production yield: 254.82 kg/rai
- Soil quality requirement: can be grown on any soil condition
- Water requirement: rain water
- Price: 400฿/kg

Sweet corns

- Harvesting period:70-75 days
- growing season: Grown throughout the year
- water requirement: require more water in the 7 first days
- soil requirement: suitable in any soil condition but better in sandy loam
- production yield per rai: 3,200-3,500 kg/rai
- price: 5฿/ear

Organic vegetables

- Harvesting period: 45 days
- Growing Season: May- Oct
- Water requirement: flow system
- Soil requirement: good soil quality

- Production yield per rai: water every morning
- Price: 150฿/kg

Appendix K: Additional Information from Methodology Chapter

Additional information on interviews

We interviewed four kinds of farmers: those who practiced both terrace and rotation farming methods without integrated farming methods, integrated terrace farmers, crop rotation farmers, and corn farmers who did not use rotation.

We wanted to obtain information based on the criteria we had determined that could be used in our comparison between rotation farming and integrated terrace farming. Therefore, we asked similar questions to both non terrace and terrace farmers about their previous techniques and their current methods. Some of the farmers did not have enough land to do rotation farming anymore, so we asked about their past when they had practiced rotation methods. Due to the time conflict of some farmers, we were not able to interview all of them in one day. We asked questions that were similar to our informal meeting during the first visit. Then, we asked more in depth questions about the variables we determined in the analysis of our observations. For the farmers who had at least partially switched to terrace farming, we asked about the transition and what problems they had faced, as well as how their new methods had benefited them. We asked questions to fill each side of the comparison between crop rotation and integrated terrace farming. For example, under the environmental questions, we first asked about how much fertilizer the previous methods had required and then asked how that compared to the new terrace farming. If the farmer had not transitioned to integrated terrace farming or had terraces that were not being used for integrated farming, we asked questions to find out what was preventing the complete transition.

In order to obtain an in-depth perspective of the farmers' lives, we interviewed individual farmers in groups of four. One interviewed while the others translated, took notes, and asked additional questions related to the categories. During the interviews, we recorded the audio so that a complete transcript of the interviews could be created.

Check for Validity

Before we submitted our report, we did our final check for validity. The key question was "Has the research really investigated what we claimed?" (Knight, 2001). This question was raised because for our comparison to be effective, our research had to be logical and provide practical information. To achieve this validity, we tried to eliminate as much bias as possible by not asking loaded questions that made one farming method seem inherently worse than the other. For example, rather than asking if the farmer used more fertilizer as a rotation farmer than they did with terraces, we simply asked how much fertilizer they used under each farming method. Also, we wanted to make our sample as random as possible to avoid sample bias. We achieved this by not only interviewing farmers at Ban Pang Yang but also some at Huay Muang. We did not focus on only interviewing integrated terrace farmers, but also farmers who had terraces without integrated farming, farmers who practiced crop rotation, and also farmers who grew corn without rotation. This method gave us a wide range of opinions and facts from a variety of people on all points in the spectrum between crop rotation and integrated terrace farming. The type of validity we analyzed was external validity, also known as generalizability (Knight, 2001). The conclusions relied on the external validity because if we could not use our research to generalize for the rest of the population in the area, our final product would not be convincing. The long term goal of our project was to encourage integrated terrace farming in villages outside of Ban Pang Yang so we needed information that could be generalized for these other villages.