Water Resources Development in Isaan, Thailand

The Social Case for Ban Thad

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WATER RESOURCES DEVELOPMENT IN ISAAN, THAILAND

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by

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Abstract

Ban Thad, a village in rural northeastern Thailand, experiences drought and significant economic migration during its dry season. This project recommends appropriate actions to the Population and Community Development Association for improving farmers' water access and income generating capabilities. Through community participation and semi-structured interviews, we determined that a solar-cell powered water distribution system would be socially appropriate for Ban Thad if sponsorship is provided, crop maintenance is not labor-intensive, and connection to individual fields is simple and affordable.

Acknowledgements

We would like to express our gratitude to our sponsor, the Population and Community Development Association (PDA), for providing us with the opportunity to contribute to the organization's rural development efforts in Ban Thad. We would like to thank Khun Wiras Tecmo and Dr. Wolfgang Frank from the central Bangkok office for taking the time to introduce us to the rural development work of the PDA and for providing suggestions on how to approach the project. We also greatly appreciate the time Miss Sheila Gungadin took to organize and answer any questions we had relating to logistics.

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Executive Summary

This project aims to identify, assess, and recommend future water resources development projects that will balance the economic needs, physical capabilities, and social dynamics in the village of Ban Thad, Thailand. Ban Thad is a fairly typical rural village in the Khon Kaen province of Isaan, Thailand. Most of its permanent residents are farmers who are happy with their simple agricultural lifestyle. Unfortunately, these residents are increasingly finding that the income from traditional agriculture is insufficient to provide for themselves and their families, especially in villages like Ban Thad that face drought conditions in the dry season and do not have consistent access to irrigation for their farms. The Population and Community Development Association (PDA) has been working to improve water availability in rural villages for decades, but some of the strategies that have been the most successful in other villages – programs like the extremely successful Sky Irrigation and Vegetable Bank projects – have not fared as well in Ban Thad. To address these issues and ensure the success of future development projects, this report contains a detailed analysis of the social and environmental considerations necessary for the successful implementation of new water development projects. It also contains as a set of recommendations for how the PDA can incorporate these ideas into its future work.

Through information gained from interviews and discussions during our participatory approach in Ban Thad over the course of four weeks, the team determined that the water gate- solar cell project would be appropriate and beneficial for Ban Thad provided a sponsor is found. Therefore, the first recommendation presented is that the PDA should seriously consider Ban Thad as one of the four recipients of its planned solar-cell-based pump and water distribution systems in Thailand. The proposed project involves using a solar cell to power a pump that would supply water to a distribution system running to the fields surrounding Ban Thad to use for dry season agriculture. The system seeks to address the primary concern in the village which is the inability to access water for agriculture, despite the existence of a large lake nearby. The PDA would help organize the project which includes finding a

sponsor to help cover the cost of the system so the villagers can afford it. In this case, sponsorship is a key requirement in order for this project to be feasible as the price of water is a very major obstacle to agricultural development in Ban Thad.

In addition to our primary recommendation of the solar cell, there are supplementary recommendations designed to make the implementation of a new system in Ban Thad successful and productive. They include plans for educating the villagers not only about how to use the system, but on things such as appropriate dry season crop choices and basic accounting skills to be able understand the costs and benefits associated with any new agricultural venture. We found that social barriers such as education and preconceived notions were just as important to address as the technical details of a new water distribution system.

One of the goals of our project was to determine what villagers were most concerned about regarding their current water resources. Through interviews we discovered that the major concern with the villagers was that they needed a way to get water from the lake to their fields, so a new distribution system was an obvious necessity. At the beginning of our project, villagers were very concerned about the cost of water and their inability to affordably connect to the government water system currently in place for domestic water use. A few farmers had successfully overcome both obstacles, but social perceptions involving expense and risk of debt associated with that system were too great for the majority of the villagers we interviewed.

We believe the water gate- solar cell project is likely to be successful in Ban Thad because the villagers continually expressed interest in it during participatory activities. They liked it primarily because it addressed their most important problem: making it easier and cheaper to get water to individual farms. If designed properly the system could provide water for a majority of the farms in Ban Thad, which would significantly improve villager's ability to farm during the dry season, improving their economic prospects.

Improving the ability to generate income in Ban Thad is especially important because 70% of the population leaves the village to find more profitable work in the cities during the dry season, leaving behind fragmented families. Urban and economic migration is a common problem for the villages of Isaan, but Ban Thad s an extreme case. Though talking to villagers we determined that the high level of migration is primarily driven by the desire for better income that can be found outside of the village, and is most likely facilitated by the cultural acceptance of leaving during the dry season. Because of this it is our belief that increasing income generation prospects in the village through improved agriculture may be one way to control the future rate of migration by improving the appeal of staying in the village, both economically and socially. Improving income may convince fewer people to leave the village in the future which will reunite families and make the community stronger and more productive.

Focusing efforts to improve income generation in Ban Thad will help to improve the quality of life of the people who live in the village during the dry season. The population left in the village during the dry season consists mostly of children and people over 50 who are left behind to take care of children while the parent generation leaves to work in the cities. Commonly the older generation left behind does not work during the dry season, leaving them dependent on money that people send home to support them. Throughout our project the older generation expressed a desire to expand their agriculture; the only factor they lacked is accessible, affordable water. Because of their age, they are unable to maintain the more labor-intensive crops recommended as part of the vegetable bank project. Instead, they prefer to grow field crops such as rice or corn that are easier to maintain. This crop preference, however, requires a considerable amount of water. Implementing the solar cell project would give them a new opportunity to increase their income during the dry season by giving them access to the sufficient quantity of water that is key for economic growth and improved quality of life in the village.

Authorship

All team members listed on the title page contributed to the editing and review of all sections of the report, and every major chapter contains significant writing from every team member. However, one team member was responsible for the final edited state of each major section of the report. This division of labor is as follows:

Daniel Bjorge was responsible for Chapter 3, "The Participatory Approach in Ban Thad." He was also responsible for the consolidation and formatting of the final report as a whole, including title pages, tables of contents and figures, and references.

Jessica Booth was responsible for the Executive Summary, Chapter 1, "Introduction," and Chapter 6, "Conclusions and Recommendations."

Korakij Cholchalatharn and Arunrat Smitasin were jointly responsible for all appendices. In particular, they were responsible for the translation of the 30 pages of interview summaries in Appendix B. They were also solely responsible for the discovery and translation of all Thai sources used throughout the report.

Katrina Crocker was responsible for Section 2.1 of Chapter 2, "Water for Agriculture in Isaan," Section 4.4 of Chapter 4, "Existing Resources and Concerns in Ban Thad" and for Chapter 5, "Analysis of Potential Water Resource Development in Ban Thad." She was also responsible for the Acknowledgements section.

David Warfel was responsible for Sections 2.2 and 2.3 of Chapter 2, "Water for Agriculture in Isaan," and for Sections 4.1 through and 4.3 of Chapter 4, "Existing Resources and Concerns in Ban Thad." He was also responsible for the Abstract.

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1 Introduction

Isaan, Thailand's northeast region, has the highest poverty rate in all of Thailand. The incidence of poverty remains high in rural Thailand in general (16%) and Isaan in particular (26%) (Fan et al., 2004). Consequently, residents' quality of life is poor compared to the rest of Thailand, and urban migration has become a significant problem (Bepler, 2003; McGregor et al., 2009). One important cause of these issues is that, although Isaan is Thailand's agricultural epicenter, from 1987 to 2004 annual farm income growth was virtually nonexistent and the percentage of income from farmland declined from 70% to 19% (Cherdchuchai & Otsuka, 2006). Because subsistence agriculture is so deeply ingrained in the traditions and culture of the region, it has remained prevalent in Isaan even as it has become less economically viable. Although residents are increasingly turning to outside supplementary jobs to fill this economic gap, many of its inhabitants still rely on farming as an important source of income and food.

One major obstacle facing agriculture in Isaan is the availability of water during the dry season. In the rainy season enough rain falls to support a single harvest of rice which serves as the primary source of income and food for the farmers in the region. However, during the six- month dry season that spans from October to May, there is almost no rain which poses a very large challenge for income generation through agriculture. To cope with this long dry season, many residents migrate to larger cities to pursue non-agricultural jobs. Although this allows income generation during the dry season, people must leave behind their families and villages for many months which disrupts the social fabric of the community.

One way to address these social issues is through increasing income generation potential during the dry season. Our sponsor, the Population and Community Development Association (PDA) has been working for over thirty years in Isaan on water resources development projects designed to improve access to water for agriculture in rural villages. The goal of this initiative is to supply water and education for people in these villages to be able to support themselves financially throughout the year using community-based water projects and the promotion of alternative agriculture.

For this study, we worked with the PDA in the village of Ban Thad, located in Khon Kaen province in central Isaan. The village is primarily agricultural, and most of the people who live there depend on a single harvest of rice during the wet season for their food and income. During the dry season, approximately 70% of the village population leaves to find work in cities in order to support their families during a time of year they would otherwise be unemployed. This migration results in the almost total absence of the parent generation with grandparents left behind to take care of small children while parents are away working in cities. To help remedy this problem, our project team conducted research about ways to help improve the income generation potential in the village through agriculture. This project focused on ways in which the water resources could be improved so that agriculture can be made possible and profitable during the dry season. This would improve villagers' ability to make money and might decrease the amount of people who want to leave the village in search of better jobs.

There is a wide body of existing research on general best practices for improving agriculture and water access – for our project, material from the International Rice Research Institution and Khon Kaen University's agriculture department was particularly instrumental – but there is limited knowledge about the social perceptions surrounding these projects and what situations they are be feasible in. For this reason, our project sought to investigate the social appropriateness of a particular project that had been proposed by the PDA prior to our arrival. Before we examined specific information regarding the PDA project, we gathered information from the villagers that answered the three following questions:

1) What physical and social resources for water storage and distribution and agriculture are currently available in a typical Isaan village?

2) What do villagers see as the biggest concerns with their current water management and agricultural practices and infrastructure?

3) What potential future improvements offer a good balance of economic improvement and feasibility of implementation in rural Isaan?

Localized information answering these three questions gave us the knowledge we needed to know how to effectively address the most pressing concerns that villagers had. Historically, most of the issues surrounding the success of water systems have stemmed from locals' willingness and ability to maintain them (Floch & Molle, 2007), or from lack of willingness to invest their limited resources in a new venture due to fear of debt (Cote et al., 2003), two things we found to hold true in Ban Thad. We also found that the primary concern the villagers wished to address was getting affordable access to water in sufficient quantity to use in the fields they already had. An important consideration when trying to address that problem was that most of the villagers were unwilling or unable to invest their time and effort in the high-value, higher labor agricultural alternatives that the PDA had been recommending. In general, because the population belonged to an older age group, people were more inclined to want to grow lower maintenance field crops that they were already familiar with. This posed challenges to our solutions because we had to ensure that our recommendations would provide what villagers desired, address their concerns and abilities, as well as meet the needs of the PDA.

In this document we address the five major phases of our project, designed to demonstrate the appropriateness of the proposed solar cell project in Ban Thad. In Chapter 2, "Water for Agriculture in Isaan," we introduce the relevant historical and social background that explains the link between Isaan's major social problems – poverty and economic migration – and water availability. The general overview of Isaan's social and economic problems also serves to provide a view of how applicable our specific results in Ban Thad might be in a broader context. In Chapter 3, "The Participatory Approach in Ban Thad," we provide details about the process we followed while in Ban Thad to gather information from the villagers regarding existing resources, concerns and potential solutions or ideas relating to water. The chapter describes the justification behind our original approach based on Participatory Rural Appraisal techniques, the challenges we faced in attempting to apply these techniques in Ban Thad, and finally the adaptations we made that allowed us to retain the benefits of the participatory approach in an individualized setting that we found more appropriate in Ban Thad.

In Chapter 4, “Existing Resources and Concerns in Ban Thad,” we present all of the information that we gathered by the method in Chapter 3 regarding the current state of the village. We organize the information into the categories of social barriers to change, income generation, existing water resources, and challenges to water access. This grouping serves to present the data in a way that leads the reader from the largest issues in the village to the more specific concerns that lead into Chapter 5, “Analysis of Potential Water Resource Development in Ban Thad.” Chapter 5 presents an overview of the solutions we and the PDA have identified as the most likely to be successful in Ban Thad and the relative advantages and disadvantages of each. It particularly focuses on the social appropriateness and expected villager acceptance of each solution, but also includes practical information about the expected economic benefits as well. Finally, in Chapter 6, “Conclusions and Recommendations,” we begin with our most important conclusions from Chapters 4 and 5, from which we provide recommendations for the PDA about the best course of action in Ban Thad relating to a new water distribution system. We also provide recommendations on ways to make these projects successful in the village by improving directed education and incorporating the needs and abilities of local community into the final project.

2 Water for Agriculture in Isaan

Isaan is the region of Northeastern Thailand known for large rates of urban and economic migration and the highest poverty rate in the country. The region's economy and culture is primarily agricultural, but its agriculture is severely limited by dependence on the highly variable climate. In the extremes of the wet season, too much water occasionally floods fields but still doesn't always provide enough, while in the dry season the lack of rain effectively halts most agriculture. In order to move beyond the limitations of rainfall, other water sources are needed for irrigation. With irrigation, yields can be assured, agriculture can be expanded, and dry season activities can be further diversified. Improving water management in Isaan would better residents' ability to use water to generate income through agriculture, which may lessen urban migration and limit disruptions of family relationships to contribute to the greater integrity of society.

2.1 Society, Economy, & Climate

This section shall establish the framework for the social context of the project. It begins with the people of Isaan themselves and demonstrate the primacy of agriculture in the region. The section next establishes the ways in which Isaan's residents are uniquely disadvantaged by the limitations and unreliability of the climate. A discussion of the social repercussions of the economic impacts of relying on the climate follows. Lastly, the section introduces the village of Ban Thad and assesses how it compares to Isaan as a whole.

2.1.1 People of Isaan

The people of rural Isaan can best be characterized (presently and historically) as farmers who do subsistence rain-fed rice-based farming and sell occasional surpluses, though they are increasingly finding other additional employment. While in 2003 only 18.3% of residents relied on agriculture as their sole source of income (National Statistical Office, Kingdom of Thailand, 2003), in 2006, 70% of Isaan residents were found to spend at least part of the year farming. This is quite a high majority, and proves

the agriculture is still a dominant way of life in the region. When considering ways to improve Isaan's economy, improving income generation from agriculture would be considered a strong potential solution since this is the major occupation of the region.

Agriculture is not only a way of life in Isaan, but is also an economically significant as a source of food and income. Fully three-quarters of all agricultural land in Isaan is devoted to rice cultivation (Floch, Molle, & Loiskandl, 2007), and the majority of rice is used for subsistence farming rather than export (Isvilanonda & Bunyasiri, 2009). While subsistence farming does not provide money, it does crucially reduce consumption costs. Agriculture in Isaan does more than simply provide food though- 19% of the region's household income sources are based directly on crop sales (Cherdchuchai & Otsuka, 2006). This, with the reminder that 70% of resident farm for part of the year, demonstrates that agriculture is a major economic power in Isaan, and as such should be examined when seeking to improve the economy.

This traditional livelihood plays a large role in the region's culture, which is closely tied to the local land and climate. As previously discussed, much of Isaan's agriculture is subsistence farmin, and so food is typically locally grown. The region also has its own food culture, as is perhaps best demonstrated by the fame of Isaan sticky rice (*khiaw niaw*) and Isaan papaya salad (*som tam*). Knowledge of wild food sources is also incorporated into Isaan's food culture and part of their daily diet, nutrition, emergency food, and even income supplementation (Setalaphruk & Price, 2007). Thus the people of Isaan is connected to their land and the cultivation of it through their food culture.

Many of Isaan's traditions and seasonal activities are based around their agricultural livelihoods as well. The year is traditionally thought of in terms of two seasons; the rice season and the silk weaving season, revealing that agriculture shapes the mindset of Isaan residents. The traditional community structure has been shaped by the relationships of trade, communal property, shared labor, and plentiful food sources of a subsistence-based economy. People also perform agricultural rituals such as one to honor a spirit presiding over their rice fields (Moulton, 2008). These rituals further connect their culture

to the long established livelihood. The importance of agriculture in Isaan communities, evident here, recommends agriculture as a socially suitable occupation that continues the ways of the culture.

Agriculture in Isaan builds cultural unity, something evident in the principle of *Long Kak*. *Long Kak* is described as being the spirit of the traditional harvest where the community works together in the style of a festival. When crops, especially the rice, are ready to be harvested, the owner marks their fields with flags so neighbors and guests know to come help. Together the community harvests the crop, and an Isaan song about a young girl is traditionally played and helps to relieve the fatigue of the hard work. To give thanks and to support all the helpers, the owner provides savory- sweet alcohol, cigarettes, and drinking water (Long Kak Tradition, n.d.). The *Long-Kak* traditional harvest festival demonstrates the spirit of Thai people helping each other, something valued by Isaan communities. Culturally appropriate ways to improve income generation should preserve the traditional community nature of agriculture.

2.1.2 Limitations of Climate

Although agriculture is very important to the region, agricultural production is severely impacted by its heavy dependence upon the climate because rainfall is essentially non-existent for half the year. Even though the total annual average rainfall for the region is significant, the unevenly distributed nature of it into a wet season and a dry season makes it a challenge for people who live there and depend upon it. The dry season begins when precipitation drops off steeply after the March-October rainy season when it dwindles to less than 25mm (1 inch) in November. Very nearly nothing falls in December, and less than 15mm (0.6 inches) falls in the months of January and February before rains resume again in March (Srisuk et al., 2001). The quantities of rain during these months simply cannot sustain most agriculture. While in the past Isaan's residents were able to rely upon the local forests at during this time of the year (Moulton, 2008), severe deforestation has eliminated this resource in many areas (Jamroenpruckaa, 2001). Therefore it is now become a problem that the typical farmer with solely rain-fed rice paddies cannot practice agriculture for at least four months of the year.

Dependence on the climate not only seriously restricts dry season agriculture, but also negatively affects wet season agriculture due to highly variable and frequently insufficient rains. Flooding during the rainy season can be a significant problem in Isaan during some years, especially in those areas next to the Mekong, Mun, and Chi rivers or with particularly low-lying land. But though the wet season tends to be associated with flooding, frequently the season's rains are actually inadequate and crops suffer. The rains in Isaan are unreliable not only with when they fall within a year, but also with when they fall during the rainy season and with where within the region they fall (Limpinuntana, 2001). Farmers cannot hope to plan to consistently water their crops over the growing season if their land is solely rain-fed. Their investments of time and money to grow a crop that fails or suffers poor yields go uncompensated and contribute to a poor economy.

2.1.3 Poverty and Urban Migration

Since the economy is primarily based upon rain-fed agriculture, farmers' livelihoods are frequently disrupted by the variable climate and many are below the poverty line and in debt. Isaan has the highest poverty rate in Thailand, with the incidence of poverty increasing from 19% in 1996 to 23% in 1998, at times double rates in the rest of Thailand. While nearly 25% of farm households in 1996 fell below the poverty line, only 18% of Thailand's farm households total did (Viratphong, 2001). 72.5% of the people of Isaan are estimated to be in debt (Thusanaroongrueng, 2010). The average resident makes 12,995 THB per month in income including non-agricultural sources of income (Charoenpun, 2008), while the poverty line is 1,300 THB per month (National Statistical Office, 2010). Thus current agriculture is currently not a strong source of income and residents must find additional employment to support themselves.

And indeed the need for a stable, year-round income to support a family has led many people in Isaan to seek more conventional employment, but frequently cannot find employment locally. Less than one-fifth of the population today reports agriculture as their only source of income (National Statistical Office, Kingdom of Thailand, 2003). Much of the other four-fifths is forced to leave families and communities behind because employment opportunities are scarce. To attempt to address this, organizations such as the

Population and Community Development association have worked with companies to locate factories in Isaan and so provide employment opportunities (Population and Community Development Association, 2000). However, these ventures can only provide so many jobs.

Thus Isaan's people have turned to urban migration for seasonal or full-time work in order to supplement their income from non-rain dependant sources. Isaan is well known for its outflow of residents to large cities like Bangkok. The 1998-99 farm survey found that 1.5 million Isaan residents had left for urban centers (Viratphong, 2001). More recently, around one million Isaan residents were determined to be gone year-round (Pirivakul, 2004), with greater numbers likely on a seasonal basis. These one million people have diverse reasons for migrating and some may choose to migrate by preference. Our project is most concerned with the rest of the one million people would prefer to live in Isaan but must leave each dry season or for multiple years continuously in order to find work.

Urban migration is very disruptive to family structure as well as the to whole village communities, negatively impacting the culture and quality of life of people in Isaan. It is common to find a village of elders and young children, with the majority of the working class living in Bangkok or abroad (Moulton, 2008). Children are not raised by their parents, and grandparents, who may be getting very old themselves, are left to take care of children. In the context of Isaan, a region where it has been established, community is highly valued, as previously established, a missing generation is a serious loss.

Urban migration negatively impacts the ability of a village to successfully practice agriculture. The leave of the parent generation results in a decline in the availability of labor for farming. The loss of younger residents also hampers technology transfer since older residents are less educated. Furthermore, The aged population of farmers additionally has been found to simply cause a lack of "energetic forces" and new initiatives in farming (Prapertchob, 2001). The new demographic of villages in turn further weakens the ability of communities to do agriculture, perpetuating a cycle of a weak agricultural economy. The impacts of urban migration further weaken the ability of a village to sustain itself.

2.1.4 Ban Thad

The village of Ban Thad is the focus of our project Water for Agriculture in Isaan. Ban Thad, while not necessarily representative of the entire region, does face many of the same challenges and has felt many of the social consequences of low water availability. Ban Thad is located in Ban Phai district of Khon Kaen, in the heart of Isaan (see Figure 1). As the demographics chart in Figure 2 shows, Ban Thad is a small village consisting almost entirely of farmers, typical of the region. Many of its residents migrate out of the village regularly. The fact that half of the migrants return to the village regularly indicates that at least a substantial portion of the migrating population remains interested in staying in the village. This made Ban Thad a particularly good fit for our project, since it meant a development project that could enable more profitable off-season work within the village had the potential for acceptance by a very large percentage of the population.

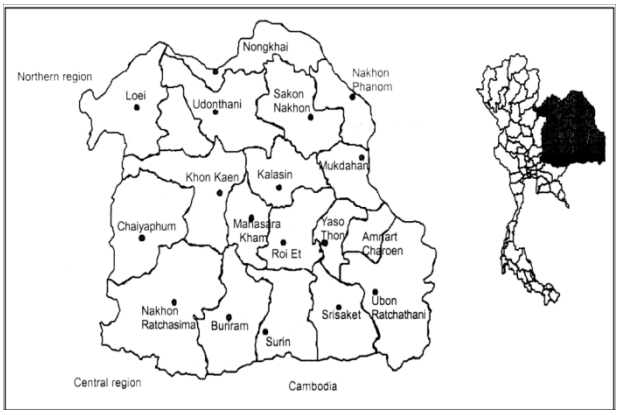

Figure 1: Map of Khon Kaen Province

Ban Thad is close to Lake Ta-wan-ron, which is connected to Kang La-wa, which is in turn connected to the Chi River. Ban Thad's proximity to the lake means that water from other areas travels down the Chi River and sometimes causes flooding to some residents with property adjacent to the lake. Flooding is a major problem in Isaan for people near the major waterways, but does not affect most people in Ban Thad. Flooding is not severe in Ban Thad as it is in other areas of Isaan.

Ban Thad	
Province:	Khon Kaen
District:	Ban Phai
Sub District:	Ban Phai
Population:	696
Men:	335
Women:	351
Households:	129
Residential Area:	0.13km^2
Farm Landowners:	~88% of households
Avg. Owned:	10 rai
Migration:	
Permanent:	20%
Seasonal:	50%

Figure 2: Demographics of Ban Thad

However, lack of rain in the dry season is a source of many of the village's issues. Most of Ban Thad's fields do not have access to the lake's water. The vast majority of people of Ban Thad thus can do farming only in rainy season, since they experience the dry season droughts typical of Isaan. In the dry season, 70% of the village leaves to find other employment in urban areas such as Bangkok, while 20% of the village is gone the full year. In Isaan as a whole, about one-twentieth of Isaan's population permanently migrates (Thai Government, 2005), while it is unclear what portion engages in seasonal urban migration. Thus Ban Thad appears to have higher than average rates of urban migration.

2.2 Supplying Water for Dry Season Agriculture

While the focus of the project was on the village of Ban Thad, the remaining content of the Literature Review examines the challenges and opportunities of the region as a whole. Obtaining an overall understanding of the water and agricultural issues, as well as the socioeconomic, allowed us to determine how representative Ban Thad was to the rest of Isaan and helped us develop recommendations accordingly.

A major concern for farmers throughout Isaan is lack of water availability during the dry-season. As mentioned in 2.1.2, many farmers in Isaan depend on the rain as their primary source of water. The lack of rain in the dry-season means that during this time farmers must utilize whatever water is available to them. The following topics in this section will discuss where farmers obtain water during the dry season and the importance of year-round irrigation in sustaining a healthy agricultural economy.

2.2.1 Water Sources

Although farmers in Northeast Thailand use rainwater as a primary source of water in the wet season, they must use water that is retained on the surface or underground to irrigate their crops during the dry season. Surface water, such as ponds, canals, rivers, and lakes, is a potential source of water for dry season irrigation. Farmers with fields near large ponds and lakes are often able to provide sufficient water for their rice paddies using only the existing water remaining from the downpours of the rainy-season (Masumoto et al., 2004). Having easy access to irrigation is important in many Isaan towns where the majority of the dry-season population consists of older adults who may have trouble carrying water for long distances.

Farmers near smaller bodies of surface water can partake in agricultural practices that require less water than rice. A majority of villages in Isaan possess at least one or two natural or manmade ponds that are sometimes used as supplementary water sources for small-scale vegetable plots and fisheries (Watershed, 2001). If constructed properly, ponds should be able to retain rainwater throughout the dry-season, allowing for farmers to own fish and frogs for personal consumption or for sale (Sethaputra et al., 1985). The ability to partake in agricultural practices that require less water than rice enables farmers to generate subsidiary income during the dry-season, when they might otherwise be unemployed.

The salty soil in Isaan sometimes prevents the groundwater from being suitable for irrigation. The geology of northeast Thailand is of fine-grained sandstone and shale with upper strata consisting of pervious sandstone, and in some places, rock salt. The rock salt has contributed somewhat to Isaan's

serious salinity problem – of the 160,000km2 of land covered by Isaan, at least 49,440km2 has problems with excessive salinity (Limpinuntana, 2001). Digging of canals for irrigation is one way for layers of rock salt to enter the groundwater. This can sometimes cause the water to be so salty that it is unusable on farmlands (Moulton, 2008). Salt acts a poison to plants when present in large quantities and makes it difficult for plant life to grow (Khetbumrung et al., 2010). The combined challenges of poor groundwater quality and inaccessibility to surface water make dry season agriculture an obstacle for farmers in Isaan. Rehabilitation of salty groundwater is an expensive process that may not be feasible for most villages. However, greater accessibility to surface water can provide farmers with increased hopes for dry-season irrigation.

2.2.2 Importance of Irrigation

Access to irrigation is an essential factor in enabling successful agriculture in Isaan. Reliable access to irrigation has a very significant effect on rice yield during the wet season, and is necessary in order to consistently plant a second rice crop during the dry season. Irrigated paddies are able to produce a yield that is fifty percent higher than that of a typical rain fed crop (Boonlue, 2005). Thus, improved water access is important not only in the dry-season but in the wet season as well. Without an irrigation system in place, few high-value crops are suitable for Isaan's climate (Polthanee, 2001). Yet as of 2005, only 17% of the region's farmland was irrigated at all, leaving the rest to be grown under exclusively rain fed conditions (Boonlue, 2005). Since agricultural yields are so dependent on irrigation, improving farms' access to water has the potential to increase

Irrigation is vital to the economic wellbeing of the residents of Isaan. According to Cherdchuchai and Otsuka's 2006 study, the ratio of irrigated to non-irrigated farmland was the attribute most strongly correlated with per capita income in Isaan. The level of irrigation was the only agricultural factor the study identified that had a significant correlation to income levels; the other variables the study mentioned were all based on either education levels or time spent on non-agricultural labor (Cherdchuchai & Otsuka, 2006). Access to water is a common determining factor for whether an Isaan farmer can remain

financially stable without seeking additional non-agricultural work during the dry season (Cherdchuchai & Otsuka, 2006). Financial stability can increase quality of life, and because increasing irrigation is closely correlated to greater income potential, progress in water access should be of great importance to rural development efforts.

2.2.3 Irrigation Development Projects

Irrigation projects can be described as either "large-scale" or "small-scale". Large-scale projects suggest that they are giant in size, costly, built to serve many people, and are usually, but not exclusively, constructed or planned by the Royal Irrigation Department and Electric Generating Authority of Thailand. A typical example of a large-scale project includes a hydropower dam. Small-scale projects suggest that they are physically small, less costly, built to serve a specific focus population, and are usually, but not exclusively, constructed or planned by non-government organizations and farmer cooperatives (Patamatamkul). Some instances include a community weir or pond. The purpose of this section is to discuss and compare the effectiveness of the two types of irrigation projects in Isaan.

The abundant amount of land and monetary resources that go into large-scale projects does not necessarily correlate to equally proportionate benefits. Large-scale projects may require individual budgets of 3 billion THB (US$100 million) or more and can provide water for 50,000-100,000 rai worth of concentrated farmland. However, areas that need irrigation the most are often scattered around different villages or may not amount to that quantity of land. According to Dr. Prakob Wirojanagud, Dean of the Faculty of Engineering at Ubon Ratchatani University, state agencies tend to overestimate the actual demand needed in large dam projects in order to acquire larger budgets that expand their administrative power (Watershed, 2001). The amount of money needed is very disproportionate to the benefits gained from the project. In a region that is very poor, efficient use of money is important to be able to improve life and agriculture.

Large-scale irrigation projects are often very generalized approaches to development and that do not utilize effective water management techniques. Many of the large-scale dam projects implemented in Isaan over the last twenty years have suffered from frequent mismanagement and lack of coordination among agencies. Without a strong connection between government management and the end-users of water, projects are more likely to fail. In addition to this, large-scale irrigation projects often destroy the usefulness of small-scale irrigation efforts that were already in place (Watershed, 2001). Effective water management considers the existence of current systems and attempts to incorporate them into the new infrastructure. Projects designed to meet people's specific needs help individual farmers achieve their goals for agriculture and quality of life. The small-scale approach focuses more on the needs of people as opposed to acquiring the maximum amount of water possible without planning in advance.

Individual or community level irrigation projects that emphasis local knowledge and utilize low-costs are generally more effective. Traditional systems like small ponds, irrigation canals and small weirs typically work better and are more affordable than more modern solutions designed by water resource experts (Watershed, 2001). Individual projects require very little monetary investment compared to large-scale projects. Dr. Prakob of Ubon Ratchatani University estimated that the budget for dams on the Mekong would be 300-360 billion THB (US$10-12 billion), while only 60 billion THB (US$2 billion) would be needed for all of the small-scale projects in the entire country (Watershed, 2001). Implementing technology that is appropriate for villages to build and maintain themselves is crucial in ensuring the long-term success of it. The facts that these projects have higher cost-benefits and are feasible for villagers should make them more attractive to non-governmental organizations such as the PDA, who have the resources to appropriately plan and implement solutions.

The community-oriented approach the PDA takes to water development projects is an effective means of managing water resources to generate income. The SKY Irrigation/Vegetable Bank project uses small-scale systems to utilize the link between water resources development and income generation. Through this project, water is pumped from local groundwater or surface water, stored in large concrete tanks, and

distributed through pipes to provide year-round irrigation to a community's vegetable plots (Population and Community Development Association, 2010). Local sources and simple technology are used in these projects and village empowerment increases because the knowledge on how to manage the systems is passed on to the village. Local sustainability is important for the prolonged ability to generate income from agriculture without dependence on outside organizations.

In addition to providing local people with technical knowledge on how to maintain their irrigation systems, the PDA provides educational training on how to effectively increase agricultural income. The community receives training in vegetable cultivation, accounting, and management, and makes it possible for villagers to substantially increase their incomes by up to 3,000 THB (100 USD) per month. This knowledge can be passed on to others so the system is self-perpetuating. A water resources management committee is also established to collect water payments, as well as run the vegetable bank and help produce and market the vegetables (Population and Community Development Association, 2010). Setting up a local water committee ensures there is little disconnect between the management and the end users of the water in the village. It thereby avoids the problems of mismanagement and lack of planning that surrounding large government water projects.

2.3 Using Water for Agriculture

Improving water access requires not just the effective acquisition and distribution of water but also the effective usage and management of it. Traditional agricultural practices in Isaan are well-suited to the wet season climate, but require too much water to be widely effective during Isaan's dry season. Replacing or supplementing traditional rice farming with less water intensive alternatives can also be an effective means of maintaining income during the dry season, but such changes may conflict with established cultural practices. Applying water saving techniques to traditional farming and irrigation methods can help reduce water needs without undue changes to existing practices.

Figure 3: Dry Rice Paddies in Ban Thad

2.3.1 Traditional Rice Crop

Rice is by far the most popular crop in Isaan and has become deeply rooted in their agricultural practices and way of life. During the wet season, approximately 70% of the region's farmland (National Statistical Office, Kingdom of Thailand, 2003) and population (Cherdchuchai & Otsuka, 2006) is devoted to rice paddy agriculture. Agriculture is the most dominant livelihood in Isaan and rice is the leading crop of the region (Polthanee, 2001). As mentioned in 2.1.1, the rice harvest is a time of family reunification and plays a major role in the seasonal and cultural activities of rural Isaan people. Since rice is ingrained in Isaan life, developments in irrigation and water management should serve to complement important societal role.

Despite its popularity and social significance, rice is so water intensive that it is highly impractical to grow in Isaan during the dry season. This dichotomy puts Isaan at a significant disadvantage compared to the rest of Thailand. Water requirements to grow the gor kor and khao dawk mali rice varieties are 1000-1200 m3/rai of water for one harvest cycle (Royal Irrigation Department, 2006). Without dry-season irrigation systems, these water requirements are often quite challenging for farmers to fulfill. According to Gilbert et al., most Isaan residents are unable to grow more than one rice crop per year due to water shortages. Where as in the rest of Thailand, were irrigation systems are more prevalent, second and even third annual rice crops are common (Gilbert et al., 2007). Increasing farmers' access to water is only one way to achieve greater agricultural success. Growing water-efficient crops with conservative water-usage techniques can help farmers achieve improved yields and profits without the need for excessive amounts of water.

2.3.2 Agricultural Diversification

Alternating from traditional crops in the wet-season to more high-value, water efficient alternatives in the dry-season can be an effective means of increasing agricultural income in water-deficient areas. Water requirements for crops such as vegetables, peanuts, soybeans, and kenaf are significantly lower than those of rice (Cote et al., 2003). This allows for farmers in water-deficient areas or situations to continue agriculture and income generation during the dry-season.

Diversifying crop choices can help farmers avoid the risks associated with single harvests and provide for greater financial stability. Maintaining a variety of crops helps alleviate potential issues with price fluctuations and soil nutrient drainage that can occur when only one crop is used. It also helps mitigate the economic repercussions of any single crop failing (Yao, 1997). If farmers have multiple sources of income, they are able to better overcome the risks inherent in agricultural investments. Diversification would thus help reduce debts incurred and ensure a more stable economy overall. Income from rice alone is typically inadequate to sustain a family in Isaan, so many farmers in Isaan already supplement rice with other upland crops, such as soybeans, peanuts, and tobacco (Limpinutanta, 2001). These existing practices indicate the potential for success in recommending further adoption of new types of crops; it suggests both that locals may feel an economic need to diversify already and that they would be open to suggestions to do so more quickly.

The PDA's Vegetable Bank projects have helped farmers generate more income through diversification and utilization of water-efficient crops. Growing vegetables such as lettuce, tomato, chili, cabbage, kale, spinach, etc. have provided farmers with as much as 3,000 THB per month in supplementary income in the most successful cases (Population and Community Development Association, 2010). As of November 2010, 154 villages and 4,049 families have participated in Vegetable Bank projects (Frank, 2010). The increased income generation from these projects can help decrease dependence on the whims of climate and promote rural empowerment in Isaan.

Raising animals such as cattle, fish, frogs and crickets can be an effective means of supplementing crops without drastically increasing water or land requirements. Some small animals, such as crickets and frogs, offer very high value per unit land and unit water (Frank, 2010). These can be valuable sources of income, even during the dry season, and since they do not require much land they can also be raised during the wet season alongside normal rice crops if desired. This flexibility makes these small animals a strong potential recommendation, since raising them could have minimal impact on existing practices despite being highly profitable.

In addition to economic benefits, animal raising also helps farmers improve the quality of their land. Fish increase soil nutrient availability during the grain-filling stage of rice, resulting in increased grain weight. They have also been shown to reduce pests, diseases, and weed species by up to 50%. Buffaloes and cattle can not only be butchered in sold, but used as sources of organic fertilizer suitable for use with crops (Polthanee, 2001). These animals are excellent candidates for supplementary income because they can also improve the yields of existing crops. They are also able to obtain free food from the rice paddies. Animal raising may help farmers increase water efficiency and overcome the many challenges of dry-season agriculture while supplementing traditional rice crops.

2.3.3 Effective Techniques

Water efficient irrigation techniques can help reduce the water needs of traditional farming without disrupting crop choice. Great success has been seen using drip-irrigation methods instead of canals or sprinklers. Israel has use this method to more than double their crop production in twenty years without having to increase the amount of water they use (Roudi-Fahimi, Creel, & De Souza, 2002). Wet-Dry field irrigation, the alternate flooding and drying out of a rice field, can safely be used to save water while cultivating rice without sacrificing yield. Wet-dry irrigation can result in 15-30% water savings, which can be greater depending on the particular crop in question (IRRI, 2009). Changing the methods used to apply the water to fields will help to decrease the amount of water required, and may even improve the

crop yield. In Isaan, a region with scare water resources for much of the year, such techniques can importantly conserve water and reduce water costs.

Practices such as soil improvement can improve the ability of the environment to retain water, thus improving agriculture. Industrial agriculture, known for its use of harsh chemicals and non-use of organic matter, requires three to five times as much water as non-industrial agriculture (Buckingham & Turner, 2008). Soil improvements such as mulching, layering with compost, or spreading manure will help improve soil's natural water retention abilities (Yuvanivama, 2001). A 1996 project in Tigray, Ethiopia has empirically determined that much greater yields can be achieved with compost than with chemical fertilizers, and that composting increases the moisture retention capacity of soil (Kassie & Zikhali, 2009). This technique does not involve any water management or complex systems, but is rather very straightforward and very accessible to most farmers. In Isaan, a similar semi-arid area that has very poor soil, such organic soil improvement techniques would allow for much improvement to agriculture, allowing farmers to increase their income generation.

2.4 Overview

Throughout the course of this chapter, it has been clear that many of Isaan's social and economic issues all tie back to the low availability of water during the dry season and its impact on the agricultural economy. First, the connection between society, climate and economy was examined. It became apparent that many of the issues Isaan faces, such as poverty and urban migration, were closely related to the difficulties with the agricultural economy, which is in turn related to the extreme climate. The next section described the importance of having access to water and irrigation, as well as some of the more successful ways in which water development projects have been executed. In the final section of this chapter, we described the many ways in which to use water for agriculture, which is a primary concern of our project. In the next chapter, we describe the method that we used while in Ban Thad to gather additional data about water resources issues that related specifically to the village.

3 The Participatory Approach in Ban Thad

The objective of our project is to demonstrate the social appropriateness of new water resources development projects in Ban Thad, as well as recommend ways to make these projects successful by incorporating the needs and abilities of local community. To accomplish this goal, our methods focus around answering the following three major research questions:

1) *What physical and social resources for water storage and distribution and agriculture are currently available in Ban Thad?*

Understanding what resources exist to be expanded, what locals are familiar with and capable of operating and maintaining, and what infrastructural and community knowledge gaps exist that need to be filled are all vital parts of identifying the necessity, social requirements, and economic costs of the improvements we will identify in answering question 3. The answers to this question will feed into our later assessment of different water solutions' feasibility of implementation.

2) *What do villagers see as the biggest concerns with their current water management and agricultural practices and infrastructure?*

Ultimately, it will be the local community's responsibility to use, manage, and maintain any project that is borne from our recommendations. Answering this question will allow us to include and prioritize recommendations that the local people will be willing to use and support in the future, instead of only creating an engineering report about solutions' cost-effectiveness.

3) *What potential future improvements offer a good balance of economic improvement and feasibility of implementation in Ban Thad?*

The answers to this question feed directly into the recommendations in our objective. For a recommendation to be useful, it must represent a change that improves the economic standing of the

community, poverty being the overarching social problem we are attempting to improve on. However, it also must be affordable and sustainable (both socially and economically) for the community for there to be any practical hope of actually implementing the recommended improvements.

In order to answer these questions about the social fabric of Ban Thad, and to help ensure a sense of community investment in future developments based on our recommendations, we based our methods around a participatory approach and in particular Participatory Rural Appraisal (PRA) techniques. PRA is an approach that involves the community in the assessment of problems and development of solutions through a variety of community activities and discussions such as mapping, problem ranking, and options assessment (Technical Cooperation Department, 1997). PRA has been used in rural communities and developing countries throughout the world to encourage local empowerment and community solution development as an alternative to having outside researchers and professionals decide on the futures of others (Chambers, 1994). This idea of community empowerment was exactly what our project needed to ensure that our recommendations would be embraced by the community, instead of being seen as just some unconnected external agency. PRA emphasizes listening to locals' concerns and strengthening partnerships between community and external agencies (Save the Children/Armenia, 1995). This was important to our methodology because successfully implementing any of our recommendations would require the cooperation of the community and an external agency: the PDA. By using these ideas and techniques, we were able to help organize the knowledge and ideas of the villagers so that effective discussion of potential solutions could take place, while simultaneously strengthening the relationship that Ban Thad has with the PDA.

This chapter begins in Section 3.1 by introducing our initial attempts at participatory relationship building with the community. The ethos established during this period would form the basis of the rest of our interactions with the community. Section 3.2 details our initial, unsuccessful attempts to apply PRA techniques in a large group setting. Section 3.3 explains how we used the lessons from this first try to adapt our methods to the social dynamics of Ban Thad. In particular, it includes the data gathering

techniques we used during interviews with individual villagers, which make up the bulk of our raw data. Section 3.4 explains how this data makes up the basis for both our own analysis and analysis by the community itself. Section 3.5 concludes the chapter by explaining the role this analysis played in developing the final findings and recommendations in the chapters to come.

3.1 Introductions, Relationship Building, and Initial Discussion

Focusing first and foremost on establish rapport with the village was crucial in attempting to make an open participatory environment a reality and to fulfill our first objective of building a trustful relationship with the people of Ban Thad. Past projects in rural areas found that the contrasting appearance and attitudes of foreigners compared to that of the locals could cause them to feel distanced and alienated from project activity (Save the Children/Armenia, 1995). This sort of alienation would be a death knell for a participatory methodology to succeed; as we described above, the participatory approach can only be effective if the villagers are empowered and invested in the project. To avoid this alienation, we began our interactions with the village by spending much of our initial meeting on relationship-building rather than information gathering.

We began our interactions with Ban Thad by organizing a friendly introductory meeting with the community. This meeting acted more to easing our entrance into the community than to begin gathering specific data from the village. The village headwoman, Khun Anong, has worked with the PDA frequently in the past and acted as our primary liaison to the village. She used the village's loudspeaker system to invite the villagers to speak with us. Approximately twenty elders, leaders, and water committee members came to the introduction. We had asked Khun Anong to invite who she thought would be most appropriate for an introduction to the village, in deference to the community's unknown social norms, so we were happy to see this high level of initial interest. With the help of the two Thai-speaking members of the team, everybody was able to introduce themselves in Thai. We then briefly stated the purpose, methodology, and planned outcomes of our project. We spent this initial time

explaining the overall goals of the project because it was important that the villagers understand how the project would benefit them and why their participation was important: they would eventually be expected to take responsibility for any future development projects that would come out of our recommendations.

Our attempts to use the meeting as a social tool rather than an informational tool were successful at establishing an initial rapport with the villagers. Though the Thai researchers necessarily did all of the talking about the more complicated aspects of the introduction, every researcher provided at least a brief introduction in Thai. The villagers were pleased to see us putting in some effort, and it helped to establish a more social atmosphere. We also expressed interest in learning about the local Isaan trades and dialect. Our attempts at speaking the language were appreciated by the community and often resulted in laughter. By beginning with these social activities instead of significant project-focused questions, we were able to emphasize to the villagers the importance of an open relationship with the community. Gaining the trust of the village allowed the locals to be more apt to discuss their problems and challenges relating to water and income generation, and helped them feel as they were equal partners in solution development later on.

Although the intended focus of the meeting was to get to know the community and gain their trust, after explaining the purpose of our project some were eager to go right to discussion on the village's water problems. Since this change was instigated by the village leader, we openly accepted it as an opportunity to discuss the village's problems. We hadn't intended to talk significantly about this at the first meeting, preferring to focus on the aforementioned relationship building. However, we felt that embracing the community-initiated discussion would demonstrate our eagerness to work with the community's ideas, rather than bringing all of the ideas under discussion in ourselves. The village leader claimed outright that there was not enough water and that they have a large lake but no way to get the water. The village leader continued to talk about the water problem and other men would occasionally join in on the conversation mentioning that they have enough land but cannot grow anything in the dry season because they do not have water. These concerns were later confirmed in virtually every interaction we had with villagers. At the time, we were pleased that the villagers were so eager to begin and had

already put thought into the problem. Retrospectively, the immediate agreement on the major problem may have been a warning sign that the villagers were uninterested in discussing other concerns in a community setting. We would soon confirm this in our first attempt at running a participatory group activity.

Figure 4: The Height of Mapping Participation

3.2 Mapping Activity and Participatory Challenges

We chose to begin our participatory activities with a mapping activity. Our initial research indicated that, with ideal levels of participation and discussion, this would allow us to build a foundation to promote future participatory activities while simultaneously allowing us to begin assessing the existing resources and concerns of the villagers relating to water access and availability. In typical PRA projects, the contents of such a map usually include major features of the village including important meeting places and locations of water sources. Maps can be drawn using any readily available materials such as sticks, stones, or chalk; the specific medium is relatively unimportant (Technical Cooperation Department, 1997). We chose to use large poster paper and markers in Ban Thad out of respect for the villagers; most of them were old enough that we did not wish to ask them to sit on the floor drawing. Using paper allowed us to use chairs and tables instead. Most PRA literature recommends that the specific contents of the map should be decided by the villagers so that their perceptions of which locations are important or not important can be evaluated (Technical Cooperation Department, 1997). We felt that this principle was sound; at this early point in the project, this perception of what was really important to the villagers was exactly what we were most interested in learning. The issue we found with allowing villagers to decide what was important to draw was that most people were hesitant to do anything but agree with what pre-established village leaders were saying and drawing. Our initial attempts at a "community map" really ended up being "Khun Somsak's map."

This was not the only issue we encountered with the mapping activity; our initial attempts at community mapping in Ban Thad were very unsuccessful. In particular, we encountered a variety of organizational problems, a lack of interest in the activity, and low levels of participation from the community. Despite scheduling the event with the village headwoman, it happened to coincide with a wedding preparation that a majority of the locals were preoccupied with. The activity was rescheduled for a later date. On this later date, even though the village headwoman notified the village of our event prior to our arrival and made announcements from the loudspeaker system once we arrived, only three to four people showed up on the scheduled day of the event. Even then, as mentioned above, only the village leader actively participated. If the goal of the mapping activity had been to learn specific pieces of physical, locational information, rather than to learn what was important to the community as a whole, this level of participation might have been adequate. Perhaps the villagers felt the same way – this would help to explain the lack of interest. We later discovered through discussions with the PDA that they had had similar experiences with group activities in Ban Thad, and that having meetings more than once a month in the village generally resulted in disinterest and a lack of participation. We realized that we would have to adapt our research methodology so that it was not entirely dependent on group events. Our experience and the PDA's confirmed that frequent group activities would not be able to gather enough of the community together to get a realistic picture of its concerns.

Even though the mapping activity did not go according to plan, it was not a complete failure. It still helped us to connect with and understand the culture of the village, even if it did not actually produce a useful map. We were able to play with the children and they enjoyed drawing their own maps and other illustrations of their village. Although the main audience that we were targeting for the activity was farmers and other adults in the village, playing with the children still served as a means of maintaining a close relationship with the village and helped us establish ethos for later interaction. The villager's resistance to following schedules and hesitance to participate in group settings during the activity helped us gain an insight into the culture of Isaan. In rural Thailand, and in particular Isaan, it is uncommon to

plan meetings much in advance; people in Isaan are well known for their laid back and easy going attitudes (see section 2.1). Understanding how the village responded to this sort of planning allowed us to adapt our later methodology to a more culturally appropriate approach. We later found that explicitly including a social component – in our case, lunch – helped to make the event seem more laid back and bolstered participation.

Based on the results of this activity, we decided to change our method to avoid large group discussions and instead focus on getting information from individuals or small groups. We did, however, still hope for at least one cohesive community discussion on potential solutions at the end of our stay in Isaan. The next section describes how we adapted the remainder of our approach to maintain the aforementioned benefits of the participatory approach without overusing large group activities.

3.3 Adapting to an Individualized Approach

Due to the lack of participation in the community, we changed our approach to include less participatory group activities and more activities based on one-on-one interactions with villagers. The goal of the method remained the same: we still wanted to create recommendations that were as socially appropriate as possible. This meant basing them on the community's needs, abilities, and preferences, and it also meant focusing on ideas that the community was actually invested in. The original participatory approach aimed to do this by holding activities that could involve the community all at once. Our new approach accomplished the same goal in three parts. First, we interviewed as many individuals as time allowed so that our information still represented a picture of the entire village's ideas. Next, we synthesized that information to form a single cohesive picture of the village's ideas. Finally, we used a single community activity to confirm this big picture and analyze it as a group. In this way we avoided many ineffective large-scale meetings, but were still able to base our recommendations on the community and its ideas.

Changing our methods in response to the dynamics of Ban Thad allowed us to involve villagers in our project as well as get the information we needed to get a good idea of the problems and potential solutions. Although it required more time and effort to piece together the results from individual interviews than a single participatory activity might have required, the mapping activity proved that this individualized method was more effective in Ban Thad.

3.3.1 Site Walks

We began our data gathering with guided site walks of the village's existing water and agricultural resources. Doing this sort of introductory information gathering in a site walks rather than simple interviews was valuable because the direct observations were effective at prompting both questions from us and ideas and concerns from the locals. Guided site walks allowed us to see existing systems in Ban Thad and served as an excellent introduction to the physical capabilities of the community. The initial walk was guided by Ban Thad's headwoman, Khun Anong. She gave us an introductory tour of the village and explained her view of the collective opinion of the village before we began formal introductions or interviews. Though we would later use individual villager interviews to support and confirm this information, the headwoman had a better general idea of what projects were planned or in progress than the average villager. Beginning our interactions with Ban Thad this way also helped us bond with Khun Anong, who proved to be an extremely important liaison throughout the project. Making these our initial observations in a context where we could get immediate feedback from a knowledgeable local helped to determine which things were important for us to look for and ask about in later meetings. This helped tremendously in determining what interview questions would be appropriate later.

Throughout our time in Ban Thad, we were taken on additional walks to see different aspects of their water management system and farms where people were utilizing – or underutilizing – water. We were normally led by PDA staff and Khun Anong, who is also the head of the village's water and agricultural committees. They were able to supply us with details on each system. Identifying and understanding these existing resources meant that we could tailor our thoughts and recommendations to using and improving

what the villagers already had and knew about. This generally proved to be both easier to implement and easier to encourage adoption of. Some of the water systems we saw were no longer functional. We were careful to look at what had not worked as well as what they were currently using; being able to see failed systems let us know what kinds of solutions were *not* viable in Ban Thad, so we could avoid them in our recommendations.

We also participated in several site walks in other villages. This allowed us to see what systems and solutions have worked elsewhere and helped identify which villages' experiences and successful projects might be most applicable in Ban Thad. We visited the villages of Ban Khan Nua, Ban Nong Thum, Ban Lan, and Ban Nong Pruek to see what systems existed to help cope with water scarcity. Summaries from each individual village can be found in Appendix B, organized by date and location. These villages all had examples of projects that were designed to improve access to water for domestic use and for agriculture. As we walked around, we asked our guides about the projects in the village so that we could get an idea if the particular solution that worked there would work in Ban Thad. In some cases, other villages had successfully implemented projects that had previously failed in Ban Thad. As with the introduction to Ban Thad, the main value of using site walks to gather this information was that making observations as we talked helped prompted ideas from both us and the interviewees. Since our time in these other villages was extremely limited, this was a useful tool for ensuring that the locals would remember and mention as many important thoughts, limitations, and suggestions as possible. Many of these ideas are incorporated into our final recommendations.

Figure 5: Khun Sudjai Saiyararm Explains Ban Lan's Village Bank

3.3.2 Interviews

Interviews with individuals were our primary mode of gathering data about water-related concerns. We conducted twelve interviews with villagers in Ban Thad. A few of the interviews were with selected people who did dry season farming, the rest were with people we met as we walked around the village. Conducting random interviews allowed us to get a good sample of opinions from the people who lived in Ban Thad during the dry season. The only criteria for selection were that the villager was outside of their home and that they agreed to talk to us for our project. This gave us a good idea of overall perceptions having to do with water availability and use.

The interviews were designed to determine what existing resources and occupational practices existed in the village, as well as what concerns villagers had regarding them. We also included questions aimed at identifying which potential solutions the villagers were most interested in, but as expected, few villagers were able or willing to offer any detailed information or ideas about future projects. A complete list of the questions we asked during these interviews can be found in Appendix A in the format and order we used during the final interviews. Those questions up to and including the Alternate Income Sources section are divided into a series of water and agriculture related topics. Within each topic we asked the following broad types of questions:

- What are your existing resources/practices?
- Why are they what they are?
- What changes have you considered or would you like to see?

The first two are meant to allow us to understand what resources exist to be expanded, what locals are familiar with and capable of operating and maintaining, and what infrastructural and community knowledge gaps exist to be filled. All of these, in turn, feed into deciding what solutions would be feasible in Ban Thad and how to take advantage of existing village resources while implementing them. The third type of question is aimed at identifying potential developments for Ban Thad. Solutions

suggested by (or at least understood by) the villagers have a much greater chance of long-term success in the village since the ultimate responsibility for the management and maintenance of any solution must come from the village itself. The remaining questions (the "Income Enough?" section and onward) are intended to identify and detail concerns about potential underlying social issues in the village. We had originally intended to leave these more open ended to allow each individual villager to provide his or her own sense of what was important, as per the PRA ideals we introduced in the introduction of this chapter. What we found however was that villagers would not volunteer this sort of detailed information without us prompting them. This echoed what we saw during the mapping activity – villagers preferred not to offer their own ideas out of hand. We left the more general questions (e.g., "What concerns do you have" and "Where do you see the village in 20 years"), but also added the more specific prompts to try to gather more details about the concerns we had already heard about from other villagers.

The format of the interviews was a balance between structure and informality. We needed specific enough questions to prompt useful responses, instead of the generalities the villagers tended to offer on their own. However, we also wanted to avoid making the process so rigorous as to be off-putting to the relatively easy-going villagers. Our goal with the interviews was to get an idea of the entire village's views and concerns surrounding agricultural water use, so we wanted to avoid limiting out interviews to only farmers who farmed during the dry season. Each interview was informal so as to make the interviewee as comfortable as possible. We had already discovered that the villagers in Ban Thad were not likely to get up and voice their opinions to a large group, so we tried to make the environment as non-threatening as possible. We avoided taking complete transcripts, since we wanted to avoid spending more time than necessary writing instead of conversing. We instead opted to write down only summaries. Translations of them can be found in Appendix B. To avoid intimidating potential interviewees, the project team split up into groups of two or three students so that individual villagers would not be confronted with all six group members at once. From playing with the children when we first go to the

village, we learned that our appearances were somewhat intimidating, so we felt that villagers might be more comfortable if we talked with them in small groups.

Additional interviews with government officials, PDA staff, and select leaders from other villages gave us information to better understand Ban Thad's water issue and how it relates to the area around it. PDA staff gave us background information on the projects that had been conducted in Ban Thad, as well as what they had planned for Ban Thad. Knowing the history and future plans for Ban Thad helped us to see if the village and the PDA were on the same page, also to see what projects did not work in the past and should not be attempted again. There were occasional but serious inconsistencies between even the most influential of the PDA staff members. Synthesizing these different ideas played an important role in shaping our final recommendations. People from other villages gave us information on solutions that worked for their village. We focused on other villages who had already implemented some of the solutions under consideration in Ban Thad. Their experiences helped us determine what factors to analyze to determine feasibility in Ban Thad. Finally, local government officials from the Ban Thad sub-district gave us maps, reports, plans and other information. This was very helpful to us to be able to see how government projects affect Ban Thad, as opposed to just PDA projects. The paperwork we obtained gave us detailed information about the pipe water system and proposed projects. The government office was also better able to answer questions about land ownership and water rights than the PDA staff or the village.

3.4 Developing Recommendations

The final step of our method was the synthesis of all of the data gathered from the community into a concise set of recommendations for the PDA's future work in the village. By using a combination of our own independent analysis and the community's analysis of potential solutions through a PRA-style options chart, we were able to form conclusions which effectively combine past research and the village's needs, abilities, and existing resources.

3.4.1 Independent Analysis

Performing some initial synthesis and analysis outside of the community allowed us to begin forming conclusions based on both community data and past research, as well as allowing us to synthesize the results of many individuals' data more objectively than a villager might have been able to easily. We began by organizing interview summary data by subject (see later interviews in Appendix B). This was an effective way for us to compare interviews and find the underlying social themes and issues in Ban Thad. This approach differed slightly from typical coding techniques in that it allowed us to keep closer to the original statements when synthesizing the data. Since we had a relatively small sample size of interviews and they we not as standardized as a less time constrained study might have allowed, the flexibility of this approach was more appropriate to our project than a more rigid coding scheme might have been.

Synthesizing data into problem analysis charts (see figures in Chapter 4) proved to be an effective way to summarize villagers' thoughts. Problems analysis charts, also called problem tree analysis or situational analysis, are structured representations of various problems, their effects, and their causes (Overseas Development Agency, 2009). These charts are a well-developed planning tool used by development agencies to find solutions through ordered examination of causes (Overseas Development Agency, 2009). The benefits of problem charts most applicable to our project include the following:

- They enable the problem to be broken down into manageable, defined sub-problems.
- Dealing with the problem through the different sub-problems allows for a clearer prioritization of factors and a subsequent focusing of objectives.
- Greater understanding of the problem and its often interconnected and even inconsistent causes is obtained.
- They identify the principal issues, arguments, and agencies involved in the problem.

- They clarify where further evidence is needed to understand the problem or develop an effective solution

(Overseas Development Agency, 2009)

These charts were valuable in our analysis because our goal was to focus our recommendations according to the prioritization of concerns in the village. The charts help to drive much of the analysis in Chapter 4 and formed the basis for choosing which options to focus on during our analysis with the community.

3.4.2 Community Analysis: The Options Chart

Though our independent analysis as outside researchers was important, returning to the community to verify, validate, and discuss our conclusions was a vital step in emphasizing the final responsibility of the community in managing future developments. Involving the community not just in the data gathering phase but in the analysis and solutions development helps establish a final sense of community ownership in the project (Save the Children/Armenia, 1995). This was especially important as the research in the village itself was concluding. We wanted to ensure that the village would maintain an interest in working with the PDA to implement our recommendations even after we left.

We used a PRA-style options chart activity to facilitate community analysis of different water development options in the village (for a precise review of the activity, see Appendix D). The villagers were already fairly clear about which solution they liked best; the chart was an effective tool for helping villagers to organize their thoughts and reasoning for *why* they liked or did not like particular solutions. The chart is meant to allow people to assign scores to potential options in categories such as sustainability, equitability, and cost. This figure below is a recreation of a traditional options chart from Ford et al.'s 1992 water development project in Gambia – the column abbreviations refer to sustainability, equitability, productivity, stability, and cost, respectively.

OPPORTUNITY	SUS	EQU	PRO	STA	CST	SUMMARY
Option #1 Construct Borehole	0	+ +	+ +	+ +	- -	**4**
Option #2 Rehab Well w/o pump	+ +	+ +	+ +	+ +	+ +	**10**
Option #3 Area Council Well nopump	+ +	+ +	+ +	+ +	+ +	**10**
Option #4 Rehab Action well w/pump	- -	- -	- -	- -	- -	**0**
Option #5 Rooftop tank (rehab)	0	0	+ +	+ +	- -	**3**

Figure 6: Traditional Options Chart (Ford et al., 1992)

Encouraging people to consider each option's pros and cons in specific categories, rather than generally, was intended to help avoid an issue we had identified in interviews: villagers tended to latch on to a single good or bad point of a particular solution, even when it had some important disadvantages. For example, villagers tended to initially dismiss building more ponds outright, but after the activity many accepted that they could be viable solutions in fields far away from central water distribution points.

Appendix E shows an English translation of the options chart we presented to the villagers. The wording is simpler than in the example from Ford et al., and it includes only three possible scores instead of five. The columns have also been slightly adjusted to better fit the requirements of Ban Thad. When we discussed the original, more complicated chart with the PDA staff, they were certain that the villagers would have a difficult time understanding the chart and would not be able to fill it in as we intended. The detailed numbers of +s and –s were not the most valuable part of the chart, so we had no issue with modifying them. The value in the chart activity was not the final numbers; it was the community discussion of the concrete pros and cons of each option.

The organizational changes we made based on the mapping results to encourage participation were very effective. Unlike the original mapping activity, enough people participated in the options chart activity that we believe it to accurately represent the ideas of the community as a whole. We organized the activity to occur in the late morning of a weekday, after most people were finished watering their crops but before children had a chance to return home from school. The mapping activity taught us that

Figure 7: High Participation at the Options Chart Activity

weekends were generally considered to be for *sanuk* (fun), not work. But weekday afternoons were scarcely any better; when we went around to individuals during the mapping activity asking them to come join us, most of them told us that they were busy with their work or their children. We therefore chose a time that would avoid both as much as possible. We also offered lunch to everyone that came, though only a third of the participants stayed to eat with us. We had expected this to be the deciding factor in encouraging participation, but since so few people stayed for lunch, we are forced to conclude that the other factors were more important in encouraging participation. Approximately 45 villagers participated in the activity in total. Regardless of which factor caused such a massive participation improvement from the last group activity, 45 villagers is a sufficient sample size to represent the village as a whole, especially given the wide variety of genders and occupations we found represented.

We believed that it was unlikely that we would have any other successful large group activities before leaving, given the aversion to frequent community meetings discussed in Section 3.2. Because of this, we used the time while people were assembling and after the main options chart activity to have villagers mark the location of their farms on a map. The map, pictured at right, gives a concise view of where individual land is located. One of our key recommendations involved ensuring that as many individual fields as possible could easily connect to any new water development systems. Thus, it was important that we be able to identify where these individual fields are so that new systems can

Figure 8: Map of Ban Thad's Farmland

actually be placed in a central location. However, we found that official maps of land ownership do not exist within the village or the local government office. Since there are no official resources for this information, the villagers themselves are the most accurate source of this information available. Many villagers could not read maps, so we asked them specifically where their land was in relation to the meeting place. Some villagers marked the location of the farms belonging to their friends and neighbors so we would know even more about where the farmland is.

We believe that the map is complete enough to be used to place new water resources in a way that is fair to the entire village. In all, over 100 plots were identified. Between our assistance and the help of other villagers, we were able to map the locations of not just every participant's land, but the land of nearly the entire village. We estimate that the map identifies contains the overwhelming majority of the village's land, since it marks nearly as many plots as there are households in Ban Thad.

In the original mapping activity, we found that one person was able to dominate discussion and writing. We successfully avoided this in the options chart activity by splitting the large group into several smaller groups, each with their own options chart. Afterwards, we summarized the results from the different groups and discussed them with the group as a whole. There were six groups of people, each of which generated at least one chart. This provided a good balance of discussion within groups and discussion between groups. There were enough people in any one group that they could talk about and combine different peoples' opinions. But there were also enough different groups that we could help facilitate this discussion by using the different options charts even if every individual group picked a single leader like we saw in the mapping activity. Some groups did exhibit this "single leader" mentality, but others discussed and filled in the charts as a group. Dividing into smaller groups as we did proved to be an excellent means of allowing as much group discussion as possible, even in the presence of these leader individuals.

Despite having simplified the options chart from those typical of PRA literature, the villagers were universally confused by the activity. It was difficult for us to address the groups' confusion, since there were fewer Thai speaking researchers than groups. This was disadvantageous because it largely prevented us from listening in on the intergroup discussions. We were forced to rely more heavily on the written results of the options charts than on the discussion about them when discussing the summaries with the whole group. This somewhat limited the richness of the discussion, since the large group was unwilling to volunteer ideas beyond what we brought up based on the chart. Even with extensive individual attention, no group succeeded in filling out the options chart as intended. It was obvious that even though the villagers had ideas about the pros and cons of the solutions, they had a hard time articulating them in a chart. It might have been more effective to assign a researcher to each group to fill out the chart based on discussion, instead of having the groups fill in the charts directly.

Even despite this confusion, the activity was successful at facilitating an in-depth community discussion of the pros and cons of different development options. Many groups wrote text describing what they thought of their preferred option in each of the categories provided. This was actually more useful in determining what was important to the villagers than the simple 3-option idea we had suggested. Using text-based charts from the beginning would have been just as useful at encouraging discussion, and would have been much easier to explain to the villagers. The charts themselves may not have turned out as planned, but between the open-ended textual responses we received and the community discussion during the activity, the options chart effectively defined what projects the community was interested in and why. Because the ideas came from the community as much as ourselves, we believe that the findings and recommendations in the following chapters represent developments that would not merely be acceptable or fitting to Ban Thad, but embraced by Ban Thad as its own.

3.5 Reflections on the Participatory Approach

We initially chose to center our research methods on a participatory approach because the enthusiastic involvement of the community was vitally important to our project. Our project is focused around the idea common in similar research projects and past PDA work that the cooperation and involvement of the community is the most important factor in determining whether a development project can succeed in the long term. The community is ultimately responsible for the oversight, maintenance, and usage of its projects, so there can be no sustainable success without their support.

Although our initial attempts to apply PRA methods in Ban Thad were less successful than we had originally hoped, we were still able to successfully apply participatory principles even in a more individualized setting. The information we were able to gather using these methods is presented in Chapter 4, which explains the current state of Ban Thad's water resources and the influence of a variety social factors underlying Ban Thad's economic and water issues. Chapter 5 explains the potential solutions that we and the villagers jointly suggested and analyzed, as per section 3.4; the final conclusions and recommendations presented in Chapter 6 build off of this analysis.

4 Existing Resources and Concerns in Ban Thad

The goal of this project is to provide recommendations for future development which are socially, economically, and physically feasible in Ban Thad. The first step in determining which solutions satisfy these constraints was determining what these constraints actually were; that is, what factors would determine the success or failure of any new project in Ban Thad. These criteria for success, as established by the villagers, form the basis for our choices of potential solutions to focus on in Chapter 5 and in the analysis and comparison of the solutions with the community that form the basis for our final recommendations in Chapter 6.

This chapter begins in section 4.1 by identifying the key social barriers that have hindered past attempts at water resources development in the village and have led to some of the village's current issues. The most significant of these include the high average age, low average education level, and strong aversion to personal debt. With these overarching social issues established, Section 4.2 begins to identify the current state of agriculture and income generation in the village. It explains what practices are currently prevalent and how the social factors identified in Section 4.1 have driven these current conditions. It also identifies several income generation strategies that have been effective in other villages in the area and provides a brief analysis of how the social dynamics of the village might affect attempts to implement them in Ban Thad. This analysis serves to confirm the justification from Chapter 2 that improving access to irrigation is likely to be the most immediately effective means of improving income generation in Ban Thad.

Section 4.3 serves as an evaluation of the water and agricultural resources currently available in Ban Thad and how they are utilized. In particular, the existence of a large surface water body in Ban Thad provides the potential for improvements in the community's ability to access water. Section 4.4 concludes the section by analyzing the issues and concerns of the community with these existing systems. These include both the physical and environmental barriers of the existing systems and how the issues the locals

defined link back to the general social barriers identified in Section 4.1. The specific water access problems identified in this final section, along with the implications the underlying social dynamics have for the implementation of these solutions, form the basis for the choice of solutions presented in Chapters 5 and 6.

4.1 Social Barriers to Change

Ban Thad faces may social barriers that it will need to account for when pursuing opportunities to develop new improvements. In no particular order, Ban Thad is challenged by the lack of youthful energy, unwillingness to expand agricultural ventures, and lack of education regarding accounting and planning. An analysis of these findings is shown in the problems analysis chart below. The chart lists the primary social barriers faced by the farmers of Ban Thad with corresponding causes and ideal actions for each. The middle column highlights the causes associated with each corresponding challenge. The column to the right indicates general actions that can be taken to improve the challenges.

Social Barriers to Change in Ban Thad		
Challenges	***Causes***	***Actions***
Lack of energetic youth results in less initiative and weaker labor force	• Urban migration of young	• Convince younger generation to return • Make village an attractive place for youth to live • Increase income generation potential
Low levels of income and fear of increased debt inhibits agricultural expansion	• Lack of economic foresight • Some institutions have high interest rates • Villagers have seen others get into debt • Villagers have been in debt themselves	• Encourage low interest loans and access to credit. • Provide education on accounting and how to manage risk and benefits
Low level of (accounting) education hinders long-term planning	• Little government required education • School expensive	• Educate on a small scale • Hold seminars for community • Use low-tech solutions

Figure 9: Problem Analysis Chart (Social Barriers)

A variety of interplaying forces contribute to these challenges and expressing them in a linear matter is a challenge in itself. Since urban migration, fear of debt, and current education levels are ingrained in the culture of the village, the actions presented in the chart are not necessarily feasible or likely to result in any immediate, apparent improvement. Nevertheless, these obstacles should be evaluated with great attention, as they are the ultimate obstacles inhibiting rural development in Ban Thad.

The first challenge is that the urban migration of youth out of Ban Thad during the dry-season limits the development potential of the village. In Isaan, most of the rural youth that finish school migrate out of town for advanced studies, employment. Many times the farmers remaining are at least in their late thirties or forties (Prapertchob, 2001). In Ban Thad, the majority of the dry-season demographic is over 50 years of age. The decreased workforce caused by the shortage of youth in villages contributes to a lack of energy and willingness to adopt new agricultural initiatives (Prapertchob, 2001). Without the vitality and support of the village youth, residents are less likely to develop their own significant improvements. Therefore, assistance from organizations such as the PDA is a crucial step towards ending the pitfalls of village disempowerment.

The amount of labor and diligence necessary to adopt new agricultural practices such as cricket farming and vegetable gardens may be too overbearing for the remaining farmers in Ban Thad. In 2005, the PDA helped established a cricket-farming cooperative among many others. Five farmers started the program but at the time of this research project only one was still breeding crickets. A similar trend has showed up with farmers' attempts at growing vegetable gardens. According to two of three successful dry-season farmers in Ban Thad, the work required in maintaining the vegetables was too much for farmers to handle so they quit the venture all together. Both farmers cited their willingness to teach others to grow vegetables, but had doubts on how successful this would be. One of the farmers already tried this and stated that no matter how much he tried to share his knowledge it was ultimately up to the farmers to put in the effort. These doubts point to possible reasons that we encountered resistance to agricultural change. If the villagers do not fully understand the potential of high-value crops and if they enter a project

without basic accounting knowledge, then it is highly probable that proposed changes to their agricultural practices will wither from lack of interest or continued effort. Therefore, it is important to realize the community's abilities and willingness before implementing new practices or systems that may require them to work beyond their current levels of comfort.

Before advising farmers to expand their agricultural production, it should be ensured that there is sufficient access to credit. The existence of a Village Bank that provides low interest loans provides hope for increased investment for farmers that are eager to expand their agriculture. Loans that are typically made widely available are quite predatory and in fact can result in an interest that exceeds the amount of the loan itself. In order to combat the high interest loans that prevent farmers from capitalizing on investment opportunities, the PDA helped establish a Village Bank in Ban Thad. The Village Bank is willing to offer low-interest microloans (of up to 10,000 THB at as little as 0.5% APR) to community members who invest in it regularly. Access to credit at lower interest gives determined farmers the opportunity to diversify their agricultural practices and generate more income.

Despite the existence of the Village Bank, concerns regarding existing debt are apparent in Ban Thad. As discussed in Section 2.1, the average farmer in Isaan is 105,006 THB in debt (Charoenpun, 2008). This large amount of debt stems partially from the high interest rate loans (Konboon et al., 2001). Although most villagers in Ban Thad did not openly express to us their specific financial concerns, our background research and informal conversations with Isaan locals gave us reason to believe that debt in Ban Thad was more widespread than stated by the community. In Ban Thad specifically, four farmers mentioned that debt was a major issue and two of these farmers elaborated that their debt was from agriculture. One of the farmers volunteered to provide the amount of his debt- 50,000 THB. This farmer's debt suggests that he will be unable to take risks in new crops without either extensive educational training or another non-agricultural form of monetary aid.

Existing debt means that farmers will be less willing to take out new loans for an agricultural project. During an interview, one farmer concisely spelled out the problem of the effects of debt, explaining that since she already has debt and does not wish to expand her agriculture because it would require her to borrow more. Fear of debt is one reason that some residents in Ban Thad migrate to seek dependable, non-agricultural jobs in urban locations and elsewhere. Since agriculture is a fundamentally risky venture, increasing farmers understanding of the risks and benefits of new ventures can help avoid the pitfalls of debt and help realize greater profit.

The current methods that farmers use to account for agricultural profits are quite rudimentary and do not include much foresight. According to the 1998 Labor Force Survey by the Thai National Statistical Office, most of the labor force in Isaan has a level of education at or below the primary school level (Prapertchob, 2001). From observations and interviews conducted in Ban Thad and in surrounding villages, it was apparent that a majority of farmers practiced agriculture through basic methods passed down from their family or friends. In Ban Thad these practices have shown some success in areas such as rice cultivation, but have not been as successful when applied to relatively new ideas, as shown in previous unsuccessful attempts at dry-season vegetables and cricket farming. This lack of planning makes it hard for them to see the risks and benefits associated with starting new agriculture, and increases the likelihood of failure. Therefore, introducing education on accounting methods and long-term cost-benefits can help farmers mitigate their fear of debt and reluctance to pursue new agricultural ventures while also enabling them to chose crops with labor requirements that they feel are appropriate for them.

4.2 Income Generation

As discussed in Section 2.1.1, agriculture is not only a way of life but is also a significant source of income for people in Isaan. This section will start by evaluating the traditional rice crop and current methods of income generation in Ban Thad with discussion on the social significance of the second

harvest in Ban Thad. The following section will highlight agricultural, as well as non-agricultural, practices that are potential future sources of income in Ban Thad.

4.2.1 Current and Traditional

The people of Ban Thad rely heavily on the single harvest of rice during the wet season as their primary source of income. All landowners in Ban Thad grow rice in the wet season and gain the majority of their income from it. The traditional practice of rainy-season rice cultivation and harvest is strongly ingrained in the culture of the village and the low amount of labor required to maintain the crop is appealing to farmers, as well as the reunification of families that occurs with the yearly harvest. As mentioned in the beginning of the Literature Review, the production of rice is a prominent economical and social aspect of life in northeast Thailand but the unreliable climate in the region makes relying on a single harvest an unstable economic practice. Therefore, although there is a traditional and social focus on the rainy-season rice crop, some diversification is necessary to avoid low yields and capacity to generate income.

A second rice harvest during the dry-season would provide economic benefits to the people of Ban Thad. Government incentives encourage its production and middlemen are willing to purchase rice from the villages to sell in the market. Farmers in a village nearby Ban Thad experienced increased levels of income after gaining an irrigation system that enabled a dry-season rice harvest. The majority of farmers we interviewed where not actively growing any crops so enabling a second-rice harvest would provide farmers in Ban Thad with an exceptional source of income during a time when money is scarcer. Although there are great benefits to be achieved from a second rice harvest, it can only be made possible with abundant access to water, which is a topic that will be discussed in the following sections of the chapter.

Although quite a challenge to achieve, solutions that can enable the second rice harvest would be met with much villager support and interest. Many villagers we interviewed identified a second rice crop as

their favored option if they had more water. The villagers' discussions during the options chart activity indicated that their choices of water systems were influenced by the degree to which the systems could make a second rice harvest possible. Growing and maintaining a rice paddy requires minimal physical labor. This eases the burden on the grandparent generation that makes up the majority of the village demographic during the dry season and has shown resistance to adopting agricultural practices that require a lot of labor. The sowing and harvesting of rice are labor-intensive activities, which the youth usually return to Ban Thad to help with. Another rice harvest could serve as a means of bringing the family together and possibly mitigating future rates of outward migration.

People who live in Ban Thad during the dry season have become partially dependent upon income from children and relatives who have migrated to cities. According to the headwoman of the village, in the dry season, 70% of the village leaves to find other employment in urban areas such as Bangkok, while 20% of the village is gone the full year. Out of 10 families we interviewed, 8 of the families reported that at least one member of their immediate family working away from home. 9 of them were working in Bangkok, 1 in the nearby city of Khon Kaen, and 4 in other urban areas in Thailand or abroad. Figure 10, below, illustrates the prevalence of urban migration in Ban Thad during the dry-season:

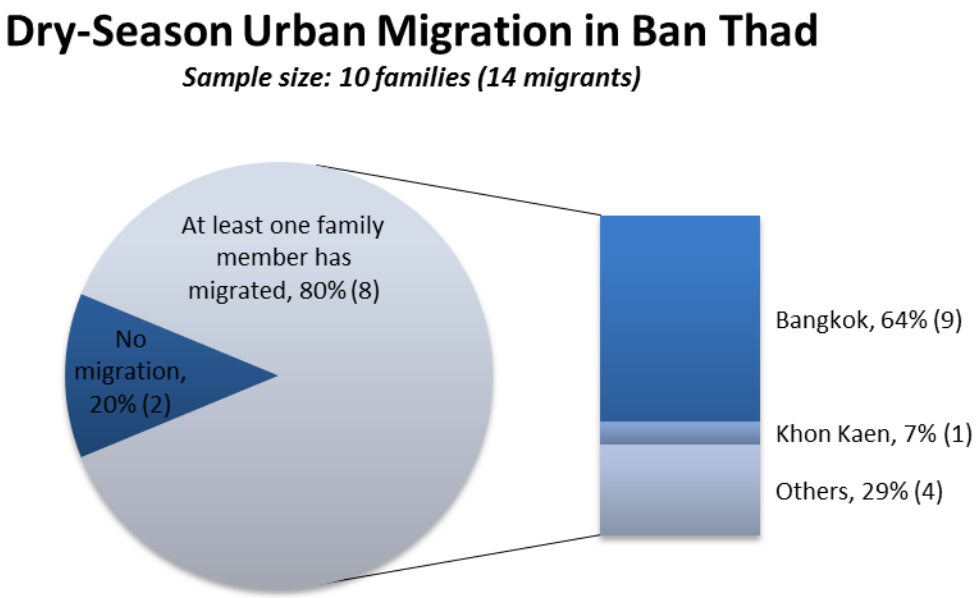

Figure 10: Dry-Season Urban Migration in Ban Thad

A second rice harvest during the dry-season would provide both economic and social benefits to the people of Ban Thad. Government incentives encourage its production and middlemen are willing to purchase rice from the villages to sell in the market. Farmers in a village nearby Ban Thad experienced increased levels of income after gaining an irrigation system that enabled a dry-season rice harvest. The sowing and harvesting of rice requires a lot of labor, which the youth usually return to Ban Thad to help with. Another rice harvest could serve as a means of bringing the family together and possibly mitigating future rates of outward migration.

Solutions that can enable the second rice harvest will have by far the most villager support and interest. Many villagers we interviewed identified a second rice crop as their favored option if they had more water. The villagers' discussions during the options chart activity indicated that their choices of water systems were influenced by the degree to which the systems could make a second rice harvest possible. Growing and maintaining a rice paddy requires minimal physical labor. This eases the burden on the grandparent generation that makes up the majority of the village demographic during the dry season and has shown resistance to adopting agricultural practices that require a lot of labor.

4.2.2 Alternatives to Rice

The traditional practice of rice cultivation is heavily dependent on available irrigation. Potential irrigation systems have varying levels of productivity, and are able to support different crop types. However, other sources of income generation exist that are independent of, or less dependent on irrigation systems.

Matt weaving may provide additional potential for improved income generation in Ban Thad if group organization is achieved. There is currently an unofficial matt weaving group in Ban Thad, but there is not a cooperative in place that would allow their mats to be sold. Currently, mats are not sold outside of the village, which is where their greatest potential for profit lies. If they tried to sell their mats they would have to work through a middleman that would inevitably reduce the profit potential of the mats. Therefore, improving available markets and encouraging the development of a matt weaving cooperative can help introduce a new source of income during the dry season, which may help alleviate future rates of urban migration.

With greater education, farmers in Ban Thad willing to invest their time would be able to increase their income through cricket farming. According to Dr. Krailert of Khon Kaen University, cricket farming can be very profitable if proper care and breeding practices are followed. There is no water required to breed or grow crickets, meaning there are no additional water fees associated with this practice. Since they can also be raised under houses with no required farmland, growing crickets would not interfere or replace any existing crops. The ability to generate income without significant land or water costs makes it an attractive option to those villagers who want to minimize initial investment risk. According to Dr. Krailert, Cricket farming has failed in the past in some villages due to inbreeding and lack of education of how to prevent inbreeding. Therefore, in order for cricket-farming to be implemented as a successful source of dry-season income, proper education on inter-village breeding programs is required.

If an irrigation system could supply water at a low cost in Ban Thad, but not at low enough a price to grow the desired second rice crop, field crops such as corn have potential as a socially compatible means of income generation. Corn is a crop commonly grown in irrigated areas of Northeast Thailand (Srisuk et al, 2001) and growing it does not conflict with the growing season of the first rice crop (Rujirawat, 2011).This is important since crops that conflict with the rice-growing season would not be appropriate in Ban Thad since they could not be grown in rice paddies, the village's dominant and preferred type of farmland. Corn only needs to be watered every three to five days, with the exception of its first week of planting where it requires water every day (Department of Agricultural Extension, 2006). This is significantly less than the needs of vegetables. Thus, field crops tend to be less labor intensive and more socially appropriate than vegetables. A PDA staff person very familiar with the local area and village recommended corn as a good option if an irrigation system was built. The recommendation of corn by a staff person familiar with the area suggests that this option would be appropriate in Ban Thad specifically. The headwoman of Ban Thad also reported that villagers, though preferring a second rice crop, were also very open to the idea of cultivating corn in the dry season. Villager willingness to raise corn favorably suggests that this crop is a highly socially appropriate option.

While vegetable cultivation in Ban Thad faces many of the social barriers developed in Section 4.1, it can still be utilized by farmers in the case that irrigation is insufficient or too expensive for more water-intensive rice or field crops. Small vegetable plots successfully grown by two farmers in Ban Thad require watering twice a day for an hour at a time. The farmers report that they water the plots every day from 5:00am to 6:00am and 3:00pm to 4:00 pm. These farmers are the most ambitious in the village, and so this amount of work may be considered to be too great a time commitment by other villagers in Ban Thad. To water the vegetables, these farmers carry large, heavy watering cans. As Dr. Krailert of Khon Kaen University points out, such a task may be beyond the abilities of seventy-year-old farmers. Since much of Ban Thad's dry season population is of the grandparent generation, vegetable production would likely not be feasible for everyone if the crop were watered by hand. However, if an agricultural water

system were implemented in conjunction with an in-field irrigation system such as drip irrigation, labor needs could be reduced, and vegetables could become feasible in Ban Thad.

If farmers constructed ponds as part of an implemented method of supplying water for agriculture, fish could be used raised in Ban Thad to generate income. Ponds can be constructed in rice paddies, and in fact Dr. Polthanee of Khon Kaen University, recommends conversion of a portion of a rice paddy into a farm pond. Since Ban Thad's farmland is nearly entirely composed of rice paddies, fish raising is highly compatible with the village's land. Researchers Ruaysoongnern and Suphanchaimart affirm that small scale fish raising can "provide household food and small cash income in addition to supporting mutual cooperation among farmers." One hardworking farmer in Ban Thad who also cultivates vegetables reported that he currently raises fish in a pond he dug. This proves that farmers in the village can successfully raise fish. However, since this farmer is particularly hardworking, this option is not necessarily feasible for all farmers in Ban Thad.

4.3 Existing Water Resources

This section discusses the physical and social water resources available in Ban Thad, answering our first research question. Before any future projects can be planned, it is important to know what resources and infrastructure currently exist and how well they are working so that any future work can build upon what is already there. Existing water resources include:

- Water jars and small household rainwater tanks
- Groundwater
- Lake La-wa
- Government domestic piped water system
- PDA water storage tanks

Understanding what water sources and systems are in place, as well as the resources that locals are familiar with and capable of operating and maintaining, allowed us to identify areas of focus for interviews with individuals. These findings served as a foundation for assessing the concerns of the villagers and developing recommendations with them.

Water jars and small household water tanks collect rainwater in the wet season and provide a sufficient quantity of year-round household water for the residents of Ban Thad. 97% of residents in rural Thailand have reasonable access to improved water sources. The World Health Organization (WHO) defines "reasonable access" as the availability of at least 20 liters per person per day from a point within one kilometer of the consumer's residence (WHO/UNICEF, 2008). The village of Ban Thad is also representative of these figures. According to the village's headwoman, with the exception of a minimal number of residents who get water from the nearby temple, all households have year-round water for drinking, cleaning, and cooking. During all interviews and meetings community members expressed satisfaction with the quality and quantity of their household water supply. Not only do the villagers have reasonable access as defined by UNICEF, their apparent satisfaction with the system suggests that drinking water is not a concern. Therefore, we were able to focus on research, not on drinking water but on water for agricultural income generation

Farmers in Ban Thad are unable to use groundwater as a viable water source for agriculture because of the high levels of salt it contains. The abundance of salty soil in northeast Thailand, as well as the adverse effects it has on the groundwater of the region, is a well-documented challenge and was discussed in section 2.2.1 of the Literature Review. Problems with salty soil in Ban Thad are evident in the crop damage caused by the high salinity in the groundwater of the village's previous distribution system. Even when the quality of groundwater is found to be suitable for agriculture, it is not always desirable to use because of the risks of overdrawing and lowering the water table (Srisuk et al., 2001). This was found to be true in the nearby village of Ban Nong Preuk, where after only two years of using a groundwater system the water potential and discharge was noticeably less. There is now discussion on switching to a

more reliable surface water source in the future. This demonstrated to us the importance of long-term planning in water resource development, and the need to include it as a topic in our recommendations.

Nearby *Lake La-wa* is a significant water source for the village of Ban Thad and its surrounding villages. The lake is used as a water source for the government pipe system that serves Ban Thad and the five neighboring villages. The government pipe system feeds into individual households for domestic use besides drinking water. Therefore, the lake water is the major source of domestic water for not only Ban Thad, but five other villages. Although Ban Thad is the closest village to the lake, our mapping activity indicated that the vast majority of farmers' land is located at a distance and elevation that requires a distribution system to irrigate their individual plots. The issue of water access was identified as a crucial concern to farmers in Ban Thad and will be discussed in further detail in the following section.

4.4 Challenges with Water Access

Villagers in Ban Thad face many challenges regarding water access. These challenges are very diverse and include physical limitations of geography and different systems, economic restrictions, preexisting perceptions, and significant social barriers. The beginning of this section will present a problem analysis chart which provides an overview of water access issues, concerns, and causes. It also lists types of actions needed to overcome the problems. A detailed discussion of the major findings of water access challenges will follow the chart.

The problem analysis chart shown in Figure 11 on the following page examines the problem of lack of water for dry season agriculture. It at the top it lists the current overarching challenges of trying to obtain water in Ban Thad. The two leftmost columns list the sub-problems and their corresponding causes. The third column lists potential actions that can be taken to in order to address the causes and ameliorate the sub-problems.

***PROBLEM*: Farms do not have access water for dry-season agriculture**		
Overarching Challenges	• No significant rain in dry season • Groundwater is beneath farms but too salty to use • The surface water (lake) too far away for most farms to use directly • Use of the two PDA water tanks next to lake is limited to adjacent farmers only • The government piped water system is the only lake water distribution system, but only two farms are connected to it	
Sub-Problem	***Causes***	***Actions***
Villagers believe current gov't water price is expensive	• Government system has fixed water price that is too high to make a profit if growing water-intensive crops	• Grow crops that have a high ratio of value to water demand • Create a new water system that charges a lower price for water • Dig individual rain-fed ponds for an alternative source
Villagers unwilling to connect to gov't water	• Connecting to the system is expensive, especially for farms the furthest away • Villagers unwilling to take out the necessary loans from village bank- don't want debt	• Bring community pipe lines closer in order to lower the connection costs • Subsidize connection costs • Make loans an acceptable risk
All villagers cannot connect to the gov't water system	• The gov't water system does not have enough capacity to handle too many large agricultural water demands.	• Help a limited number of individuals connect to the gov't system • Help implement individual solutions such as rain-fed ponds • Create a new community water system with greater capacity to bring water from the lake to the farm area, and then help individuals connect to community system

Figure 11: Problem Analysis Chart (Water Access)

The first major barrier listed above is the expense of the water from the village's existing government pipe system. All farmers interviewed claim that the 6 THB/m^3 price of water from the government system is "too expensive," and six out of nine cite it as a reason for not doing dry season farming. The rough cost analysis for the water requirement of a second rice crop found in Appendix E confirms that farmers cannot make a profit if they irrigate their paddies with water from the 6 THB/m^3 piped government system. Although the major problem in Ban Thad is getting access to water in the fields, doing so through the existing central pipe system will be too expensive if rice is grown. Future irrigation systems would need to ensure that they can keep user costs low enough for villagers to still make a sufficient profit from agriculture. Not doing so would perpetuate many of the challenges already faced by the population, such as rising debt motivating economic migration to urban centers.

Villagers tend to perceive the current water cost as "too expensive to use", even when the expense of water is much lower than the potential profit from using it. It is often not the price of water but the *perception* of the price that stops its adoption by villagers. Two men and one woman in Ban Thad are able to use the government water and make a profit. They simply grow crops that use less water than rice. While the cost of water may be perceived as very expensive, it is not prohibitively so for all types of crops; high-value, water-efficient crops can in fact be profitably cultivated with government water, as these successful farmers have shown. A plausible explanation for why people think the water is too expensive is that the previous water system costs only 2 THB/m^3, as opposed to the current price of 6 THB/m^3. In the case of rainwater during the wet season, rural farmers as a whole are accustomed to the idea that water is free, so their claim that water is expensive is likely relative to what the cost used to be, or what they think it should be. This perception is further evidence for the aversion to change that was discussed in section 4.2.1. This also reinforces the theory that education is a major underlying issue in Ban Thad. Even though there are profitable ways of using the water at the current rate, villagers tend to dismiss the ideas because the cost of water is "too high." However, expense is a relative quantity and villagers have demonstrated that they have a hard time understanding that costs could be economically acceptable even though water costs may seem to be high. For this reason, any proposed irrigation project should make sure to address this social barrier through explanation and interpretation of the price charged for water.

The chart also reveals that one of the most crucial factors limiting access to water is the difficulty of connection to water resources due to distance and the associated expense. The lake (Kang La-wa), the government piped water system, and the two PDA tanks all exist within Ban Thad, but are too far away for most villagers to make use of for agriculture. All farmers without irrigation say they do not have water because the water simply is not there and that they are too far away from potential sources. This obstacle can be overcome by a few people in the village as was demonstrated by one farmer 500m away from Kang La-wa who built his own personal water system to bring water from the lake to his mango field.

Unfortunately, over 95% of Ban Thad's fields are further away from the lake and would have a much harder time getting water in this manner. The PDA tanks that were installed in the village for agriculture have been of limited usefulness given that only the handful of farmers with land adjacent to the two PDA tanks are able to use the water they contain. Currently, only three farmers in Ban Thad have found a way to irrigate their land on their own, and all three have the special advantage of being in close proximity to water sources. Future proposed irrigation systems would need to make sure that their distribution systems extend not just to general farming areas, but also within an economically feasible connecting distance of the different farms.

The underlying reason that distance to the central line is such a concern is that it makes connecting an individual farm to the water system prohibitively expensive. The two farmers who connected to the government system paid 2,000 and 2,500 THB each, but their vegetable plots were only located approximately 15m away from the pipeline. Most farms are considerably more than 15m away from the pipeline, and would incur correspondingly higher connection costs. Even 2,000-2,500 THB is often the better part of a farmer's monthly gross earnings, and would represent a significant financial risk. As section 4.1.2 explained, we cannot expect farmers to be readily willing to make this kind of investment on their own. Their fear of debt limits their ability to make use of community-level systems without outside aid. It is therefore possible that reducing or subsidizing this individual cost could help spur the adoption of irrigation for dry season agriculture.

Finally, the last row in the chart reveals that irrigation systems must be designed with a capacity sufficient for intended crops. While two farmers successfully irrigate their vegetable plots with water from the government system, the system cannot support very much additional agricultural demand. The chief reason villages named the government system a bad alternative at the options chart meeting was because the system has to support four villages in addition to Ban Thad and would not be able to give them domestic water as well as give enough water for agriculture in Ban Thad. That capacity limitation is especially apparent because rice, the current preferred crop of Ban Thad, is extremely water intensive, and

growing it would thus require an irrigation system. The water requirement for a rice crop would be unsustainable using the government system.

5 Analysis of Potential Water Resource Development in Ban Thad

Four different potential solutions, listed below in order of villager preference, offer viable ways to provide water for irrigation to farmers in Ban Thad:

(1) Water gate – solar cell power

(2) Water gate – electric power

(3) Individual ponds

(4) Expansion of the government system

These options utilize different opportunities, and vary in terms of productivity; feasibility; and social, economic, and environmental considerations. In this chapter, an options chart leads analysis by comparing the potential projects. A discussion of the chief benefits and limitations of the project follows, and preliminary conclusions are drawn that conclude a solar cell-powered water gate system is the most socially appropriate option for Ban Thad, followed by an electric water gate system, individual ponds, and lastly expansion of the government system.

Figure 12 analyzes these four options in terms of the following categories across the table: productivity, implementation, equitability, social change, cost, economic sustainability, sponsorship, environmental impact. These categories have been adapted from other work with Participatory Rural Appraisal by Ford et al., with some additional categories that have specific relevance for Ban Thad. Reading the chart down the columns will allow one to compare and contrast the different choices. The four choices are listed in order of villager preference.

OPTIONS CHART: Improving Access to Water for Agriculture								
	Productivity	**Implementation**	**Equitability**	**Social Change**	**Cost**	**Economic Sustainability**	**Sponsorship**	**Environ-mental Impact**
Water Gate - Solar Cells **#1 by Villagers**	High potential- pump capacity limited by available light, amount of cells	Easy- associated company would implement at community level	Potential for good equitability- design dependent	Requires management group, may require new (non-rice) crops in dry season	System is the most expensive, but low PDA usage cost	Questionable- long-term maintenance of solar cells may be problem; water gate maintenance may be significant	Marketable- water/ renewable energy is good for public relations; sponsorship needed	Minimized contribution to climate change barring manufacture, little impact to surface water resources
Water Gate - Electricity **#2 by Villagers**	Very high potential- limited by pump capacity	Easy- associated company would implement at community level	Potential for good equitability- design dependent	Requires management group, may require new (non-rice) crops in dry season	System is expensive, but low PDA usage cost	Relatively easy to maintain electric source- known technology; water gate maintenance may be significant	Marketable- less expensive than solar cells, water development is good for PR; sponsorship needed	Little impact likely to surface water resources, negative climate impact from power source
Individual Ponds **#3 by Villagers**	Moderate potential- limited by size, but can profit from efficient crops	Easy- low tech, known technology, but difficulties if implemented at individual level	Equally available to all dependent of location	Requires new (non-rice) crops be grown in dry season	Varies by size- small ones relatively affordable	Very easy to maintain- very low tech	Less likely but not strictly needed- at the individual level	Negligible negative impact, may create habitat
Expanded Government System **#4 by Villagers**	Extremely limited by system capacity	Moderate- known technology, but difficulties if implemented at individual level	People further away are at disadvantage	Requires management group, requires new non-rice crops in dry season	Too expensive for most individuals to connect	Relatively easy to maintain- known technology	Unlikely- not a widely viable option; not strictly needed	Minimal impact likely to surface water resources, negative climate impact of power source

Figure 12: Options Chart of Potential Water Resource Development in Ban Thad

Key highlights of the chart are listed below:

- Rankings: Note the villager's *rankings* of the options, listed in the first, leftmost column. In order of preference, most people want a solar-powered water gate system, an electric water gate system, individual ponds, and lastly an expanded government system.

- Water Gate – Solar Cells: All the categories for a solar water gate project have positive or neutral remarks, barring *economic sustainability*.

- Water Gate – Electricity: An electric water gate project fairs better in *economic sustainability* than does a solar water gate project, but does worse in the *environmental impact* category.

- Individual Ponds: This option is the best in three categories: *cost*, *economic sustainability*, and *environmental impact*. However, it requires more *social change*.

- Expanded Government System: The *productivity* of government system is extremely limited.

An explanation of each of the categories follows here, from left to right:

1. Productivity: *How much output the system is capable of.*
2. Implementation: *How easy the system is to implement.*
3. Equitability: *How equally individuals will be able to benefit from the system.*
4. Social Change: *How large of a change the system will cause in the village.*
5. Cost: *How expensive the system is to construct and use.*
6. Economic Sustainability: *How upkeep of the system will fare in the long term.*
7. Sponsorship: *How marketable the system is to a sponsor, how necessary sponsorship is.*
8. Environmental Impact: *How the system will impact the environment.*

These terms shall be italicized when they appear in the text in order to remind the reader to reference the options chart.

5.1 Water Gate Systems

This potential solution is incorporated into two different options, water gate – solar cells and water gate – electricity. These solutions have two main components: (1) the water gate system itself, and (2) the source of power for the system. Since alternative power sources are available, the two elements are discussed separately. This separation allows for better comparison between the water gate – solar cell option and the water gate – electricity option, with the understanding that the basic water gate component is the same for each.

Our findings demonstrate that water gate systems represent the most socially appropriate solution to provide water for agriculture in Ban Thad. In this section water gates are first justified as a potential solution, and their potential productivity is examined along with different considerations. Information on the design of water gate systems is then explained within the context of the social significance of such a project in Ban Thad.

Water gates are recommended by the Thai Government as a good system for distributing water for agriculture, making them a suggested potential solution in Ban Thad. The Thai Government builds water gates in order to provide irrigation in villages (Vanjararat & Nathomtong, 2005).This suggests that water gates are an established method for providing water for agriculture.

The government describes the advantages of a water gate system as follows (Vanjararat & Nathomtong, 2005):

- Increase the efficiency of water use to maximize benefit
- Effectively distribute water
- Address problems of water scarcity
- Expand agricultural income opportunities; create jobs
- Enable dry season farming and livestock raising

- Improve quality of life

If successful, a water gate project would remedy thus the problems of water access with existing piped water system, as developed in Section 4.4, and through improved water access improve the community's economy and quality of life.

The example of Ban Khok Saam Ran, a nearby village with a government-built water gate system, suggests that water gate systems have the potential for high productivity. A village schoolteacher reported that multiple farmers in Ban Khok Saam Ran are able to profitably (successfully) grow a second rice crop in the dry season, and green rice paddies were observed by the researchers during the dry season. Since rice is a highly water-intensive crop, this implies that water gate systems are able to supply large quantities of water. Supporting this potential for high productivity is that a government water gate system assessed by a third party was found to have the capacity to irrigate 1412 rai of land (Vanjararat & Nathomtong, 2005). A farmer in Ban Thad typically owns around 10 rai of land, so this is a significant quantity. While the finished project did not successfully supply water to 1412 rai, the design flaws that limited water access are preventable through improved design, as shall be discussed in greater detail in upcoming paragraphs.

All farmers in Ban Thad would not necessarily be able to do a second rice crop with such a system, causing social change by requiring different crops. The corresponding increase in labor requirements, however, could be mitigated through tools such as drip irrigation techniques. While some farmers in Ban Khok Saam Ran are able to grow a second rice crop, other farmland was observed to be planted with fields crops such as cassava, or to remain without irrigation. Thus, not everyone in the village was able to use the system for dry season rice production. A water gate system in Ban Thad would also likely not be able to supply water for everyone to produce an extremely water intensive second rice, but could grow field crops, vegetables, or other water efficient crops instead.

In Ban Nong Preuk, a PDA-sponsored village in Isaan's Chakkarat Province with a water distribution system used for agriculture, all users interviewed said they employed drip irrigation systems to water crops such as corn and pumpkin. Ban Thad could thus too potentially reduce the labor requirements of non-rice crops through mechanized water distribution systems that eliminate the need for farmers to water their crops by hand. Such a solution would increase the social appropriateness of alternative crops.

Now, an explanation of a water gate system: A water gate system is essentially a piped water distribution system with gates that can alternately open and close off pipeline, allowing a pump to distribute water to multiple areas. See Figure 13, below.

- Point (1) marks the system's source, at which a pump is located.

Figure 13: Model of a Water Gate System (Kasetsart University, n.d.)

- Letters (A), (B), and (C) label the system's three branches.

- The legend at the right explains additional symbols used to label gates, water level meters, a rainfall level meter, the solar cell power source, and the canals that distribute water. Additional labels written in Thai appear since this is a bilingual project and the image was adapted from a Thai source, but this information can be disregarded.

- Different variations of the example system are possible. Note that the canals in the example system may be replaced by pipes, and the solar power source may also be replaced with an alternate source of power. Additional sub-branches may be added. Optional large storage tanks may be additionally utilized as appropriate. Water level meters and rainfall meters are included since this system is automated, but are not strictly necessary.

Water gate distribution systems allow distribution in different directions, which will enable equitable irrigation of Ban Thad's multiple areas of farmland. While expansion from the existing system would be restricted by the old design, a new system has the potential to properly plan for widespread agricultural demands. The example in Figure 13 shows canals distributing water from the solar-powered source at Point (1) through Branch A going north, Branch B going east, and Branch C going south. Rather than linearly channeling water through a single pipeline, water gates have multiple branches through which water travels. The map developed at the community options chart meeting, shown originally in Chapter 3 and repeated below in Figure 14, shows that Ban Thad's farms are spread out all around the village center, so this advantage of water gate systems is key to village water access.

The map illustrates that the majority of the farmland in Ban Thad is grouped sufficiently close together that a water gate system could feasibly connect to most of the village's land. Some outlying farms, such as those isolated groups in the far east and northeast of the map, may be too far away to economically connect to such a system. Such farms would need to find an alternative, individual source of irrigation, such as independent ponds, even if a water gate system were built.

The ability of water gates to distribute water in different directions extends beyond the first level of branches; sub-branches can be used to enable a broad distribution throughout an area that enables more individuals to connect. Main branches of pipeline can have sub-level distribution with canals or smaller pipeline that are opened and closed with gates just as the main branches are. Such broad sub-level distribution is a necessary component of a community level system since costs of individual connection will need to be both feasible and affordable, something not currently possible with the existing system in Ban Thad. Furthermore, as established in Section 4.1, farmers do not understand the benefits and risks

Figure 14: Map of Ban Thad's Farmland

investment well, and so will need assistance is making good decisions about whether or not to connect.

In Ban Khok Saam Ran farmers whose fields the pipeline did not pass used long hoses to transport water over to their land. Some of the farmers using hoses had asked that the system be designed to avoid their fields since they thought it would cause them to lose their land. However, afterwards they saw their neighbors benefitting from the system and claimed that they too wished to use it. Two important lessons can be gleaned from studying Ban Khok Saam Ran's use of hoses. Firstly, hoses a way to potentially extend the reach of a water gate distribution system and increase water access. Secondly, if a water gate system were to be used in Ban Thad, education would need to be provided to increase villager's understanding and enable them to make informed decisions that maximize their benefit from the system.

Each branch of the example in Figure 13 models a slightly different way of using water gates to restrict and channel water flow. Such restriction makes it possible for water to flow in different directions needed to give widespread water access, but requires proper planning. Branch A does not have a gate at the source of pumped water, but ends in a gate. Branch B has a gate at the source and at its midpoint. Branch C has a gate only at the source (Figure 13). The design suggests that only either the Branch B or the Branch C can be open at once and that water usage needs to alternate between the two branches. In order to arrange alternating usage, a schedule must be developed.

In Ban Khok Saam Ran this design of alternating water flow through one branch at a time has not been successfully scheduled; villagers complained about having to queue in order to access water, though their crop yields are not affected. Though Ban Khok Saam Ran's crop yields are not as of now affected by the scheduling problems, the potential for impacted yields and income generation remains. To prevent such problems with alternating water use in a potential system for Ban Thad, it is advised that an analysis of the design be conducted to yield a fair schedule of when each water gate should be closed and opened. Moreover, successful execution of the schedule itself would require management.

If a water gate system were implemented in Ban Thad, planning would not only be required to manage alternating use of branches, but also to ensure access to water throughout the branch. The model shows that since water flows from the source at Point (1) through the canal towards the canal's end, farms at the end of a branch receive water after the farms at the beginning of a branch (Figure 13). This indicates that issues may arise if the first farms along the branch use the water before it reaches the last farms. In fact, in a water gate system studied by Health Systems Research Institute researchers, farmers at the end of branches were found to lack access to water since the farmers upstream, afraid that their crops would not receive sufficient irrigation, continually flowed water into their fields (Vanjararat & Nathomtong, 2005). It is unclear whether or not the upstream farmers truly required as much water as they used, or if their fears were unfounded. If the former, then the problem could be solved by growing less water-intensive crops. If the latter, than farmers could simply be educated on crops' water needs and follow a rotating schedule of water use.

Such a project would likely require significant management and support due to its complicated nature and tendency to break and need repairs. Unrepaired problems have the potential to prevent the water access granted by the system and impact *economic sustainability*. One government water gate project examined by researchers from the Health Systems Research Institute found that much of the system was unusable since the storage tank was not sited correctly and pipes were leaky, obstructed, and left unrepaired (Vanjararat & Nathomtong, 2005). According to an interview with Ban Khok Saam Ran's maintenance worker, their pipeline breaks every year and requires repair.

The maintenance needs of a water gate system need to be carefully considered before trying to implement such a system in Ban Thad; it is likely that a formal caretaker position would need to be established to ensure the system's proper upkeep. It would be highly beneficial to examine the problems of water gate systems in Ban Khok Saam Ran and other locations so that the maintenance problems they have faced could be avoided from the start in Ban Thad. At the very least, recognizing the problems early on would allow the costs arising from their maintenance to be incorporated into a water user fee. This is

important because the maintenance for these systems can be so extensive. For example, we learned from Ban Khok Saam Ran's schoolteacher that their system requires a full time government position just to manage its upkeep. The PDA's relative inexperience with water gate systems mean that any water gate system in Ban Thad is likely to be implemented using nearby villages like Ban Khok Saam Ran as an example. Thus, it is likely that a similar position will be necessary in Ban Thad.

All together, the water gate systems are Ban Thad's overall favorite option, indicating that it is a socially appropriate option. The water gate – solar cell option was *ranked* as the first choice of all the groups at the community meeting, and the water gate – electricity option was *ranked* as the second choice of about 80% of the groups. This option has broad community support. Village leaders also reported that Ban Thad had in the past submitted a proposal for a water gate irrigation system to the government sub-district office. This proposal demonstrates an invested commitment to a water gate option.

In summary, water gate systems are a strong option, with high marks in *productivity* and *equitability* of access. However, they require some *social change* within the village, have some concerns with *economic sustainability*, and require *sponsorship*.

Considerations of a Water Gate System	
PROS:	**CONS:**
• High productivity • Design enables good access through wide distribution • Cheap water use charge available through PDA	• Expensive; sponsor needed • Significant maintenance needs • Will likely need to grow non-rice crops • Would require management of water fee, maintenance, and usage schedule

Figure 15: Summary Chart: Considerations of a Water Gate System

The chart in Figure 15, above, shows that the major concerns related to the existing system regarding capacity, difficulty of connection, and water use prices would be addressed through this potential solution. It also states that such a system would be expensive and require a *sponsor*, placing this option outside the reach of individuals. Users might need to grow alternative crops to rice, causing *social change* in the village. Water gate systems would also require management due to their complicated nature.

5.2 Powering a Water Gate System

Our findings indicate that a water gate system as the best option for Ban Thad since it is the most socially appropriate option. Research suggests that solar cell power is the best option for powering such a system due to the advantage of renewable energy. This section begins by rationalizing solar power as a potential option and then continues by developing the advantages and disadvantages that would be experienced by Ban Thad with the adoption of a water gate project powered by solar cells. It then compares solar cells to conventional electric power, concluding that solar power is best, but that an electric water gate option would be the next best alternative in the event that sponsors are not willing to provide solar cells, but would be willing support a water gate system with a cheaper source of power.

5.2.1 Solar Cell Power: The Preferred Option

A pilot case of a solar cell system in Ban Nong Preuk, a PDA-sponsored village in Isaan's Chakkarat Province, suggests that a solar powered water distribution project for irrigation could be feasible in Ban Thad. Ban Nong Preuk uses solar power to operate a pump that draws groundwater and conveys it to a large storage tank a distance away. This system is used to provide water for both domestic and agricultural use, though only 10 rai of agricultural land currently receive irrigation. While only 10 rai of agricultural land are watered under this system, it also supplies domestic water to the entire village. Therefore, if the system were to supply water

A university model of a water gate project powers its system with a solar cell, proving not only that solar cells are suitable for water distribution systems in general, but that they can be applied to water gate systems specifically. Kasetsart University has built a water gate system (see Section 5.1) that successfully distributes water through a section of its campus with a solar cell (Kasetsart University, n.d.). While this is not a full scale model, it does prove the compatibility of solar cells with water gate systems.

Solar cells, though expensive themselves, could be sponsored through the PDA to provide water at a low cost to villagers. Low water use costs are a key component of socially appropriate and favored

systems since they maximize profit and permit less labor intensive, more water intensive crops. The users in Chakkarat reported that with the low cost (2 THB/m3, originally 3 THB/m3) of the solar-powered system there, they were able to profit. PDA staff expect a similar water cost to be likely in Ban Thad, though the final cost would be up to the village water committee to decide on. Our interactions with the villagers suggest that this would be sufficient to make them want to adopt the system.

If the cost of water is lowered, people may be more inclined to try growing more during the dry season. Watering one farmer's worth of vegetables during the dry season using the existing government pipe system costs about 500 THB per month. Farmers in Ban Thad estimated water cost savings of 50% with the solar cell project, with subsequent increases in profit. Such price reduction would enable farmers in Ban Thad to generate more income from crops with the same level of water intensity, or allow them to grow crops with greater water intensity that, as determined in Section 4.4, may require less labor and be more socially appropriate.

Villagers would need to be educated beforehand on the significance of a water gate project in Ban Thad so that they can choose this option as fully-involved decision makers. While we recommend a water gate – solar cell project for Ban Thad and it is the first choice of the villagers, as apparent in the options chart, they likely do not understand how such a system would impact their village. One woman was asked at the community options chart meeting about why she favored the solar powered version of a water gate project even though it was expensive. She replied that she liked this option since it represented a long term solution with a one-time investment. Because of this she believed that since no continuous electricity fee applied, villagers could pay back the cost in smaller increments over a longer period of time. While it is true that no electricity fee would need to be paid and that the sun itself will remain strong, the long term use of the system itself is not as certain. Issues with long term maintenance of this high-tech make it unclear how long a lifespan such a system would have. Others also reiterated this perception of the project, as well as added that they wanted it because were interested and curious. These additional reasons

suggest that villagers are not sure what the system would mean for their village, though they also think it would be beneficial.

Solar cells are a superior power source due to advantages of renewable energy in the *environmental impact* category, its independence from the electric grid and eliminated electricity usage *costs*, and due to the fact that it may be easier to sponsor since renewable energy projects are good for companies' public images.

5.2.2 Comparing Solar Cells to Conventional Power

While the initial *cost* and *economic sustainability* of electric power are better than those of solar power, solar power is still the better option. Solar power is a superior power source due to advantages of renewable energy in the *environmental impact* category, its independence from the electric grid and eliminated electricity usage *costs*, and due to the fact that it may be more easy to sponsor since renewable energy projects are good for companies' public image.

Considerations of Powering a Water Gate Project	
Solar Power	**Electric Power**
• Power is from renewable sources • Full support of villagers; first choice • Independent of electric grid • No continuous power fee • More expensive than electricity • More difficult to maintain, long term unclear • May be easier to sponsor • Dependent on sunlight	• Power is from non-renewable sources • Most villagers' second choice • Dependent upon the electric grid • Must continually pay for electricity usage • Cheaper than solar cells • Well known technology, easier to maintain • Not as attractive to sponsor companies • Independent of sunlight

Figure 16: Comparison Chart: Powering a Water Gate System

The chart in Figure 16, above, allows for final comparison between a water gate – solar cell and water gate – electricity project. The pros do much to recommend this power source as a strong option, but the cons show that it lacks the additional benefits of renewable energy. It is worth noting here that while ponds are the best in the environmental impact category and also are not associated with a continuous water fee, questions remain concerning ease of sponsorship and productivity that will examined in Section 4.4.3 on individual ponds.

Villagers prefer solar power over electricity since they would have eliminated usage costs associated with power supply. While a solar project is more expensive overall, there is no continuous usage fee associated with powering the system. Again, villagers at the options chart meeting discussed their current dissatisfaction with electricity payments for the existing government domestic water system, and expressed liking that this expense could be eliminated through solar power. However, if sponsorship could not be found for a solar power source, PDA staff have said that even their electric water distribution systems are able to charge lower water user fees than the government ones charge. Water users in Ban Nong Thoom using an electric PDA agricultural water system expressed satisfaction with the PDA water fee of 2 THB/m3. Thus an electric water gate system could still be affordable for villagers to use through the PDA.

All the advantages of the water gate system itself are still inherent in this project since a different power source does not significantly alter the benefits of water distribution. Around 80% of villagers

named the electric water gate system as their second choice. This suggests that most villagers prefer the advantages of water gate-based solutions in general. While the solar cell system in the village in Chakkarat could only operate during the day, the headman's assistant confirmed that it was still able to supply the village's agricultural water needs. Electricity would not provide a significant advantage by overcoming the day-light limitations of solar power.

Thus, we can say that while a solar cell version of a water gate system is recommended as the best option for Ban Thad due to the advantages of renewable energy, we recommend an electric version as a second choice in the event that a solar project cannot acquire *sponsorship*. Though electric water gate project is dependent on the electric grid and would pass on usage costs to villagers, its power source contributes to climate change, and it may not be as attractive to sponsors; it also has a few advantages over a solar-powered water gate project that make it a strong second alternative.

If Ban Thad cannot find a sponsor for a solar cell system due to concerns unique to the power source aspect of the system, the village could propose an electric project instead. An electric water gate project would be cheaper than a solar-powered one; solar cell power is established as costing more conventional electricity power. If a sponsor's reluctance was due to cost concerns, an electric project would be a less expensive but fully beneficial alternative. Electricity is a well-known technology that is easier to maintain in the long term. If a sponsor's reluctance was due to concerns with the long term economic sustainability of solar cells, electric power can overcome this problem. Electric water gate systems are similar to but not as advantageous as solar-powered water gate systems.

5.3 Individual Ponds

This potential solution is recommended as an alternative plan if the cost of a water gate system proves to be prohibitive and a sponsor cannot be found. Additionally, individual ponds are recommended as a necessary component of a water gate system to provide a source of irrigation for farms too far away to

connect to the pipeline itself. Though ponds have unique advantages in terms of *equitability*, *cost*, *economic sustainability*, and *environmental impact*; water gate systems are more socially appropriate.

This section first defines the term "pond" as it is used here and demonstrates that this option is indeed feasible in Ban Thad. Next it describes current opposition to this option, and then lastly explains how the advantages of ponds have the potential to prevail over these barriers.

Here, a pond is intended as a tool for increased irrigation is not a small, naturally occurring surface water body, but rather a man-made excavation dug such that it strategically retains rainwater. His Majesty the King of Thailand has developed calculations determining dimensions of such excavations that best ensure sufficient retention of rainwater:

- The surface area of a pond should compose 30% of the land that it is intended to irrigate.
- The depth of the pond should be 4-6m deep depending on the soil type (4m deep in clay soils, 6m deep in soils of mixed composition) (Boonjarus, 2011).

These calculations ensure that ponds are properly sized and provide sufficient water for agriculture.

The nature of Ban Thad's farmland suggests that ponds are an appropriate option for the village. Ponds are most suitable for low-lying areas where rice production occurs (Prapertchob, 2001). This makes sense since rice is an extremely water intensive crop and would need to be grown in areas capable of holding water for periods of time, areas that would be conducive to ponds. The clear majority of Ban Thad's farmland is composed of rice paddies, and Ban Thad can be considered low-lying land since it is situated next to a lake and its land is flat by observation. Thus Ban Thad fits the description for areas suitable for ponds.

Additionally supporting the feasibility of *implementation* of ponds in Ban Thad is the fact that a pond has already been put into practice in the village. One farmer in Ban Thad uses a pond he constructed to supplement irrigation from the piped government water system. Although the farmer says this pond could

not supply enough water to fully support all of the farmer's operations, it still was a viable source of irrigation in the dry season. This indicates that Ban Thad's topography is suitable for storing rainwater in ponds. While this farmer's pond was insufficient on its own, this problem can easily be overcome through larger ponds designed using the calculations of His Majesty the King of Thailand that can provide adequate supplies.

While ponds are feasible, villagers currently are largely opposed to ponds, believing that ponds will put them at a disadvantage or are unreliable, but this opposition is largely unfounded. At the options chart meeting, the individual pond proposed solution met a strong negative reaction from many villagers. Only around 20% of the people at the meeting thought ponds were a better alternative to a solar cell water gate project than the electric water gate project. This suggests that individual ponds may not be a socially appropriate option for everyone in Ban Thad because if villagers dislike an option, it is unlikely that they will utilize it. However, that 20% is open to considering ponds as a good option and this option is thus more socially appropriate for them.

One of the main misguided perceptions preventing effective utilization of ponds is the belief that they cause farmers to lose their land. When three people at the options chart meeting were asked why they were opposed to ponds, all of them replied that they were afraid to lose their land. One villager specially said that she could not build a pond since she had only had 2 rai of land. Local PDA staff also confirmed through interview separately that this fear of loss of land was a dominant opinion in the village. However, the New Theory of sizing ponds accounts for differing amounts of land, and simply says that ponds should use 30% of any size of land. Thus ponds can still be appropriately implemented on 2 rai of land. While it is true that crops cannot be planted in the space taken by the pond, the remaining land can yield significantly more income.

Although we explained the advantages of ponds at the community options chart meeting and a PDA staff member explained a second time that the benefits outweigh the land investment, not everyone

seemed convinced and ponds were ranking at the third choice by 80% of the village. This suggests that simply telling people that they would receive greater benefit than disadvantage from ponds is not enough to change their minds. Greater education, perhaps through demonstration sites as the PDA has done in the past, on the management and benefits of ponds would be needed in order to fully develop this option.

Ponds cannot support water-intensive crops such as the villager's familiar preferred second rice crop. Rice is an extremely water intensive crop, making ponds an impractical source of irrigation for a second rice (Kam et al., 2001). Since villagers want to grow a second rice crop with an irrigation system, it means that they would prefer other options that would allow them to do so over ponds. Thus water gate systems are preferred over ponds.

Although many villagers seem to prefer water gate-based solutions over ponds, ponds are widely endorsed in Thailand as a good solution since they still enable diversification of income generating activities. Conversion of a portion of paddy fields into ponds is recommended as an alternative for an integrated farming system in which crops, trees, and livestock are intermingled. (Polthanee, 2001; Ruaysoongnern & Suphanchaimart, 2001). His Majesty the King of Thailand has promoted ponds for irrigation of integrated farming as a part of the previously mentioned "New Theory" system, based on the idea of self-sustenance (Prapertchob, 2001). The Thai Government has also supported farm ponds as valuable source of irrigation, constructing more than 65,000 ponds during a two-year farm restructuring program from 1994-1996 (Ruaysoongnern & Suphanchaimart, 2001) that had some success in encouraging integrated farming and dairy farming. As discussed in Section 2.3, such diversifying is a recommended agriculture since it results in tangible economic and environmental advantages. Having multiple income sources from so-called integrated farming mitigates the risk incurred due to reliance on only one source, and is better for the environment and corresponding long term agricultural yields than is monocropping.

While other crops do not appear to be widely socially desirable since they tend to be more labor intensive (see Section 4.2 for details), some villagers may want to take advantage of the opportunity for increased income generation. The fact that about 20% of the groups at the community options chart meeting choose ponds as the second best option to a solar-powered water gate system suggests that at least some villagers are open minded to this option, and may be willing to grow new crops in order to improve increase their income. Additionally, three farmers currently cultivating vegetable crops in Ban Thad have overcome the social barriers of small-scale crop production, even though they are within the senior demographic of Ban Thad's dry season population. This indicates that if individuals are motivated to increase their income generation, the amount of labor required by crops supported by ponds is not insurmountable.

An additional benefit of ponds is that while ponds are unsuitable for a second rice crop in the dry season, they can help improve yields of the first rice crop. As established in Section 2.1, precipitation in the rainy season is variable and sometimes inadequate, hurting yields of the first rice rainy season crop. At least one farmer in Ban Thad confirmed that first rice crop yields suffer sometimes when the variable rains of the rainy season are insufficient. Ponds can provide supplementary water for rainy-season rice (Ruaysoongnern & Suphanchaimart, 2001). Since this crop is the single largest agricultural source of food and income in Ban Thad, its success is extremely important to villager's well-being and supplementary water from ponds is thus highly beneficial.

While other irrigation systems could also be used to diversify agricultural activities and supply additional irrigation to a second rice crop, ponds represent a fairly strong alternative due the unique advantages inherent in small scale projects. It is possible for individuals to obtain ponds on their own since their cost, priced in THB per cubic meter soil removed, is directly proportional to size. The two farmers mentioned previously said that they were able to dig their ponds on their own, proving that it is possible to implement ponds even if external organizations are unable to provide support. See Appendix F outlining rough cost estimates for small ponds of varying sizes.

Furthermore, ponds can be built piecemeal, according to a farmer's available budget and human resources. A pond need not be built all at once to be the final desired size; rather farmers can start with a small pond and enlarge it later as many times as are necessary (Satri Wat Absornsawan School, n.d.). Thus, with a relatively small starting budget a famer can still make initial income and slowly expand in accordance with his means. This ability to make a series of smaller investments allows farmers to avoid acquiring large amounts of debt at once, something valued by Ban Thad's community.

Another economic benefit of ponds is that they have no continuous maintenance or power needs. This option only requires a single initial investment, giving them an advantage over projects that charge a water fee. While the upfront cost of ponds may seem to be a large amount to the villagers, the long-term savings of not having to pay a water fee are an advantage in the long term. For this reason 20% of villagers preferred ponds over an electric water gate system, saying that they were wary of the ongoing expense of electricity. Since ponds are a low tech solution, they also rank highly in terms of *economic maintenance* and will not require farmers to expend additional significant resources over the long term.

Another economic benefit of ponds is that they have no continuous maintenance or power needs. This option only requires a single initial investment, giving them an advantage over projects that charge a water fee. While the upfront cost of ponds may seem to be a large amount to the villagers, the long-term savings of not having to pay a water fee are an advantage in the long term. For this reason 20% of villagers preferred ponds over an electric water gate system, saying that they were wary of the ongoing expense of electricity. Since ponds are a low tech solution, they also rank highly in terms of *economic maintenance* and will not require farmers to expend additional significant resources over the long term.

If a community-level water gate system were to be implemented, ponds will be needed to supply irrigation for outlying farms located far from the general distribution system. Ponds can be implemented in any low-lying land, eliminating the problem of distance from surface water or groundwater sources (Prapertchob, 2001).This gives the option of individual ponds high *equitability*. As previous analysis of

Figure 14 showed, Ban Thad has several outlying farms that may lie too far from the others to be able to connect to any new community water system without undue cost. Even these farms, however, would be able to take advantage of an individual pond.

However, as an overall solution, ponds are recommended second to a water gate system (solar or electric) since they are not as *productive* and would consequentially demand greater *social change*. Water gate systems are able to provide water independent of stored rainy season precipitation, and so allow greater income generation and production of field crops that require more water for equivalent profit, but require less labor. Additionally, mechanized distribution systems such as drip irrigation can be connected to water distribution systems that can reduce the labor of watering crops. Furthermore, many villagers are currently opposed to ponds but strongly support a solar powered water gate system. Villager's preferences further suggest that a solar powered water gate system is more widely socially appropriate than is the individual pond option.

Summary Chart: Considerations of Individual Ponds	
PROS:	**CONS:**
• Distance from sources not a problem • Affordable at the individual level • One-time cost only • Positive environmental impact	• Does not provide enough water for second rice or for crops with low ratios of value to water intensity • Income generation is more labor intensive • Negative social preconceptions

Figure 17: Summary Chart of Considerations of Individual Ponds

Figure 17, above, clearly organizes the advantages and limitations of ponds. One can see that the advantages of ponds are quite significant, since they are unique to small scale, independent solutions. These pros overcome the existing problems of access due to distance, affordability of connection, and high water use prices that are inherent in the government system. Though some of the cons of ponds are possible to address through growing alternative crops or through providing education on the benefits of ponds, their moderate *productivity* potential is a key limitation that requires *social change*.

5.4 Expanded Government System

Expansion of the government system to improve access to water for agriculture is not recommended, with a few exceptions. This section first establishes the potential of this option, then makes it clear that expansion of the government system is an extremely limited option, though still possible in some situations.

Expansion of the government system to provide water for agriculture is known to be a viable option since some farmers have already utilized this option. Two farmers have connected agricultural land to the government system and have reported that they make a profit. As mentioned previously, note that one of these farmers additionally receives supplementary water from a pond. This demonstrates that connecting to the government system can be a successful, profit-making venture. While one farmer does also receive water from a pond, the other farmer without a pond still profits using the 6 THB/m^3 government water.

To make this profit, the two farmers grow vegetables such as Chinese kale, chili peppers, and lettuce; as well as of juju bean fruit trees. However, they reported that the high water use price prevents them from producing a second rice crop, a claim supported by the calculations in Appendix F. Most of the other farmers in Ban Thad currently only grow rice on a large scale, so these types of more labor intensive crops would be new to them, as noted in the *social change* column of the options chart. As previously discussed in Section 4.1, these types of farming might also do not appear to be widely socially desirable since they are more labor intensive. However, some villagers may want to take advantage of the opportunity for increased income generation as these two farmers did.

Though success with income generation via water is possible, this option is largely unsuitable since the *cost* of connection is prohibitively high for most farmers. The two farmers who connected to the government system stated that they paid 2,000 and 2,500 THB each, but their vegetable plots were only located approximately 15m away from the pipeline. To contextualize these amounts, even 2,000-2,500 THB is often the better part of a farmer's monthly gross earnings and represents a significant financial

risk, as discussed in Section 4.4. Nevertheless, as Figure 14, the map of Ban Thad shows, most farms are considerably more than 15m away from the pipeline. Connection costs are therefore correspondingly considerably higher for all these farms, suggesting that connection is certain to be an unwise investment. This option consequentially receives low marks for *equitability* as well.

Furthermore, the potential *productivity* of an expanded government system is severely constricted, critically blocking widespread execution of this option. Developing an expanded community agricultural system from the government system is not an option due to the system's limited capacity. Ban Phai's sub district officer said that since the since was designed for domestic use, agriculture usage would exceed its capacity. Villagers at the community option chart meeting were also aware of capacity issues, saying that they were concerned about the water needs of other villages they share the system with. This suggests that this option, rather than simply being the least popular of the options, is actually not possible for use on a large scale. At the very least, it can be said for certain that there is no way to use the existing system to benefit most farmers in Ban Thad.

The summary chart in Figure 18, below reiterates the conclusion that expansion of the government system is not a highly recommended solution.

Considerations of an Expanded Government System	
PROS:	**CONS:**
• Can be affordable for certain individuals	• Only an option for rare cases with nearby location • Low additional capacity limits productivity • No potential for wide expansion • Too expensive to use to grow water-intensive crops

Figure 18: Summary Chart of Considerations of an Expanded Government System

This chart makes it apparent that expansion from the government system is a highly unattractive option. While it does have one pro in its favor, many of the cons are insurmountable.

6 Conclusions and Recommendations

As can be seen from the previous four chapters, the problems related to water resources development in Ban Thad are very complex and encompass many physical, economic, and social issues. The following conclusions represent the most important findings we had during our time in Ban Thad, Thailand. Each one is applies directly to Ban Thad because of the unique characteristics of the village, but due to the similarities between Ban Thad and other villages in Isaan, some of the conclusions can be applied to other parts of the region.

Major conclusions that guided our recommendations:

- There is enough water in Kang La-Wa to support additional dry season agriculture, but people cannot access it. A new water distribution system would open new avenues for dry-season income generation in Ban Thad.
- Many villagers in Ban Thad are unlikely to cultivate anything but field crops due to cultural labor habits. Future projects that enable this will likely see more interest and support than further efforts to introduce alternative, more labor intensive crops.
- Implementing a new water resources development project may or may not have a significant effect on the urban and economic migration in Ban Thad, but would significantly improve the income potential of the remaining residents.
- There are income sources outside of agriculture that are currently available in Ban Thad. The PDA has the opportunity to help villagers to organize, expand, and market the products that result from these sources.

The recommendations presented in the following sections represent what our team feels would be the best course of action for the PDA to take for the village of Ban Thad. We begin by recommending the

implementation of a new solar cell water gate system in the village and ponds when appropriate. We then follow with recommendations about actions that should be taken by the PDA before the project is implemented concerning education and development of other income sources. If all recommendations are taken into consideration, a future water resource development program in Ban Thad will be more likely to succeed.

6.1 Recommendations for Water Distribution System

The primary results of this research are recommendations for a specific water distribution system for Ban Thad. During the course of our project we found overwhelmingly that the most pressing need for farmers in Ban Thad was a way to get water to their fields. There is already water near the village in the form of a lake, and it was clear to us that a distribution system would be the best way to get that water to their fields as required. This section only contains only two recommendations about potential distribution systems, listed below:

- The PDA should strongly consider Ban Thad as a recipient of the solar powered water gate system because with sponsorship it is the most socially appropriate solution.
- Individual ponds should be used in conjunction with a water gate system; and, if such a system is not viable, be implemented as an alternate solution.

These recommendations represent the most general solutions that our project has produced in that they are simply suggesting possible distribution systems. The following paragraphs include some information regarding considerations that need to be attended to before the projects are implemented.

1) **The PDA should strongly consider Ban Thad as a recipient of the solar powered water gate system because with sponsorship it is the most socially appropriate solution.**

Ban Thad is a good village to consider as a potential recipient of the solar cell water gate project introduced in Chapter 5 for the reasons listed below:

- The village is physically well suited for a community-scale water development project because there is a lake next to the village that can be used for agriculture.
- The system would provide water at a price that overcomes social perceptions of cost and will allow people to have more freedom relating to crop choice.
- The solar cell is preferable compared to other options such as an electrically powered water gate system, individual ponds, or the existing government system.
- The solar cell is attractive to sponsors because of its use of alternative energy.
- The solar cell project is likely to see the most use because the villagers indicated their desire to have the system in the village.

The village is physically well-suited for a community-scale water development project because there is a very large body of water (Lake La-Wa) with good quality water right next to the village that can and should be used to supply water to help improve agriculture during the dry season. The lake is a good source of water because it is close enough to the village so water will not have to travel more than a kilometer or so to reach many of the fields owned by the farmers in Ban Thad.

The cost of the water from the solar cell project is very cheap compared to many alternatives which is crucial because the cheaper cost would overcome the concern that water is too expensive to use for agriculture, and so the villagers would be more inclined to use the system. This lower price would allow people to choose their crops more freely without being as concerned about a prohibitive cost of water. This is especially important because many people in the village belong to the grandparent generation and have a stronger preference for field crops, which require more water than vegetables or mushrooms, for example.

In addition to a lower cost for water, the solar cell system is preferable to the alternatives for a number of reasons. The solar powered source is better than using electricity because it relies on a

renewable source that will be very attractive for outside companies to sponsor, an important consideration when planning for the cost of the system for the villagers. For this project, a sponsor is crucial in order for the system to be affordable to the villagers. It offers benefits over ponds because ponds are best suited for small- scale, more labor intensive crops that have proven to be inconsistent with the preferences of Ban Thad's population. It is also a community-scale project so it is more equitable. Finally, it is much better than expanding the government system because it would provide water access directly to fields, would have a capacity large enough to support agricultural water needs and will be cheaper for farmers to connect to and pay for.

When compared to the other potential solutions presented above, the solar cell is likely see the most use. During the options chart activity, the villagers liked the idea of the water gate – solar cell project the most and were much less enthusiastic about other options. Throughout the course of our research we found that the perceptions and preferences of the villagers were almost more important than economic motivators. If the village wants the project, it will be more likely to succeed. In addition to their enthusiasm during our activity, we learned that a group of villagers had submitted a proposal to the local government a few years ago regarding plans to implement a water gate system in Ban Thad, similar to the one in a neighboring village. The proposal was never acted on by the government, but because of their continued interest it would be beneficial for the PDA to assist the villagers in the development of the project.

Though the goal is to improve life in Ban Thad through water resources development, a new project may or may not help alleviate the problem of urban migration. According to Rhoda in his 1983 report, activities which raise rural incomes may increase, decrease, or have no effect on the levels of migration to cities, which is why it is extremely difficult to predict the long term results of the solar cell project. Increasing income may convince people to come home from the cities or it may not affect their decisions at all. The outcome is entirely dependent on individual opinions, and the culture of the village. The Cost Benefit model of migration Rhoda presents states that people will migrate if the benefits outweigh the

costs. This includes not only economic benefits but changes in living conditions or location preference. If the new project increases the appeal of living in the village to the point where people prefer to live in Ban Thad and feel that they will be better off both financially and socially, then they will stay. However, the current pattern of migration may be difficult to overcome because "Past mobility patterns are likely to influence present and future levels and directions of movement" (Fuller et al., 1985). This means that the history of abundant migration in Ban Thad may continue to exist because villagers know from their friends and families in the city that migration was a good option. If the pattern is to be broken, people in the village need to be convinced that that the village is a better place to live than the city and so decide to stay.

2) **Individual ponds should be used in conjunction with a water gate system. Should a water gate system prove to be impractical in Ban Thad, ponds should be implemented as an alternate solution.**

Though ponds were ranked third during the options chart activity, they represent a potential option for the following reasons:

- They can be constructed anywhere, which is a distinct benefit for farms that are far away from community water systems.
- The costs associated with ponds are more individually manageable than a community water system.
- Individuals can afford to dig them as their cost is proportional to their size.

Even though ponds are a good option for many reasons, there are also reasons why ponds are not the ideal choice for Ban Thad as a whole.

- They generally will not store enough water for large amounts of water intensive crops, a problem if people wish to grow rice.

- There is a preexisting disfavor among villagers against ponds which prevent many of them from being willing to consider them.

- During especially dry years, a pond may not accumulate enough water to be useful for dry season agriculture.

Most importantly, ponds are good because they can be constructed anywhere and have manageable costs. They can be dug at any location on a farmer's field, regardless of distance from a water source due to the fact that they are rainfed. This is especially beneficial for farms that would be far away from a community water source, even if a new system were to be built. It would be very difficult and expensive to design a system that reaches all of the farms in Ban Thad, so it is advantageous to have a backup plan for a farm far away. For the other options considered in Chapter 5, distance away from a community water source is a major concern when considering connection costs. For ponds, there are no connection costs - only the cost of digging them. The cost of digging a pond is also based on the size so people can design the pond based on how much they are able or willing to pay. Ponds are controlled entirely by the farmer who owns them, so they have the added benefit of helping a farmer be self-sufficient. This is good because it avoids any complications with a larger system and also means there is no usage fee.

Even with those many benefits, there are some disadvantages that are significant and need to be accounted for. The villager preference for larger scale field crops could be a challenge with ponds because they may not provide enough water. As discussed in Section 5.3, ponds are more aptly suited for small amounts of crops that are not very water intensive, namely crops such as high-value vegetables. If the aversion to those kinds of crops can be overcome, then ponds may be more attractive to farmers. Even if a farmer is growing small-scale vegetables, it is possible that the pond may not store enough water to supply sufficient amounts for the entire dry season. If the pond is not big enough or if there is a drought during the rainy season, there may not be enough water in the pond to be useful. Lastly, many of the

villagers do not like the idea of ponds. As previously mentioned, villager opinion and preference is very important when considering an option because if they do not like the option, they will not use it.

6.2 Recommendations for PDA Action

The following recommendations are intended to be used as supplements to the implementation of a water resources development project such as the solar cell to ensure that the project is successful. They focus on education and finding ways to use the system most effectively to get most benefit from a sponsor investment. They are as follows:

- The PDA should conduct further research on how to effectively build and maintain a water gate system.
- The PDA should assist the villagers with utilization of the new system by providing education about the best field crops to grow.
- The PDA should educate villagers about all costs and benefits associated with the new system before the project begins.
- The PDA should ensure that the villagers are aware of the long-term maintenance needs of the project before the project begins.
- More research should be conducted to examine ways to improve the income generating potential of non-agricultural sources in Ban Thad

1) **The PDA should conduct further research on how to effectively build and maintain a water gate system.**

The neighboring village of Ban Kho Sam Yan has a moderately successful water gate system. Therefore, there it can act as model for a system in Ban Thad, keeping in mind the things that worked well there as well as the things that did not. The villagers there did not fully understand the system before it was built, resulting in complaints over not having received the system or having to wait in line. These problems are now known, so they can be avoided by educating the villagers in Ban Thad before the project starts so they know what to expect and how it will work for them. Just like in Ban Kho Sam Yan, the water gate in Ban Thad will require a management system. The system in Ban Kho Sam Yan works on a schedule such that people have to wait for their turn to get water for their fields and so equitably distributing the available water. This coordination requires the attention of a full-time government employee, and it is reasonable to predict that a similar system would be useful for Ban Thad.

As mentioned in section 5.1, the operation maintenance for the water gate system is significant, and so a plan should be made before the project is implemented. This plan might involve creating a committee in the village that is in charge of maintaining the schedule and keeping it running in a regular manner. The maintenance on the physical structure has proved to be an issue in Ban Kho Sam Yan due to pipes breaking often, an easily avoidable design flaw. There are many design and operation lessons that should be learned from the water gate system in Ban Kho Sam Yan so that the system in Ban Thad makes use of all the best aspects of the system.

2) **The PDA should assist the villagers with utilization of the new system by providing education about the best crops to grow.**

Most villagers expressed a large interest in growing second rice during the dry season. However, rice is extremely water intensive and is not appropriate when water is scarce, especially since there are more efficient options available. In order to overcome this strong preference for rice, the PDA needs to educate

farmers about alternatives that will allow people to maintain work habits they are used to, but also make effective use of the water that is available. The less water intensive alternatives the PDA normally suggests, like crickets or vegetables, have proved to be socially unsuitable for most farmers in Ban Thad due to unfamiliar labor requirements and fear of debt. Therefore, the PDA should focus education efforts on crops that require the amount of labor that the grandparent generation can handle while also being affordable enough to not require farmers to take out large loans. Field crops such as corn or cassava would be consistent with the culture in the village because they are large field crops that do not require a lot of continuous labor and are economically feasible to begin growing.

3) **The PDA should educate villagers about all costs and benefits associated with the new system before the project begins.**

As discussed in the previous chapter, villagers have a hard time understanding how costs and profits interact. For this reason, it would be very beneficial to the villagers if the PDA provided them with basic accounting skills so that they will be able to understand how the whole system will work financially for them. The current level of education has lead us to predict that if the villagers see that water is expensive, they may change their minds about wanting to do agriculture all together and the system will be wasted. If they were given a little bit of knowledge about how to manage the cost of doing agriculture to generate income, then they might not see the water cost as a limiting factor, and instead would see it as part of the system.

Villagers continually expressed their concerns with cost, namely the cost of water and connection to the government system, which has prevented most people from trying to use it for agriculture. Unfortunately, costs of connection to the government system are closely related to the distance from the main line, and therefore the connection for a new distribution system may be comparable to the government system unless a cheaper mode of connection is used. In order to prevent any unpleasant shock and potential rejection of the system, the PDA needs to ensure that villagers know what kind of

investment will be required to hook up to a new system before they commit to it. In addition to the cost of connection, villagers need to be educated about the cost of water associated with different potential crops so they can choose the best one possible for their situation. They have a strong preference for rice, but the amount they would have to pay for water may deter many people and convince them to grow other crops. The accounting education mentioned above would go a long way in convincing people to choose the most profitable course of action possible given the limitations of a new system.

As a demonstration about the need for education, we asked villagers about what they thought of the costs associated with a new system. Many villagers were under the impression that they would not have to pay anything for the actual system because there would be a company to sponsor it. If there is no sponsor, people need to understand how expensive the project is and be given a chance to decide if it is still the best option available to them. Villagers do not seem to have an idea of how much a new system will cost other than 'it will be cheap.' In order for them to know how to use the system to their benefit they need to be educated about costs versus benefits. This problem is compounded by the relatively low level of formal education, so whatever numbers are presented must be done so in a manner that is easy for the villagers to understand.

4) The PDA should ensure that the villagers are aware of the long-term maintenance needs of the project before the project begins.

As previously mentioned, the village of Ban Kho Sam Yan had the pilot program for the solar cell projects in the Northeast. As part of that system there is a 20- year maintenance agreement with the solar cell supplier, though as we were asking questions about the system, no one seemed able to tell us what would happen to the maintenance of the system after that plan expired. It was unclear if villagers understood that the cost of the system for them might change once the maintenance plan no longer existed. To avoid the same potential problem in Ban Thad, as well as any unpleasant surprise costs for the villagers years from now, a long term plan needs to be established at the beginning so people understand

that costs may change. This will ensure that the villagers will assume ownership of the project and that it will be successful for many years in the future. The system is complex enough so that maintenance will need to be done by an outside company and could quickly become very expensive, so there should be plans made ahead of time.

5) More research should be conducted to examine ways to improve the income generating potential of non-agricultural sources in Ban Thad.

Ban Thad has potential for income generation through sources other than agriculture. There are two major occupations that exist in the village already; mat or cloth weaving and chili paste production. However, the products from these activities are rarely sold outside of the village so the profit potential for them is very limited. The chili paste group expressed an interest in expanding their production, but they were unable to do so because they have not found a larger market to sell to. For mat/cloth weaving there is currently no occupational group so the products are generally created only for personal use or for limited sale in the village. The establishment of an occupational group for cloth and weaving would benefit the villagers who participate because they may have a greater ability to market and sell all of their products. Helping individuals or groups in the village find new markets will benefit everyone greatly because it will be a reliable source of dry-season income that is not dependent on water. These cottage industries are a great alternative for people who are physically unable to perform the labor necessary for most agriculture, so the people left behind in Ban Thad will not necessarily be without a job. Improving and expanding on existing industries is likely to be more successful than trying to introduce a new trade, for the same reasons why field crops would be more appropriate than vegetables. If the profit potential for these groups is improved, it will increase the incomes of the people who work in the village and may lessen their dependence on income from relatives in the city, which will in turn improve their self-sufficiency and quality of life.

6.3 Conclusions

If the development efforts in Ban Thad are successful, the lessons learned from their implementation can be used by the PDA as a tool to help improve work in other villages in Isaan. Though Ban Thad is a single village with very unique challenges and characteristics, it is a part of Isaan and shares many of the same features of any village in the region. Therefore, many of the experiences from Ban Thad can be applied elsewhere, keeping in mind the differences that exist. Ban Thad has unusually high rates of urban migration, and while not representative of the entire region, impacts of development projects on migration rates will be useful indicators of strategies that might be good for other villages that face similar issues. If development efforts are not successful in Ban Thad, the knowledge gained from the experience can also be applied to efforts in other villages as strategies that may be better to avoid.

We faced many issues with villager participation during our research as detailed in Chapter 3. There is a limited amount of established literature available for how to alter the participatory approach to compensate for a community that is very hard to engage. PDA staff in Ban Phai expressed an understanding that it is difficult to have a meeting in a village more than once a month, or to get good attendance at meetings in general. This is an issue because this level of disinterest poses a large obstacle for improvement in the area. From examples seen throughout the rest of Thailand and other countries, development efforts that heavily involve the community are very successful and have the potential to continue and expand after researchers or NGO's have left. As we have seen in not only our work but some PDA work in Ban Phai, a participatory approach involving community meetings, discussions, and activities may not be ideal, so the development of an alternative method would be very beneficial so future researchers do not encounter the same roadblocks.

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Appendix A: Interview Questions

Methodology

1) Introduce yourselves first, then ask if the person has time to talk to you.
2) Ask if they've heard about the project, then explain in anyway regardless. Say we'll be here for half a month more
3) Ask them their name and ask about what they're currently doing/ working on.
4) Interview Questions.
5) Do you have questions for us?
6) Say thanks very much, ask them to spread the word about and let us know if they know anyone who would like to help out more or talk to us with ideas. Mention that a community discussion will be coming up, please come? When is most convenient?

Tips

Be sure to smile and look friendly :)
Farangs be sure to speak in Thai as much as possible; you can refer to naa' lang and naa' fon (dry and wet seasons), tham naa (farming), etc. in your English conversation.
Also introduce yourself in Thai in order to make yourself part of the interview and not a random person tagging along.
Take off sunglasses to make some eye contact.
Sit/ squat if the interviewee is on the ground.
Don't get caught up in details of the early questions; the later ones are more important.

Questions

Name?
Occupation:
What do you spend your time doing during each season?
How did you come to do this (why do you have this occupation)?
Crops:
What crops/ rice types do you grow?
During which parts of the year?
How much do you grow (and what are your yields)?
How much do you eat yourself, and how much do you sell?
What are your food costs?
If growing high-value fruits/ veggies etc, how and why did you start?
How did you overcome any problems you had?
Animals:
Do you raise any animals?
Do you sell any, or are they mostly for your family to eat?
Land:
How much land do you own or work on?
What do you do with it during the year?
How did you get your land? Where is your land located?
****If near Lake: Flooding:** What problems do you have with flooding in the wet season?
How much damage did it do?
Were you able to do anything to help stop some of the damage?
PDA tanks: To what extent do you use the tanks? Details on costs.
Education:

What education have you received on farming practices?
Can you tell me anything about the PDA's initiatives with farming education?
If they do know about the seminars, why did you attend/not attend/stop attending [as appropriate]?

Water:

Do you irrigate any of your crops?
How do you get the water?
How do you irrigate?

Water Workload:

How much time do you spend watering your crops?
How do you feel about this amount?

Soil Improvement:

What have you done to improve the soil in your fields?
When you farm, do you use organic or chemical fertilizers?

Marketing:

Where do you usually sell crops?
Do you use middlemen?
Would you prefer to?

Income and Expenses:

About how much are you able to make per month farming?
How much do you have to spend on water (in each season) - how much is the water cost and how much is the maintenance cost?
Do you have any other major expenses?
How much have you had to invest to start your farm (irrigation, tools, seeds, land...)?

Alternate Income Sources:

Do you do any non-farming activities to help with income?
How many others do you work with?
How much time do you spend on it, how much can you make from it, does it have any major expenses or initial fund requirements?

Income Enough?:

How happy are you with how well you're doing now?
Is your income currently enough to support you and your family?

Migration:

How many family members have worked outside the village? Why? Are they still there?
How much time did they spend there? If they came back, why did they return?

Would Parents Farm?:

Do you think that with your concerns addressed/ more water provided that the parent generation would stay in Ban Thad (and farm) in the dry season, or that they would probably still prefer to go to Bangkok?

Concerns:

What are the biggest problems you face in farming now, or in expanding your activities?
What are the villages biggest concerns overall?
Do you have any other ideas that you think we should know about?

Change:

What change do you most wish to see in the village?

Expansion:

Have you ever tried or thought about expanding your farming with more dry season crops/activities?
What stopped you?
What would help you most in the future?
What would you be most interested in doing - maybe a second rice, or vegetable farming, or animal raising?
Do you know anyone else in the village that tried new crops, dry season farming, or new techniques?
Do you know why they failed or succeeded?

Risk (if interested in expansion):
Would you be willing to take out a loan from the village bank to help expand your efforts?
Why or why not?
Future: What do you think Ban Thad will look like in 20 years? What do you hope for your children?

Appendix B: Interview Summaries

January 23, 2011: Ban Lan

Khun Ratree, PDA Staff

- Lack of water…there are 2 types. Lack of drinking water and lack of household water
- Pipe water come from the center which is not enough for use because out of ground water in dry season
- For drinking water (tank, jar) in each house, if in rainy season, it's enough for use as household of drinking water. After the rainy season, villagers will keep water only for drink. Some houses don't have enough jars, so they have to borrow their neighbor or temple because if they buy drinking water. It's also an expense because one person use lots water.
- In each house, they have tank or jar, some house has both. For poor people they use jar and use water from the center. In dry season, if at the center doesn't have water, villagers will go out to find water in other resources for household (washing) because water in jar use for only drinking, means that villagers never lack of drinking water all the year unless they don't know how to manage water (especially some years when the rainy season comes late)
- Agriculture system, PDA has to look first that in that village has enough water for household and drinking. If It's enough and have more water so PDA have to find the information about ground water of that village from Department of Mineral Resources so if the information is good, PDA can build another water system for agriculture, for example as in Ban Nong Toong. Moreover if there is a lot of water, villagers can use it for frog farms, fish farms or vegetable gardens for their household to eat (to decrease expenses).
- Pressure to pump the water between for household and agriculture is different. If use the same tank, it's hard to manage so they separate into 2 tanks, for agriculture from underground water because more clean and filter by natural but if use water from surface water we don't know that it's clean or not so have to buy strainer which is very expensive.

Village property	Family property
Piped water system	Tank, Jar
Ground Water	Rain water
PDA Paid for the instruments (no need to pay	PDA Paid for the instruments (Pay back

back)	monthly)
Pay for water	No need to pay for water

January 23, 2011: Ban Thad

Khun Ratree, PDA Staff

- General information about Ban Thad:
- Location: in Moo 1 Ban Phai sub-district Ban Phai district Khonkaen
- Area: 80 rai, 5 ngan, 73 wa^2
- 129 families
- Population: 696 people (Male: 335 people, Female: 351 people)
- Water in Ban Thad has been supported by government, this village has surface water call "kang la wa" which use by many sub-districts. Water in Ban Thad is managed by the subdistrict government, so villagers are not become part of it which is different from PDA that villagers are the owner of tank and manage by themselves and money comes into village bank.
- Ban Thad use surface water, pump, filter and keep for a while to make it clean, kill the bacterial which is very expensive
- Ban Thad didn't use underground water.
- Villagers don't plant the vegetable much because they don't have space at the back yard but some have so they plant for themselves and family and also frog farm and fish farm. These activities don't have in every house but most of them around 80%
- The occupation that Ban Thad has is
    1. Grow rice
    2. Fishing
    3. Plant fruits (ex. Mango)
    4. Work as employee
- 80% of people in Ban Thad are Farmers. Main income for Ban Thad is from agriculture the second is from fishery and the third is from employee in the factories

- Older people: Assemble together for Waving silk, cricket farm, buy fruit, vegetable, cricket from farmers and sell it in the market.
- Most of teenagers work in factory not agriculture
- Ban Thad has a lot of space but they don't dig the pond because high cost so they need help from government and another idea from Khun Ratree is that if the village has solar cell, it will help to decrease the expense of electricity that use for pump the water and sometimes villagers waiting for rain water instead of increase the income from agriculture ex. In dry season villagers grow sugarcane and cassava because these crops use less water but if want to plant the high value crop, they need lots of water ex. Papaya, mango which is the main problem because villagers don't have enough water to plant.
- Villagers are afraid that if they dig the pond, they will lose the space for agriculture. But the truth is they will have water and they will increase value of that space. As you know, dig the pond use lots of money
- Mr. Gerard who gave 1 million THB to help the villagers to earn a living. The interest rate is only 0.5%. This is cheaper than borrowing from other people, where the interest rate is around 5-10%.
- In the past foreigners donate money for PDA. Nowadays, PDA gets less money from donations. So, PDA needs to run some businesses, such as the Cabbages & Condoms restaurant and the nearby mini mart. They use the profits to fund village development programs.
- In Ban Thad has a piped water system but they lack of piped water, made from ground water, during dry season especially in April. There is one lake in Ban Thad but people think that use piped water is much more comfortable so they don't want to use water from the lake for household use anymore also they think that the water is not clean enough.
- Piped water system in Ban Thad is supported by the government and run by sub-district organization 6-village use this piped water system. For Ban Thad piped water is for household use only not for agriculture.
- In the past they have a problem about urban migration but now a day there are some factories near the village so people come to work
- Rice season is from May-September (use rain water) they are the owner of the land
- Livestock: cow, water buffalo
- They have enough water to drink all year except some families that don't have a good management
- There are fish, shells, and small shrimps in the lake
- Ban Thad don't have flood that cause damage to the houses but cause damage to the rice field.

- Income: 30,000-40,000 THB/year/family
- Some other villages that have enough water resource they may have piped water system for household use and another system for agriculture use

Khun Virad Moowong, Farmer

- Grows vegetable, canton, papaya, chili, and lettuce.
- He uses piped water to grow crop it cost about 400 THB/month for the water and he can generate about 10,000 THB/month.
- He runs a cricket farm. This can generate about 6000-9000 THB/45 days

January 24, 2011: Ban Khan Nua

Khun Manop, PDA Staff

- The village has 2 community groups, 1 for agriculture and 1 for water management.
- Many of the houses have large concrete storage tanks.
- The PDA pays for the initial construction of these household tanks, and the villagers pay the PDA back as they can.
- PDA Tank Specs and Village Pipe Water System
    - The tank 3.6m high, D=2m, filled 11.3 m^3
    - 60% of families have a tank or jar
    - Water in piped system is from groundwater
    - Fee = 3-5bt / m^3
    - The tank is built on highest ground
    - Piped is for domestic use, not drinking
    - Drinking water is from rainwater
    - Before built piped system, PDA researched quality & other organization (maybe dept of water resources) researched quantity of water
    - Built in 1991
- Household tanks from PDA, jars are PDA or bought on own
- cleaned once/ year
- Income: agriculture, factory work, construction

- Ag: sticky rice, sugarcane, cassava
- When not rice season, factory work
- Younger people do agriculture, but mostly middle age and older farm
- Elders stay at home, care for grandkids, weave together, make chili paste together

Khun Sawat, Village Agriculture Head

- Head of agriculture group
- Organic farm
- Use rainwater
- Produce 600kg rice/ rai
- Flood does not damage rice here
- He only uses organic fertilizer
- He makes the organic fertilizer from cow and water buffalo and fermented compost with sugar. Uses effective microorganisms (EM)
- Each year different amounts of water, some too much, others not enough; weather is the problem.
- Some people have cricket farms, cows, water buffalo, and pigs
- People grow corn and tomato near the lake after the rice harvest
- Some people dig ponds in rice fields; not enough to grow more rice, but enough for corn and tomato
- Rice problem= pests (aphids) and disease
- His neighbor uses chemicals; this farm has more disease and pest than his organic farm
- The neighbor sees that the organic farm has less pests and disease and wants to be organic next year, and also other villagers might too since Khun Sawat is the head of the agricultural group
- Khun Sawat wants to improve the soil even more and get 800kg/ rai next year with more fertilizer
- If far away from water source, than only have rainwater; than farm sugarcane and cassava
- If close to the water source, use in dry season and in wet season if need to
- Jasmine Rice = 12 rai, Gornkor 6 (sticky rice) = 10 rai **but maybe the village has more sticky rice overall

Khun Sawat, Village Agriculture Head and Khun Manop, PDA Staff

- PDA Projects in Ban Khan Nua
- Reforest project = 60 rai
    - 300 rai of natural forest
    - 360 rai of forest total
- Community Shop Project
- High Value Wood- Tree Growing - Eucalyptus
- work with Khon Kaen University to give rainwater jars to temples and schools for free
- Microloan fund for weaving
- fence construction- no interest microloan. Almost finished for every house
- old project to get each house a toilet
- check dam
- piped water system for domestic use

January 24, 2011: Ban Nong Thum

Khun Manop, PDA Staff

- Problem is dry land before PDA came, no lake or river, only rainwater
- After PDA, starting in 1990, built water system for farming.
- PDA divided the land, village property, for the villagers to grow vegetables
- No need to pay for the rent fee
- The main crop of this village is vegetable
- For the price, they negotiate with middle man and price also depends on market price
- animal farming = not for sale

Khun Arunee Kaongial, Farmer

- Organic farm
- Income: 200-300 THB/day
- 2000-3000 THB/day during celery season (March-May)

- used to grew cabbages and change because a lot of pest
- now grow lettuce, parsley, and basil (can grow all year, this is the main income of the village)
- There are 104 houses in Ban Nong Thum
- There are 100 field for grow vegetable
- Buyers come to buy at the field (middle man)
- Rice field is own by the farmer, Vegetable field is community property
- Go to farming in the morning and in the afternoon go to growing vegetable plot
- In 1 family there are 4-6 people
- Only 10 people go to work in Bangkok (no urban migration problem in this village)
- Use piped water to for grow vegetable (~80 THB/month)
- water fee: 1 unit (cubic meter) = 2 THB (from PDA's system), or 1 unit = 3 THB (from sub-district's system)
- No vegetable flood prob. because the buyers come from other district
- Prob. sometime lack of piped water (only for sub-district's system)
- Go to work in the factories less (grow vegetable instead)
- PDA piped water system for domestic use
- PDA piped water system for agriculture use
- PDA give rainwater jars to temples and schools for free

January 25, 2011: Ban Lan

Khun Manop, PDA Staff

- The water system in this village is the same as Ban Kan Nua but it has one more pipe for drinking water. Start doing at 2010 (600,000 THB from Coca Cola and 400,000 THB from PDA)
- Ban Lan separate into 3 villages.
- The water system just start only for 4-5 months. The cost is from villagers but now they don't have to pay back because PDA wants this system more stable at first. (experiment)
- 1 day, the drinking water system can produce 6000 liter. Villagers do it and manage it by themselves and send to school. These water system they do it for sale and all incomes go to village bank. In future, PDA try to make ice.

- This project is to make villagers participate and love their own assets.

Khun Sudjai Saiyararm, Village Headman

- There are 142 houses in this village (about 600 people)
- This village has a water bottling facility. The cost of bottle is 3.50 THB. Villagers can sale in price 55 THB per 12 bottles, income around 7000-8000 THB per month. Delivery in Ban Lan is 8 THB and outside is 10 THB.
- This water name is "Nam mee chai" on the process of advertising.
- The problem of this product is don't have enough car to delivery.
- Before PDA comes to this village, villagers don't have enough water use especially in April - August. They have to asked water from sub-district administration organization 4-5 times per day. They drank rain water.
- When PDA comes, PDA helps about drinking water system project, village bank and HIV
- Drinking water system start in 2010 by director Sanit, now is around 1 year and doesn't have any problem.
- Most occupation of is farmer others are employee.
- Most of incomes are from farming. For each house can't mention because depends on family and space of farm.
- This village don't grow crop for sale but only for themselves because villagers afraid that if they grow crops, they will not have enough water for drink.
- No problem about flooding
- one house use water around 20 -50 liters
- water price = 4 THB per unit
- urban migration = no problem
- expense = cook rice, washing, electricity fee, for children to go to school. each house around 100 THB per day.
- animal farm = cow, water buffalo, frog
- In village has fish pond for 20 rai (village is owner)
- PDA introduced organic farm to this village.

- Maintenance: when the pipe broke, villagers help to repair and pay for equipment. If the pipe that use to suck water from underground broke, it cost around 16000-17000 THB
- The maintenance of filter machine is very expensive, but until now it's never break.
- Village bank start by 48000 THB from PDA, after 2 years it has 3.6 million THB. interest rate = 2% per month
- member of village= 227
- Waste, trash = no problem, refuse collection vehicle comes to village and take them.
- Waste from toilet = in each house has their own well to collect the waste. A waste car drives through the village every day; if the well of any house is full, they just call the car.
- Need to do research, quality of water, before build the piped water system
- Water source in the village is salty so PDA need to use the water source 600m. away from the village
- Sub-district's system: Open 9AM-11AM and 9PM-11PM (have water to use only opening time)
- Income from frog 2,000-3,000 THB/month (price of tadpole is 1 THB for each)
- drinking water: from bottled drinking water
- They have enough land and village property, so if they have more water they willing to grow more crops.
- Water in jars or tanks, from rain water, is for emergency usage (lack of piped water).
- They are proud of themselves and have a good quality of life.

January 29, 2011: Ban Thad

Khun Anong, Village Headwoman

- Ban Thad has 4 PDA tanks
    - 2 tanks at lake are used for watering vegetables around the lake. All villagers can use this water but it is often too far for them to carry back to their farms unless there are located near the lake.
    - 2 tanks at temple are used to collect rain water for drink. If villagers don't have enough drinking water they can ask to borrow some from the temple.
- The land surrounding the lake is owned by the Royal Irrigation Department (RID). Before RID become the owner, the land was used by many villagers to grow rice. There are currently 11 families with that grow rice here.

- 10-20 families don't have their own land. Most of them are employees at PDA 's factories or migrant workers in BKK.
- The reason some people do not own land is because they sell their land, sometimes to relatives.
- It is unusual for people from outside villages to move into Ban Thad.
- Population increases every year because people have children.
- Even though the village has problem with urban migration the population still increases because the migrants don't document this, they just go to work at BKK and come back on long holidays (New year, Songkran, Chinese new year)
- 20% move to work at BKK all year.
- Most of villagers grow primary rice for personal consumption, second rice for sale. Those who do not want to grow the second rice will grow corn.
- There are only 3 people that do agriculture in dry season. All of them grow vegetable for feed and sale (Khun Kumpong Mowong, Khun Virat Mowong, & Khun Tawet Ponchannieng)
- This 3 persons can grow vegetable because they have land that pipe water system pass their land and they connect the pipe line by themselves.
- Price for pipe water system is 6 THB/m3
- Expense for pipe water system is around 400-500 THB per month
- One reason why villagers do not use the government pipe system is that they already have some debt and are not willing to invest anymore.
- They would rather work as employees in factories.

January 31, 2011: Ban Thad – Initial Mapping Activity

Khun Somsak, Village Headman

- If there's limited budget, they want main pipe first [from lake to storage tank in the fields]
- Binding pipe that connects from the main pipe [storage tank] to individual fields. This would cost a lot of money for an outsider to built so villagers should do it themselves.
- Standard depth of pipes is around 50-60 cm
- Binding pipe 80cm width
- Wants water pressure to be powerful enough for 10 km.. from lake to storage tank

Khun Somsak, Village Headman and Khun Virad Mowong, Farmer

- One harvest can get around 50 bucket/rai but depends on rain
- Without disease or other damage to fields, farmers usually get 100% yield of rice
- Rice used for personal consumption is saved for over a year. They wait until the next year to see how much rice is left over to sell. If there is enough they will sell the old rice from last year. If not, they will keep the old rice to eat.
- Farmers that own irrigated late can hire others to work in their rice fields.
- Lowland farms grow rice, upland grow cassava
- July-Nov rain season, but in some years there is little rain in July.
- Soil around lake is very salty cannot use for agriculture
- If has more water, can income for each family 40,000-50,000 THB/year
- Second rice grows for 3 months
- If they have more water, villagers will grow second rice or corn
- High value vegetables grow around 30-60 days

January 31, 2011: Ban Thad

Khun Tawet Ponchannieng, Farmer

- Chinese lettuce, kale, salad, cauliflower, chili
- Animal farm, cow, chicken, frog
- Land comes from old generation, his younger brother sale his inheritance land to him about 7rai
- His father taught how to grow crop when he was young
- He started agriculture because he went to market and saw that vegetable is bestseller
- He's not afraid to invest because he love agriculture
- He grows and sells by himself. He sells at Ban Phai market behind school.
- He waters vegetable twice a day, 5am and 3pm. One time takes around 1hour
- He has his own pond for collect rain water and he uses pipe water in dry season
- Rain water depends on year
- Expense for pipe water is around 500 THB per month

- PDA taught villagers about how to grow vegetable and how to make fertilizer
- Today he earned 600 THB selling vegetables
- His earns about 5000 THB per month. After living expenses, he saves about 3000 per month.
- He thinks that nowadays he get enough income so he ok with it
- Chicken = 70 THB/kg. Takes 6-7 months to get to market.
- in rain season, expense for pipe water system is around 300-400 THB per month
- pipe water system for his house use from underground water, he made it by himself
- he used to teach other people in village and sometimes other people from other village come to his farm
- He invest for water system in his farm (include springer) around 2500 THB
- He said that invest one time use lots of money and have to diligent. To teach people diligent is harder than teach how to grow crops
- If can reduce the price of water, he wants to grow more crops
- He thinks that now the price for agriculture is expensive

Khun Virad Mowong, Farmer

- Has been doing "it" for 30 years. Taught himself.
- 30 years ago a subdistrict offer organized a vegetable workshop in Ban Thad. The only people that went were the three successful farmers.
- Vegetables:
    - Chinese lettuce 6-chinese lecttuce each bundle (sell at 5 THB/bundle)
    - Kale 10-30 THB/Kg
    - Lettuce:
        - small size 10-lettuce each bundle (sell at 2 THB/bundle)
        - larger size 2-letuce each bundle (sell at 2 THB/bundle)
    - rose apple
    - kenaf
- Middle man comes to buy from his farm

- Chinese lettuce sell only in Ban Thad (not enough to sell to middle man) 100-140 THB/day
- water cost 400 THB/month
- Cut juju bean tree because let it to spire. He says it regrows every year.
- If he sell all the vegetable in one time he will earn about 10,000 THB
- soil preparation: mix soil with manure
- he dug the pond himself (sometime use water in the pond to water vegetable)
- pond is for storage rain water and for fish farm
- water vegetable twice a day
- In rainy season he can produce 2 time of the productivity in dry season
- He connect the pipe line for the main pipe on the road (Gov. pipe sys) to his farm and cost him 2000 THB
- Main income is from rice. vegetable, cricket, silk worm, etc are additional income
- sell price in the village is higher than sell to middle man
- In dry season need more water
- he want more water to grow more
- He pound of himself
- others don't want to grow vegetable because afraid to do, don't have enough water
- Many people start vegetable gardens but give up, he says people think its hard work and some are too tired/old and prefer town jobs.
- he also makes charcoal
- willing to teach other farmers, he has nothing to hide
- wife has a silk farm nearby
- 5 more years of loan from BAAC (about 9-10% interest per year).

February 1, 2011: Ban Thad

Khun Ranipa Palasard

- Occupation = rice farm
- Her husband is a construction worker in another village

- Now she is unemployed and waiting for rain water
- She has 10 rai, for fruits but she's not successful, not profitable and also not enough water.
- She has 2 children working in Bangkok
- She said that when their children get older they will come back and become farmer but for now she think that live in Bangkok is better and get more income
- Life cycle = parents are farmer, children work at Bangkok, when children get older then they will come back and become farmer
- 30-40 years ago she said that Isaan people are often tricked into being prostitution so she don't want to go to Bangkok
- Her farm land = 10 rai 3 ngarn, her house = 10 wa^3
- One harvested got 100 fertilizer bag and product depends on rain water
- Last year was very dry, lots of bugs
- She use organic+chemical fertilizer
    - Organic fertilizer = make good soil
    - Chemical fertilizer = more products, beautiful
- She don't have enough time to make her own fertilizer
- Agriculture sufficiency

Khun Napatsorn Petchtong

- Main occupation = rice farming
- Hobby = cotton bud
- She sells cotton bud to company (company comes to take them)
- Price for cotton bud = 100 pack for 25 THB (one pack has 80 pieces)
- She get cotton bud from cotton industry and pack then sell
- She used to work at BANGKOK but the company hired out
- Her parents grow the second rice in RID land
- She got flood and drought in RID land
- She has one younger brother work at Taiwan
- Future she wants to become a farmer

Khun Panom Kodkaonga

- He has cassava farm. Once a year around may-June. In dry season, baked clay so he has to use more time to harvest
- Rice farm = 3 rai at backyard, 6 rai close to lake and 20 rai in RID land
- Wait only rain water to grow rice

- Sometimes fishing
- 10 years ago he used to work in Bangkok but was hired out
- He has a son, now in elementary school
- He wants his son get more knowledge and don't want him to become a farmer
- He has cows
- Rice farm, he made his own fertilizer from dung
- 100% product in raining season
- Organic fertilizer = no problem about bugs
- Dry soil = more bugs and pest
- Everything depends on weather
- 1981 rats ate all rice for 2 rai
- He sells rice to rice mill (in Ban Phai), no middle man
- 1 rai = 100 bucket, 1 fertilizer bag = 30 kg
- Government used to help but no maintenance
- Future if has enough water, villagers can grow rice and fishing in the same time

Khun Sung

- 70 years old
- Became a farmer since 20 years old until now
- Before PDA came, life is very bad
- After PDA helps, everything get better (village bank, fishing)
- Urban migration = younger people go to work and send money back to their parents
- No improvement about water system

Anonymous Interviewee 1

- make mat during dry season
- material cost:
- thread 30 THB/ (can make 5-7 mats)
- dye 5 THB/pack
- labor
- time

Anonymous Interviewee 2

- lack of rain even though in the rainy season
- their children come back to help to harvest the rice
- NEED more water, grow rice, vegetable, corn

Anonymous Interviewee 3

- have 2 sons, in Bangkok and Rayoung, didn't come back to help to harvest the rice
- hire somebody to do agriculture
- NEED more water
- Rice, in season, for feeding themselves. if can produce 2nd it will be for sell
- make mat during dry season (not for sell, do in free time)

Anonymous Interviewee 4

- didn't do anything during dry season, too old cant go to fishing
- lack of water
- grow some vegetable in their house (use piped water) but mostly buy it
- sell rice in case don't have money
- NEED more water, grow vegetable, corn, rice
- use organic and chemical fertilizer

February 2, 2011: Ban Phai Sub-District Office

Khun Nat Pralubruska, Engineering Surveyor

- Before having pipe water system, villagers use underground water but it's too salty.
- Pipe water system for 5 villages created in 2006 and finished in 2007
- Basic need of villagers
- Step to create pipe water system
    - Designed and gave budget by department of mineral resources then transfer to sub-district to mange
    - Sub-district supplied the construction company
    - Appointed the village committee, 2 persons from each village. Total is 10 persons and 3 sub-district staff.

- All these people should sign for approve before build the pipe water system

- This system is open system, if other village wants to use this system, they can build pipe line to connect with.
- Price for create pipe water system cover 5 villages = 5.6 million THB
- The system of pipe water system

- Price = 6 THB/m^3 this price come from negotiation of committees
- Used to plan about water system for agriculture but stuck because no budget
- Sub-district is only trainer for villagers, if villagers can't maintain of fix it, sub-district can help. For now, no problem, villagers can fix by themselves
- In the past, Kang Ta-wan-rorn (small lake) was not deep so in dry season, water in this lake will gone away
- Nowadays, kang ta-wan-rorn was dig to 3 meters deep and dig way to connected with kang la-wa wider.
- Royal irrigation is the owner of the land, even now or before.
- Villagers come to farming in RID land before established sub-district office.
- Actually villagers are not allowed to farm in RID land but, sub-district office asked for permission from government.
- If RID wants the land, they have to give them back.
- Future project is to dig another pond and connect to 2 lakes. Now sub-district already started to dig pond.

February 4, 2011: PDA CBIRD Center, Ban Phai

Khun Ratree and Khun Sanit, PDA Staff

1) How/Why did the PDA start working in Ban Thad?
    a. Start by looking at which village in Ban Phai sub-district wants to participate and close to PDA office
    b. Meeting between PDA, sub-district officer, village leader
    c. Ban Thad offer to participant and Ban Thad used to participate in "project on support to poverty alleviation fund house elements"

d. Ban Thad start working with PDA at the end of 2006 by observe the area and have meeting.
e. Give budget in 2007

2) Why was the intended purpose of the two PDA tanks? Who are they for? How many people do they serve?
    a. Before create the tank near the lake, PDA supported the villagers to grow the vegetable on area near the lake.
    b. The plots for the project were intended for poor people that didn't own land
    c. They did a raffle to select the poor people
    d. PDA didn't observe that area before, so they don't know that the soil in that area is very salty
    e. PDA brought soil from other villages to try to improve vegetable plot
    f. Now PDA tanks use for water the crops in that area.
3) Has there been a technical assessment of the groundwater in Ban Thad? Why is the soil salty here and not in Ban Lan and others? Is it just because of the well depth?
    a. Villagers used water in that area for washing cloth (no bubbles), cooking so they know that salty.
    b. Salt shows up on rim of valve
    c. The soil near Virad's land is much better
    d. The reason why the soil is salty is because "GEOGRAPHY" only!!
4) What are other projects that the PDA has considered implementing in Ban Thad?
    a. Village bank
    b. Water
    c. Toy library
    d. Youth participate in village development
5) How does the PDA interact with Ban Thad now?
    a. Coordinate with head of village – tells detail what we are going to do and methodology
    b. Don't go often because villagers will not come ex. Once a month in the evening or available time
    c. Banquet
    d. Check before have meeting first because have many agencies
    e. Join with other agencies

- Does not solve the problem = afraid to invest
- Area near the lake gives to the poor people or who don't have land to draw

- Never check soil before
- Try to grow vegetable 3 times but fail
- Normally, K.Anong comes to talk with PDA so PDA knows what's going on in village (She is a sub-district officer)
- Soil near the lake can change but use a lot of money
- Solar cell project is going to sign contact and ask for budget
- This project have to calculate stage pipeline, budget, ask the idea from villagers
- TBIRD daily wages: 167 THB minimum, 180-200 THB average

Febrary 4, 2011: Ban Thad

Name:	• Khun Urai Moongun
Occupation:	• Farmer
Crop:	• Rice (in-season rice, May-Dec) • 20 sack for eating
Animal:	• No
Land:	• 6 rai
Education:	• Learnt by herself • PDA gave agricultural knowledge • if have a seminar she would like to attend but now her health is not good
Water:	• use only rain water
Water Workload:	• no need work, use rain to irrigate
Soil Improvement:	• never improve the soil
Marketing:	• -
Income & Expenses	• Income from her children, depends on month, some month didn't get any money • about 5,000-6,000 THB is expenses per month • most of expense = insurance, food
Alternate Income Source:	• No
Income Enough:	• Need more income if possible, if not enough have to starve
Migration:	• All children work in BKK as employees
Concerns:	• "Need water for agriculture"
Change:	• Want to see "binding canal" in the village
Expansion:	• If has water, want to grow more rice, vegetable, corn, tomato for sale
Risk:	• Not afraid if has more water

Name:	• Khun Boonchoo Kornchai
Occupation:	• Farmer
Crop:	• Rice, sticky rice (in-season rice, May-Dec) • Vegetables, beans (in winter)
Animal:	• Water buffalo, cow • Duck and chicken stall near the lake
Land:	• 6 rai
Education:	• Learnt from her parents
Water:	• use only rain water • use pipe water for grow crops in winter
Water Workload:	• no need work, use rain to irrigate • if in winter, too expensive
Soil Improvement:	• use organic fertilizer
Marketing:	• sale in village
Income & Expenses	• Income from mat weaving 50-120 THB depends on color • Water expense = 60-100 THB/month • Expense = 5 grandchildren go to school
Alternate Income Source:	• Mat weaving
Income Enough:	• Need more income if possible, some month not enough
Migration:	• Some children work in BKK
Concerns:	• “Need water for agriculture”
Change:	• Have water for agriculture • In the past, pipe water system very condensed but now ok
Expansion:	• If has water, want to grow more rice, vegetable, corn, tomato for sale
Risk:	• Not afraid if has more water
Future:	• Clean village

Name:	• Khun Sunisa Piantum
Occupation:	• Farmer
Crop:	• Rice, sticky rice (in-season rice, May-Dec)
Animal:	• Water buffalo
Land:	• 6 rai
Education:	• Learnt from parents • PDA gave agricultural knowledge • if have a seminar she would like to attend
Water:	• use only rain water
Water Workload:	• pipe water system for rice noodles
Soil Improvement:	• use organic fertilizer
Marketing:	• use pickup sale in sub-district, sometime outside
Income & Expenses	• Income from rice noodle • Can't remember • most of expense = for her son
Alternate Income Source:	• rice noodles
Income Enough:	• not enough for her son
Migration:	• No
Concerns:	• Need more water
Change:	• Wants more water for agriculture
Expansion:	• If has water, want to grow more second rice, corn
Risk:	• Not afraid if has more water
Future:	• If has water = civilization

Name:	• Khun Napatsorn Petchtong
Occupation:	• Farmer
Crop:	• Second rice
Animal:	• Water buffalo
Land:	• 8 rai just start this year (land near the lake)
Education:	• Learnt from parents • PDA gave agricultural, drinking water, village improvement, daily life knowledge • if have a seminar she would like to attend
Water:	• use water from lake
Water Workload:	• No
Soil Improvement:	• use organic fertilizer
Marketing:	• No (only grow rice for feed)
Income & Expenses	• Income from cotton bud, maximum =1500 THB/week • Water expense = 80 THB/month, maintenance 25 THB/month
Alternate Income Source:	• Cotton bud
Income Enough:	• enough
Migration:	• No
Concerns:	• Dry land, lack of rain
Change:	• Wants more education for new generation and come back work as farmer
Expansion:	• Wants more land
Risk:	• Not afraid if has more water
Future:	• Nothing change

Name:	• Khun Sommai Teabheang
Occupation:	• Farmer
Crop:	• Rice (in-season rice, May-Dec) • 87 sack for yield, 15 sack for sell
Animal:	• No (no land to do it)
Land:	• 9 rai (near the lake) • Drought, lack of rain water
Education:	• Learnt from her parents • if have a seminar she would like to attend
Water:	• use only rain water
	• no pond
	• drink rain water
	• piped water for household use
Water Workload:	• no need work, use rain to irrigate
Soil Improvement:	• chemical fertilizer 5 bags/ 9 rai (980 THB/bag)
Marketing:	• sell to rice mill • no middle man
Income & Expenses	• she can't estimate the income and expense • most expense is from payback for debt • 25-30 THB for water cost
Alternate Income Source:	• No (want to do but lack of labor)
Income Enough:	• Want more income but do have enough labor to make more money
Migration:	• 1 in BKK
Concerns:	• "WATER"
Change:	• Want to see "binding canal" in the village
Expansion:	• Never try to grow crop in dry season • Want to do a cricket farm but don't have initial fund
Risk:	• Afraid to start

Name:	• Khun Hong Kornchai
Occupation:	• Farmer
Crop:	• Rice (in-season rice, May-Dec) • 30 buckets for yield, 60 sack for eating • about 3,000 THB is expenses per month
Animal:	• No (cannot do because health condition)
Land:	• 27 rai (near the lake) • Flooding, damaged 100%, last year
Education:	• Learnt from her parents • PDA gave occupational knowledge not agricultural knowledge • if have a seminar she would like to attend
Water:	• use only rain water
Water Workload:	• no need work, use rain to irrigate
Soil Improvement:	• never improve the soil
Marketing:	• transport rice to rice mill by ask someone in the village to do for her (have to pay for sack cost) • rice mill come to buy directly to her (no sack cost)
Income & Expenses	• 3,000 THB from her children, 1,000 THB from government for disable ppl • about 3,000 THB is expenses per month • hire ppl to sow rice, 2 ppl for 400 THB/day, and 1 to plow, 270 THB/rai
Alternate Income Source:	• No (cannot do because health condition)
Income Enough:	• Need more income if possible, if not enough have to starve
Migration:	• 1 in BKK (21X THB/day, 6 days/week) • 1 in Nakornchasima • 1 in Phuket (22,000-23,000 THB/month) • 1 in collage
Concerns:	• "HER HEALTH"
Change:	• Want to see "binding canal" in the village

February 7, 2011: Ban Nong Pruek, Chakkarat

Khun Nor, Assistant Village Head

- Solar cell system from underground water is for agriculture and domestic use
- Before that, electricity fee was very expensive so it made water fee expensive too [5 THB] now only 2 THB/unit
- Before has solar cell system, this village used pipe water system from government pump water and collected in tank, sometimes water overflow
- Use solar cell system on day time, 6am-4pm
- Now also has a problem, solar cell system use for domestic and agriculture, in future it will be out
- Water tank far from pump 680 meters, this system can flow water for 2km, insurance 20 years
- Price for solar cell = 370,000 THB by IDA-TECH company
- Water pressure depends on submersible
- This system never have problem, if has any problem, company will fix it for free
- Create tank to collect water (future project)
    - Collect water on daytime so don't have to pay for electricity fee
    - By every house should have tank to collect water on daytime
    - Don't have to use electricity system
- 117 houses, 102 meters (some house use 2 meters) that use pipe water system. Others use water from other village
- Used pipe water system from sub-district, tank capacity = 2000L which was not enough, now PDA built tank 20,000L
- Solar cell is on the land of headman's mother-in-law so who own this land use water for free
- Water meter, village gave them for free but some who wanted first have to pay because they don't want to wait (pay = 34 meters)
- Water price = 2THB/unit, electricity fee = 3.80 THB/unit
- Normally this village grows cassava and sugarcane
- 3-4 persons got flood, but their land are not in this village
- This village don't have problem about village bank so PDA suggest this village to standard charter

- Who came back from Bangkok, grow mushroom or recycle plastic bag

Khun Kiatisuk Chaiyasit, Chakkarat PDA Staff

- Start this project because electricity fee in this village very expensive
- This village is the first village that use solar call (test)
- Didn't look for other power source because PDA thought that this is the most cheapest
- 20 years warrantee (problem by itself only)
- Propose this project to standard charter, they paid part of it (tank, main pipe)
- For next village plan to pay 100,000 per year
- No interest fee from IDA-TECH, but they also want money back
- Director of PDA Chakkarat began the idea by having solar at PDA office first
- Solar cell is good but in future will have problem because underground water will run out
- PDA tank built at the highest land
- Near- far of the tank effect to water pressure (near = high pressure)
- Dripping system for sugarcane start by took villagers (9-10 persons) to see how it work at Suranaree university and the product is double (co-op with headman)
- PDA gave knowledge by looking what villagers grow now and suggest new technique how to grow crops higher yield = less land
- Pipe water system that connect to farm, take a loan from village bank and some help from sugarcane industry
- There are 2 main pipe line first is from Sub-district other one is using money from S M L project (Gov. project give 200,000 THB each village)
- Standard Charter give 10,000 THB to build jar with floating ball (now can build only 10 houses)
- Main factor that choose this village
    - Clean energy
    - Water fee and electricity fee not balance (electricity fee higher than water fee)
    - Land factor unrelated

Khun Man, Mushroom Farmer

- Learn how to grow mushroom from a group grow mushroom in Pimai district
- Water cost : 80 THB/month

- Sell to middle man at Salaburi province
- Sell at 65 THB/Kg
- After 1 month can harvest
- Watering twice a day
- Income 7,000-8,000 THB, profit 4,000-5,000 THB
- Cost of growing mushroom is about 15,000 THB/mushroom house
- Water cost used to be 120 THB/month now is only 80 THB/month (after has solar cell)

Khun Thanaya, Farmer

- Grow corn and pumpkin all year
- Corn: after 2 and a half month can harvest
- Income 6,XXX THB/ 2 month and a half. water cost 500 THB
- Grow corn and pumpkin in 1 rai and a half of land
- Grow cassava in dry season (not the same land with corn and pumpkin)
- Initial cost of connecting pipe and pump is about 10,000 THB
- Use dripping system
- Use chemical and organic fertilizer
- About 1 year that use dripping system
- 30 rai of land grow cassava, yield is 6 tons/rai, sugar cane, yield 10 tons/rai

February 9, 2011: Ban Thad

Khun Anong, Village Headwoman

- Groups in Ban Thad are:

1. Chili paste
2. Thai dessert
3. Expel Poverty Fund (PDA)
    - Cricket Farm
    - Weaving
    - Silk worm
    - Fishery
    - Foot Scraper
    - Agriculture
    - Rice mill
    - Organic Vegetable

4. Village Bank

- Committees in Ban Thad are:

1. Village Committees
2. Water Committees

- People that stay in the village are older people, people in the occupational group, people have young children, people do weaving mat
- If has more water want to grow corn instead of vegetable
- Demand of rice is higher than other crops

	K. ThongSuk (Chili paste)	K. Suporn (Thai dessert)
Group members	• 30 people • Work in shift (5people) and rotate	• 15 people • Work in shift (5people) and rotate
Income	1,400 THB/month	> 1,400 THB/month
Activities	Meeting once a month	Meeting once a month
Become a member	Pay for stock, 100B/person	Pay for stock, 100B/person
Change	Find more market	Find more market, package improvement

Appendix C: Crop Water Usage Calculations

Rice: Flooded Irrigation Usage Per Season

Water usage per season: 900-2250mm (Food and Agriculture Organization, 2006)

Average land owned per household: 10 rai (Figure ?)

1600m^2 per rai

Minimum estimated water per season: 0.900*10*1600=14400m^3

Maximum estimated water required per season: 2.250*10*1600=36000m^3

Estimated seasonal water cost at 2 THB per cubic meter (proposed with solar cell):

28800-72000 THB

Estimated seasonal water cost at 6 THB per cubic meter (current):

86400-216000 THB

Appendix D: Notes from Options Chart Activity

- Chairs for about 30 people were arranged around five different tables, with additional chairs left on the sides for additional people to use when joining full tables.

- When villagers arrived one by one at first, the researchers greeted them, encouraged them to sign their name in the community check-in book, and asked them to located their farmland on a printed, large, gray-scale Google map of the village and the surrounding land.

- Upon arrival of the first few people we discovered that many of the villagers cannot read maps and could not understand them even after brief explanation was provided and the maps were oriented according to the actual layout of the village.

- Because of this, the map with farmland was not filled out until about a few later, when villagers were given more instruction and more villagers who understood arrived. Villagers that were particularly good at understanding maps assisted others in locating their farms when the researchers visited each table with the map. The map remained through the meeting at the mostly men table, where one villager led the others in located the farms of other people from the village on the map in order to give a more complete picture of where Ban Thad's farms are.

- As more people arrived in groups, signed in, and chose their seats, everyone chose to sit at the tables the furthest away from the front. Rather than sit in the first row of tables when the back row of tables got full, the villagers moved chairs and crowded ariound tables in the back, and sat on the low wall in the back. Villagers sitting on the wall in the back were invited to sit at the empty tables, and eventually one of the three front tables was filled, though the other two remained empty. Some of the last women to arrive sat on the wall in the back corner and stayed there.

- To keep people engaged while they waited, the researchers went around to all the tables with the map to locate farms.

- It only took about 30 minutes for the majority of people to come to the meeting place and sign in. When we began speaking, 43 people had signed in. A few additional latecomers signed in while the researchers were saying their introductions and explanation of the meeting.

- About 2/3 of the attendees were female, 1/3 were male. Most of the men stuck to one table in the corner, the women and a few men took over the rest of the tables. About 40-50 villagers attended the meeting for at least the beginning.

- Once people were settled in and every table had filled out where their farms were located, we used the microphone to introduce ourselves, give a speech about our purpose, and summarize our project over the past 3.5 weeks. The farangs each said something in English that the group had discovered about Ban Thad, and Warm and Goong translated for the villagers.

- At this point we handed out options charts to each table. Each table was given 2-3 charts, based on how many people were sitting around it – we tried to give about one chart per 4 or 5 people.

- We then explained the options chart activity, including the different criteria by which to judge each option. Details were given about each of the options presented on the chart: connecting to the gov't system, new system with solar cells, new system with electricity, and digging individual ponds. Although the researchers did not speak for a very long period of time, this may have been too much information for the villagers to understand since the concept was very new to them and something they had likely never done before.

- All groups were very confused as soon as we finished our explanation and looked over the option chart handouts; not much discussion occurred. It was clear that despite having simplified the chart

from the PRA literature it was based on, the villagers had a hard time understanding what was expected of them.

- The researchers attempted to go around to the table to explain and answer questions, but only one Thai student could do this at first since the Headman was asking the other Thai researcher questions. The researchers enlisted the help of Khun Radree to help explain to tables since she speaks Thai. Still, there were not enough people to go around and help each group.

- At this point, one man said that he could not do the options chart because he had a headache.

- Khun Ratree, the PDA staff person who is the chief liaison with Ban Thad, took the microphone and addressed the confusion and questions that the villagers seemed to have. In particular, she elaborated on the individual pond option and how you only have to pay one time, of which the villagers had overwhelmingly negative pre-conceptions. Also she walked around to each table to helped researchers explain more about option chart in Isarn Thai.

- After that explanation, things went much more smoothly and groups began discussing with each other.

- However, it became immediately obvious that the villagers were uninterested in filling out the chart as intended.

- Most preferred writing short phrases instead of simple checks and Xs, and no group filled in every cell of the chart. Many ignored the columns completely and just wrote down general thoughts about the different options.

- Occasionally individuals (e.g. a lone man sitting a women-dominated table in the front) filled out their own papers without group input. However, these were exceptions and much discussion occurred - overall, people were very engaged.

- Some tables passed their charts to neighboring groups because they didn't understand the chart, or perhaps because they were uninterested in filling them out.

- The back left table ended up with the majority of the options chart papers; though more than one person was filling out the different charts, several of them were returned with identical text.

- One of the tables gave away all of their charts. The team took a new chart and verbally questioned the table about it, writing their answers in for them on the chart so that group's opinions could be heard.

- There was not much interaction between the two sides of the room (men vs. women) as the options charts were being completed.

- The tables took different amounts of time to finish their charts. The first to finish, the men's table, was given the farmland map to continue with. A few other people came over from other tables to help with this as they finished with the options chart too.

- At first, we were going to have people make a tally of how many people in Ban Thad owned land in different areas in general since they could not identify where exactly others' land was located, but one villager took charge of locating everyone's land.

- That turned into marking where their own land or the land of their friends/neighbors was by making a red mark over the field on the google map.The land ended up being more wide-spread than we had originally been told, maybe indicating that one single pipe or system might not be able to reach as wide a selection of villagers as we had expected.

- Meanwhile, the options chart continued with other groups. General impression while we were walking around was that people wanted the solar cell project, did NOT want to connect to the government system, and preferred non-electricity sources (Katrina has notes with greater detail).

We asked a few questions such as, if the solar cell project is too expensive, what is your second choice? If your farm is too far away, would you consider a pond?

- Some people really didn't want ponds, others thought they might be useful since there's only a one-time cost. Major issues were that people with little land didn't want to use their land for a pond, the ponds wouldn't store enough rainwater for a second rice. Good part about ponds is that they only have to pay once, as opposed to continuing to pay for electricity.

- This preference for cost being all up-front instead of spread out over time was the primary reason they claimed to like the solar cell and pond projects.

- People did not seem concerned about the initial cost of the solar cell project - it was generally assumed that PDA would find a sponsor and the villagers would not have to pay for the expensive system. People also simply thought solar cells sounded interesting.

- However, they associated an electric system with charging rates for electricity, and so very much disliked it. This is significant because the cost of the solar cell project is much, much more expensive than the cost of an electric project would be. Furthermore, it is unclear whether or not the villagers would have to pay back the cost of a solar cell project, in which case the electric option would be cheaper for the villagers.

- Some people who had finished began to get bored and wander away about 40 minutes after handing out the options charts.

- At this point we declared the activity done, collected all charts, and summarized their contents on a large version of the options chart.

- While we created the summary chart, Khun Sanit spoke and talked about many different things: how a solar cell project may not provide enough water for second rice, how villagers and not the PDA are ultimately responsible for change in the village.

- We used the microphone to explain the summary of the charts as we held up the summary chart for everyone to see. It had overall rankings of each project and the general comments people had. The researchers also explained their opinions of the different options.

- As expected, no one was very interested in discussing in a big group – they seemed to accept the summary as we saw it as accurate. One man gave a comment about the pond that pond may not collect water enough for the second rice and also some year lack of rain so farmers can't collect water as much as they can.

- We then thanked everybody, took a group picture, and lunch was served. Only about 15 villagers stayed to eat lunch, which surprised us since we thought this was a main reason so many came. Perhaps this suggests that people in Ban Thad are willing to participate as a community because they care significantly about getting more water and changing their village.

General notes on Options Chart:

- People did not understand the criteria columns such as equitability and productivity, even when worded more simply than PRA literature suggests (eg, "fairness").

- It was much easier for them to tell us in words what they think of the system.

- Villagers knew very little about the ideas before we told them about them, even though some of their neighbors had already implemented ponds and attachments to the government system.

- The "new systems" ideas were the most foreign – the only really understood that "they will bring more water" and "The PDA will pay for them".

- Some villagers did not want to fill out the chart at all. It was unclear whether the chart was too hard to understand or if there was some other reason.

- Attendance was MUCH better than the last participatory attempt (the mapping activity). We originally assumed that advertising an included lunch was the main driver for the participation, but since most people did not stay for lunch, it is unclear why participation was improved. Possibilities include telling people about it further in advance and that we held it in the morning on a weekday, i.e., when children were busy at school.

Appendix E: Options Chart

Potential solution of water for agriculture

Classification

- Satisfaction = Ranking from 1 to 4, 1 means very like and 4 means don't like at all
- Construction = Difficulty, can built by villagers or have to hire some company
- Maintenance = Villagers can maintain by themselves or have to hire some company
- Equitability = Everybody can access to the water system or not
- Productivity = Amount of water enough for all villagers or not

	Satisfaction	Construction	Maintenance	Equitability	productivity
Connect pipe to the main government pipe					
Water gate + Solar cell					
Water gate + Electricity					
Ponds					

Given score

✓ Like

0 So so

X Unlike

Appendix F: Individual Pond Cost Analysis

Estimated cost of digging an individual pond:

$$35\frac{THB}{m^3}$$

(Ruaysoonnern, 2008)

Estimated volume of pond suitable for vegetables in Ban Thad (based on Khun Virad's existing pond):

$$Volume = Width \times Length \times Depth$$

$$Volume = 6m \times 8m \times 2.5m = 120m^3$$

Estimated cost of vegetable pond:

$$Total\ Cost = Unit\ Cost \times Volume$$

$$Total\ Cost = 35\frac{THB}{m^3} \times 120m^3 = \mathbf{4,200\ THB}$$

Khun Virad's pond is not actually able to supply all of his dry season water needs. To account for this potential error, we consider a pond of the same lateral area but dug to a depth of $4m$, the minimum depth recommended by His Majesty the King of Thailand for vegetables under the New Theory Agriculture plan (Royal Irrigation Department, n.d.):

$$Volume = 6m \times 8m \times 4m = 192m^3$$

$$Total\ Cost = 35\frac{THB}{m^3} \times 192m^3 = \mathbf{6,720\ THB}$$