Rural Livelihood Strategies and Natural Resources in Oudomxay, Lao PDR

Master's Thesis

For the Master's of Science Degree in Natural Resources Management and Ecological Engineering

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Abstract

Rural communities in Lao PDR are highly dependent on natural resources such as timber and non-timber forest products, and agricultural land, for cash income and subsistence. Approximately 80% of the Lao PDR population live in rural areas with a 40% incident rate of rural poverty. Oudomxay, a province in the northeast of Lao PDR, is a mountainous rugged region, with a high rural population. It is the second poorest province in the country. Due to a variety of factors such as population growth, opening up of the economy, implementation of government policies (i.e. land allocation) and forest degradation, the livelihoods of the rural peoples and their access to natural resources are being altered. Within this setting a livelihood strategy analysis was conducted, focusing on specific livelihoods and specific natural resources, in Mang village, Oudomxay. The interrelations between changing access to specific natural resources and rural livelihood strategies of villagers within different wealth categories and different genders were studied.

This research was conducted using the sustainable livelihoods framework. Research methods employed Participatory Rural Appraisal techniques such as, time trend analyses, focus groups, and semi-structured interviews. Results show significant changes in livelihood strategies and associated land uses over the past 10 years. Upland rice cultivation and animal husbandry, although still important, have decreased; while strategies such as lowland rice, sesame and maize cultivation have increased. Other strategies have also become important. Farmers now cultivate puak muak, posa and rubber trees. Mang village is transitioning from extractive to domesticated production. To illustrate, the density of puak muak and posa trees have decreased within the forest but increased on domesticated plots. Nevertheless, not all livelihood transitions are occurring at the same rate or in the same direction. Adoption disparities of certain livelihood strategies are apparent between wealth categories. For example, people within the richest wealth category tend to cultivate more lowland rice and were the first to adopt this strategy. In addition, the access to certain natural resources also differs between wealth categories. For example, the majority of the agricultural land of the richest wealth category is located closer than that of the other wealth categories. The way in which natural resources are accessed has also changed over the past 10 years. One of the most noticeable changes is in the access to land due to the new land allocation polices enforced by national and local governments.

This study was conducted within the CIAT-BOKU Research for Development Project in Oudomxay entitled 'Spatial trade-off analyses for site-sensitive development' which works in collaboration with the provincial Oudomxay Community Initiative Support Project and IFAD. This project requires site specific information on natural and socio-cultural resources to facilitate effective project interventions and policy analyses. The main objective of the CIAT–BOKU research project is to enable rural dwellers in Northern Lao PDR to effectively engage in market activities while maintaining and enhancing the productive capacity of their lands.

Zusammenfassung

Ländliche Gemeinden in der Demokratischen Volksrepublik (DVR) Laos hängen zur Erzielung eines Einkommens und zur Deckung des Eigenbedarfs stark von ihren natürlichen Ressourcen ab. Diese sind vor allem landwirtschaftliche und forstwirtschaftliche Produkte. Circa 80% der Bevölkerung der DVR Laos leben in ländlichen Gebieten, davon 40% unterhalb der Armutsgrenze. Oudomxay, eine Provinz im Nordosten von Laos (die zweitärmste des Landes), ist eine bergig-felsige Region mit einem hohen ländlichen Bevölkerungsanteil. Aufgrund verschiedener Faktoren wie Bevölkerungswachstum, Öffnung der Märkte, Umsetzung von gesetzlichen Auflagen (z. Bsp.: Flächennutzung) und Walddegradation ändert sich die Existenzgrundlage der ländlichen Bevölkerung und ihr Zugang zu den natürlichen Ressourcen. Diese Situation berücksichtigend wurde eine Analyse der Lebensstrategien in der Ortschaft Mang, Oudomxay durchgeführt, mit Hauptaugenmerk auf bestimmte Lebensweisen und bestimmte natürliche Ressourcen. Es wurde untersucht wie ein sich verändernder Zugang zu bestimmten natürlichen Ressourcen und die Lebensstrategien der ländlichen Dorfbewohner zusammenhängen, aufgeschlüsselt nach verschiedenen Bevölkerungsschichten (passierend auf deren Reichtum) und des Geschlechts.

Diese Studie wurde mittels Verwendung des Sustainable Livelihoods Frameworks durchgeführt. Angewandte Untersuchungsmethoden waren Participatory Rural Appraisal Techniken wie Trendanalysen, Fokusgruppen und semi-strukturierte Interviews. Die Resultate zeigen eine signifikante Änderung der Lebensstrategien und der damit verbundenen Landnutzung in den vergangenen 10 Jahren. Der Anbau von Hochlandreis und die Viehzucht, obwohl noch immer wichtig, haben abgenommen. Dafür wurden verstärkt Flachlandreis, Sesam und Mais angebaut, sowie Puak Muak, Posa und Kautschuk kultiviert. Im Allgemeinen ändert sich die Lebensweise in der Ortschaft Mang von der Nutzung natürlich wachsender Ressourcen hin zu zum Anbau von Kulturpflanzen. So hat sich zum Beispiel der Anteil von Puak Muak und Posa im Wald verringert, zur gleichen Zeit jedoch auf landwirtschaftlichen Flächen zugenommen. Die Änderung der Lebensgrundlage läuft jedoch nicht für jeden mit der gleichen Geschwindigkeit und in die gleiche Richtung ab. Die unterschiedliche Anpassung einzelner Lebensstrategien zwischen verschiedenen Bevölkerungsschichten ist offensichtlich. So zum Beispiel tendiert die reichste Bevölkerungsschicht eher zum Anbau von Flachlandreis und war auch die erste die diese Strategie angewandt hat. Zusätzlich unterscheiden sich die einzelnen Bevölkerungsschichten auch in ihrem Zugang zu bestimmten natürlichen Ressourcen. Zum Beispiel befinden sich landwirtschaftlichen Flächen der reichsten Bevölkerungsschicht näher bei den Dörfern als die Anbauflächen der anderen Schichten. Auch die Art und Weise wie natürliche Ressourcen verwendet werden hat sich in den letzten 10 Jahren geändert. Eine der offensichtlichsten Änderungen betrifft den Zugang zu Landbesitz, hervorgerufen durch die Flächennutzungspolitik der nationalen und lokalen Behörden.

Diese Studie wurde innerhalb des CIAT-BOKU Forschungprogramms für Entwicklungsprojekte in Oudomxay mit dem Titel „Spatial trade-off analyses for site-sensitive development" durchgeführt. Dieses Programm arbeitet mit dem lokalen Oudomxay Community Initiative Support Project und IFAD zusammen. Dieses Projekt benötigt lokale Informationen betreffend der natürlichen und soziokulturellen Ressourcen um die effektive Umsetzung des Projekts und die Analyse der politischen Rahmenbedingungen zu erleichtern. Das Hauptziel des CIAT-BOKU Forschungprogramms ist es, den ländlichen Bewohnern im Norden der DVR Laos den Einstieg in den Markt zu ermöglichen und zeitgleich die Produktivität ihres Landes zu steigern.

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1. Background

Lao PDR (Laos) is a landlocked country, covering a total area of 236,800 km^2 with 6,000 km^2 of water. Five countries surround Laos including: Myanmar (Burma), Cambodia, China, Thailand and Vietnam (Figure 1) (CIA 2006). Approximately 80% of the land area is mountainous with some plains, along the border of Thailand, in the south-west and west (FAO 2006). Elevation at the lowest point is 70 m along the Mekong River and the highest point is 2,817 m at Phou Bia. The Mekong River forms a large part of the western boundary with Thailand and is the largest waterway in the country. The climate is tropical monsoon: the rainy season is from May through October; the cool dry season is from November through February; and the hot dry season is from March to April (CIA 2006). Rainfall varies regionally, with the northern mountainous region and the floodplain region of the Mekong River receiving an annual rainfall of approximately 1,500-2,000 mm and the central and southern mountainous region receiving an annual rainfall of approximately 2,500-3,500 mm (Bouahom *et al.* 2003).

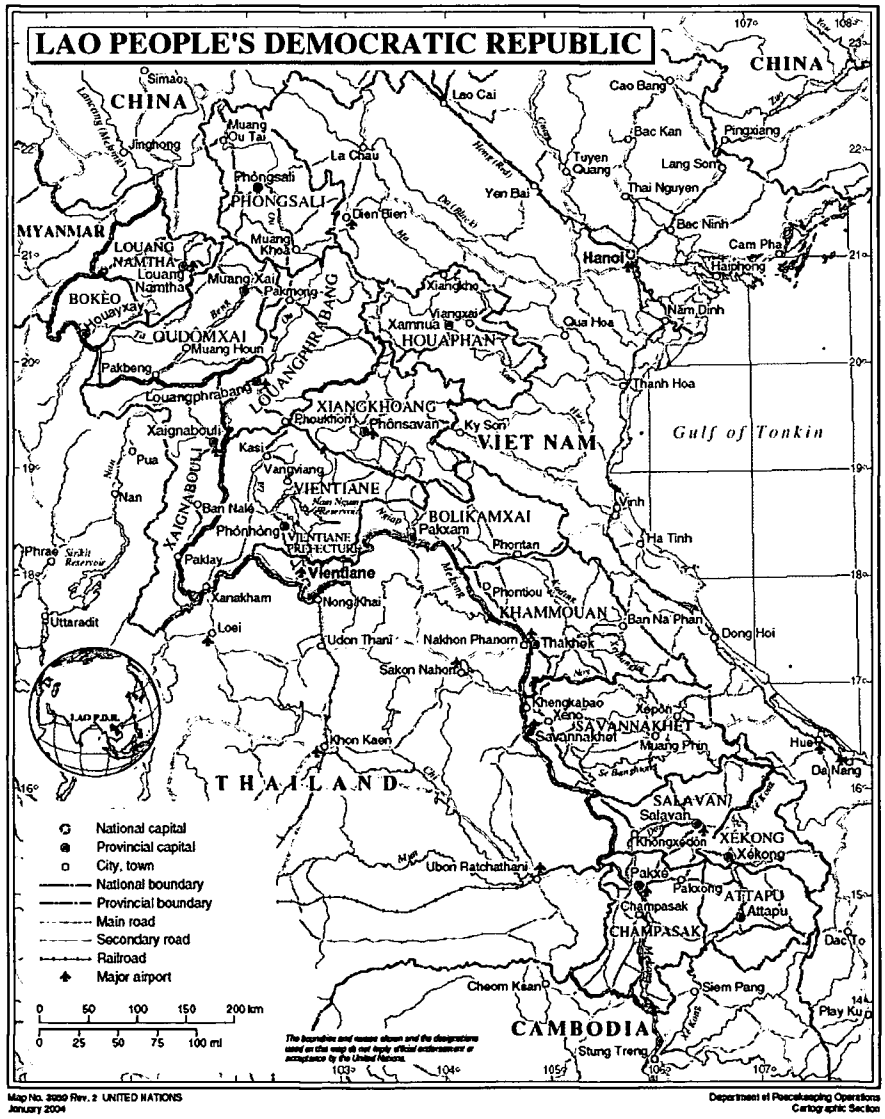

Figure 1: Overview map of Laos with provinces and neighbouring countries (Source: United Nations 2004)

Oudomxay is a province in the north of Laos and has a total area of 15,370 km^2 which is approximately 6% of the total area of Laos (Figure 1). The capital of Oudomxay is Muang Xay (also known as Oudomxay town) located in the north of the province. Oudomxay shares a

small part of its border (15 km) with China in the north and it is also bordered by five other provinces: Bokeo, Louang Namtha, Phongsaly, Louang Phabang and Sayaboury. The Mekong River flows through the south of Oudomxay along part of the border of Louang Phabang and Sayaboury. This northern mountainous province has a moist to dry sub-tropical climate (Bouahom *et al.*; FAO 2006). In northern Laos slopes are steep and elevation is generally greater than 1,000 m (FAO 2006; Bouahom *et al.* 2003). Only 5 - 6 % of northern Laos has a slope of less then 20 %, while 46 – 50 % has a slope of more than 30 % (Forppes 2004; Bouahom *et al.* 2003). The area experiences a cooler dry season and greater temperature variations during the year than other parts of the country (Bouahom *et al.* 2003). There are seven districts within Oudomxay: Beng, Houn (alternate spelling Hoon), La, Namo (alternate spelling Namor), Nga, Pakbeng and Xay (Figure 2). This research was conducted in the village of Mang located in Beng district (Appendix B).

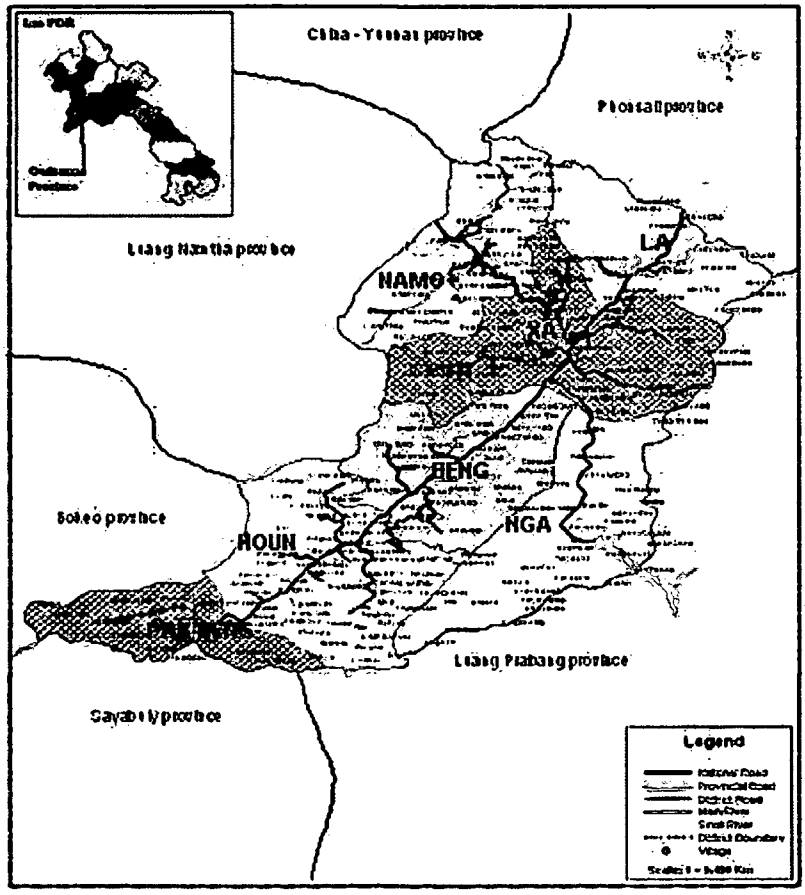

Figure 2: Districts of Oudomxay province

1.1 Social Characteristics / Population

The population of Laos is approximately 6.5 million with an annual growth rate of 2.37% (CIA 2006). Of the Asian countries, Laos is one of the least densely populated countries with 23.3 people per km^2. Approximately 80% of the population is rural. Laos has a diverse range of ethnic groups, indigenous communities and languages. 47 ethnic categories were recognized in the National Census of 1995; however, between 130 - 230 ethno linguistic groups have been identified within four linguistic families: the Tai-Kadai, the Mon-Khmer, the Hmong-Mien and the Sino-Tibetan (Bouahom *et al.* 2003; Yokoyama 2003). These linguistic families can be incorporated into three main geographical categories: the Lao Loum, Lao Theung and the Lao Soung. The Lao Loum, live in the plains around the Mekong river valley and constitute 68% of the population. The Lao Theung, live in the middle slope region, and account for 22% of the population, and the Lao Soung, live in the remote highlands and account for 9% of the total population. The final 1% of the population is mainly ethnic Vietnamese or Chinese (Bouahom *et al.* 2003; CIA, 2006). The two common religions in Laos are Buddhism, and Animism, other small religious fractions are also found (CIA 2006).

In Oudomxay, the population, in a 2004 estimate, was 275,300 with a population density of 18 inhabitants per km^2 (Quickseek 2005). The largest ethnic group in Oudomxay, is the Khamu ethnic group (alternate spellings include Kammu and Khmu), who are a part of the Lao Theung ethnic category (Foppes et al. 2004; Savada 1994). While the Khamu are a minority in Laos they are the majority in Oudomxay. The Khamu ethnic group, whose language belongs to the Austro-Asiatic-Khmer language family, is one of the oldest ethnic groups in northern Laos (Foppes *et al.* 2004). Other ethnic groups are found in Oudomxay such as Hmong, Iko and Pouthai (not a complete list) (Laos Embassy 1997). In Mang village where this study takes place the villagers are Khamu (IFAD 2005). The religion of the Khamu is generally Animism (Savada 1994).

1.2 Agro-ecological & Natural resources

1.2.1 Forest and wildlife

Forest cover in Laos is extensive especially in the mountainous regions such as in Oudomxay. Currently, approximately 40% of Laos is covered with forests. However, in the 1940s 70% of the country was forest. This drastic reduction in forest cover is mainly due to the rapid population growth resulting in over utilization of the forest, logging (both legal and illegal) and a large conversion of forest to agriculture land (Foppes & Ketphanh 2000; Seidenberg *et al.* 2003). There are currently 20 National Protected Areas (NPAs) and two corridor zones in Laos covering approximately 13% of the country (Hansen & Jeppesen 2004). Within the forest is a large amount of non timber forest products (NTFPs). The World Conservation Union (IUCN) - NTFP Project has identified more than 700 species of NTFPs (Foppes & Ketphanh 2000). Examples of some common NTFPs, for subsistence or commercial use, are paper mulberry bark (*Broussonetia payrifera*), cardamom (*Amomum* spp.), bamboo shoots (ex. *Bambusa* tulda or *Oxythenanthera* parvifolia), rattan (*Calamus* spp), fish and wildlife. Laos is rich in biodiversity with forests estimated to contain over 10,000 species of vascular plants and wildlife (Bouahom *et al.* 2003).

Oudomxay, in the year 2000, had three different types of protected areas: provincial, district and watershed, with a total protected area of 315,000 ha. The watershed protected area, however, had not been fully delineated (ICEM 2003). Typically exported NTFPs from Oudomxay include cardamom (*Amomum* spp.), Kisi damar resin (*Shorea obtuse*), sugar palm fruits (*Arenga pinnata*), bong bark (*Nothaphoebe umbelliflora*), broom-grass (*Thysanolaema*

maxima), orchids stems (mainly *Dendrobium spp.*), rattan canes (*Calamus* spp), paper mulberry bark (*Broussonetia payrifera*), Mai chandai stems (*Draceana spp*), Tout tiang bark (*Boehmeria malabarica*) and Eaglewood leftovers (Aquilaria spp.) (Foppes 2004). NTFPs constitute a large portion of the Oudomxay people's food security and cash income.

1.2.2 Agriculture

Within Laos most farmers employ one of two cultivation systems: either the wet-field paddy system, practiced primarily in the plains and valleys, or the swidden cultivation system, practiced primarily in the hills such as in Oudomxay. 45% of the rural villages are dependent upon swidden agriculture for their subsistence. Under the swidden agricultural system long fallow periods are required for the productivity of the land to recover (Evrard & Goudineau 2004). The main crop is rice and other important produce are vegetables, fruits, corn, cassava, coffee, sugarcane, tobacco, cotton, tea and peanuts. Livestock grazing is also an important component of rural livelihoods, with water buffalo, pigs, cattle and poultry being the principle livestock. Although the government is attempting to eliminate opium production, it is still prevalent in some regions (Bouahom *et al.* 2003). Non-timber forest products (NTFP), some now being cultivated and domesticated, are a major contribution to household food security and cash income in certain regions (Foppes & Ketphanh 2000).

Approximately 40,000 ha of land is cultivated in Oudomxay with rice as the major crop. The rice is mostly from rain fed upland systems with some rice growing in rain fed lowland systems and a small amount of irrigated systems. Maize and soybeans are other important crops in Oudomxay. Table 1 gives an overview of the crops being cultivated within the province (Ministry of Agriculture and Forestry 2000; Phongsavath 2003).

Table 1: Crops in Oudomxay (Ministry of Agriculture and Forestry 2000)

Crop	Cultivated Area (ha)	Total Cultivated Area (%)
Rice	29,430	76.5
Maize	2,300	6.0
Soybean	140	0.4
Vegetables	3,670	9.5
Other bean and cash crops	2,920	7.6
Total	38,460	100.0

1.3 Economy and Government Policy in Laos

Laos became a Communist state when the Pathet Lao came into government in 1975. In 1986, however, the government adopted its New Economic Mechanism and open door policy allowing the country to change from a command to market-driven economy thus allowing liberalization of foreign investment (UNDP 2001, Lao PDR). A 2005 estimate of the GDP is $2.523 billion with a growth rate of 7.2%. Approximately 43% of the GDP is from the agricultural sector and it is estimated that 66% of the GDP is contributed by biodiversity (UN 2003, CIA 2006). An estimate in 1996 by Oudomxay residents indicates that the majority ($\approx$ 60%) of their income comes from NTFPs with additional income being derived from livestock, rice, other crops and only 1% coming from off-farm activities (Foppes & Ketphanh 1997). A 2002 estimate of poverty indicates a national poverty rate of 34% (CIA 2006), and a rural poverty rate of 40% (Foppes & Dechaineux 2000; Rigg 2003). Although the poverty rate for the country is decreasing the inequality between rich and poor is increasing. The second-poorest province in the country is Oudomxay with a poverty index of 73.2% (IFAD 2006; Lao PDR).

The main government strategy which is guiding and providing a framework for the development and implementation of all government poverty eradication programmes is the National Growth and Poverty Eradication Strategy (NGPES). This strategy was developed from the National Poverty Eradication Programme (NPEP). This NGPES is serving as the International Monetary Fund and World Bank required Poverty Reduction Strategy Paper (PRSP). The NGPES was approved by the National Assembly and submitted to the World Bank and IMF in 2004 (IMF & IDA 2004; Lao PDR). The ultimate objective is for Laos to no longer be categorized as a least developed country by 2020. Within the strategy is the goal to reduce rural poverty and conserve natural resources through the holistic transformation of upland livelihoods (Thomas 2003). Some of the sub-objectives, priorities and policies of the programme are stabilising and eliminating shifting agricultural cultivation, eliminating opium production by 2006, increasing service provisions, decentralization, and implementing land allocation programs and relocation programs (Baird & Shoemaker 2005; IMF & IDA 2004; Lao PDR) The strategy makes a point of focusing on the poorest districts in the country of which 5 of the 7 districts in Oudomxay were listed as priority poor districts and one is a poor district (Appendix A) (Lao PDR unknown date).

1.5 Development Challenges and Project Context

In Laos in general and Oudomxay in particular, rural communities are highly dependent on natural resources such as agriculture and forest, both timber and NTFPs, for cash income and subsistence. As a result of population growth, government policies and a transformation from a command to market economy the traditional livelihoods of rural communities are being altered. Availability of and access to land and natural resources is changing. Access to adequate land for cultivation and other natural resources is lacking in Oudomxay (IFAD 2006). Land access is changing, partly as a result of population growth, land allocation programs and designated forest conservation areas (Foppes & Ketphanh 2000; Rigg 2003). Forests are generally decreasing due to an increased conversion of forest to agricultural land, increased utilization of forest resources and increased timber production. One of the development challenges relevant to this study is implementing appropriate development projects within the rapidly changing context of the rural areas. Also, due to the diversity of both the landscape in Laos and the ethnic, linguistic and cultural mix another development challenge is to facilitate suitable livelihood development strategies within this varied landscape.

It is believed that current development work in Oudomxay would be enhanced through site specific information and culturally sensitive implementation which incorporates the needs and goals of the community. With these ideas in mind the CIAT-BOKU[1] research for development project entitled 'Spatial trade-off analyses for site-sensitive development' is being implemented. The overall objective of the CIAT-BOKU project is to enable rural dwellers to effectively engage in market activities while maintaining and enhancing the productive capacity of their lands. It is hypothesized by the CIAT-BOKU research team that site specific information on natural and socio-cultural resources will facilitate effective project interventions and policy analyses. This will enable communities and development practitioners to implement livelihood strategies that are appropriate to local conditions. To reach the stated objectives the CIAT-BOKU research project includes three interconnected components: a GIS analysis of fallow systems; a market chain analysis and learning alliance; and a livelihood analysis. One particular section within the livelihood analysis section is the collaborative livelihood system appraisal and development (CLSAD) approach. This approach commenced in June 2006 and is working with focus groups in villages of Houay Sang, Saluang, Phou Lat and Namheng Neau,

[1] http://www.wiso.boku.ac.at/laos.html

recognizing strengths, envisioning future goals, designing action plans, implementing action plans and conducting participatory monitoring and evaluation.

This MSc study is embedded within the overall CIAT-BOKU project and in particular within the livelihood analysis section. This thesis utilizes information and methods from the CLSAD approach to provide some site specific information required with respect to natural resources and rural livelihood strategies. It is hoped that the information gathered and analysis conducted within this thesis will be utilized within the CIAT-BOKU project to assist with tackling the above mentioned development challenges.

2. Previous Research & Research challenges

2.1 Research

Natural resources can be defined as materials that occur in nature and are essential or useful to humans, such as water, air, land, plants, forests, livestock, fish, wildlife, topsoil, and minerals (The World Bank 2000). Research has been conducted emphasizing the importance of natural resources in both Laos and Oudomxay for subsistence and cash income (Foppes & Ketphanh 2000). The importance of natural resources in Oudomxay is highlighted by a study conducted by Foppes & Ketphanh (1997) which shows villager's rankings of income sources in some villages in Oudomxay (Table 2).

Table 2: Villager's ranking of income sources in Oudomxay (Foppes & Ketphanh 1997)

Resources	Oudomxay
NTFPs	61%
Livestock	16%
Rice	8%
Other Crops	14%
Off-farm income	1%
Total	100%

As NTFPs are of major importance to upland livelihoods (Table 2) research studies are being conducted in Laos on a variety of aspects concerning NTFPs and the importance of forests. Globally there is a lot of research, such as Angelsen and Wunder (2003) and Belcher *et al.* (2005), studying the role of forests with respect to poverty alleviation. Areas of investigation include whether forests provide safety nets, poverty traps and/or pathways out of poverty. NTFPs and their function in rural livelihoods, poverty alleviation and forest conservation are also receiving much attention with researchers, development agencies and NGOs (Arnold and Pérez 2001). The validity of the 'conservation through commercialization' hypothesis is also being evaluated by researchers. The hypothesis speculates that forests and biodiversity can be conserved through the commercialization of forest products while providing livelihoods for rural people. What is known in Laos and Oudomxay is that forests and NTFPs are vital to the livelihoods of the rural villagers (Hansen and Jeppesen 2004; Foppes *et al* 1997; Foppes 2004). Studies have been and are being conducted on the availability, domestication and marketing of NTFPs. For example there is literature on the sustainable management of NTFPs such as wild frogs (Dechaineux 2001), domestication of paper mulberry (Aubertin 2004), the availability and use of NTFPs in specific regions in Laos (Hansen and Jeppesen 2004) and case studies on the sustainable commercialization and usage of NTFPs (Foppes & Dechaineux 2000). However, due to the diversity of NTFPs and the different usages of NTFPs more research is still required in this area. Additional research contributing to the debate on forest conservation with respect to NTFP utilization is also required in Laos.

Within the agricultural sector much research has been conducted on swidden agricultural practices (Yokoyama 2003) as it is the main agricultural system in the uplands of Laos. Research on the relationship between shifting cultivation and deforestation is also being investigated and debated (examples: Rigg and Jerndal 1996; Seidenberg *et al.* 2003). Due to population growth and government policies swidden agriculture is slowly being phased out and fallow periods are being reduced. This is also the case in Mang village where a study was

conducted within the CIAT project showing the land pressure around Mang village is high (Forster 2007; Appendix C). Current studies are investigating how to improve the fallow cycle and incorporate forest management strategies. Different studies are looking at the limits of shifting cultivation. For example, de Rouw *et al.* (2004) conducted a study looking at the adaptation of upland rice cropping with shorter fallow periods. Shorter fallow periods are causing weeds to proliferate and soil quality to deteriorate therefore research has been conducted to develop suitable sustainable alternatives or complementary strategies to upland cultivation (Lai *et al.* 2005). Studies, such as Ducourtieux *et al.* (2005) are looking at the introduction of cash crops as an additional livelihood strategy in shifting cultivation regions. Other investigations are looking at alternative strategies such as livestock intensification (Phengsavanh *et al.* 2005) and fruit tree integration. Adaptation and adoption of new technologies has been seen to be somewhat slow due to the high degree of diversity in the uplands (Lai *et al.* 2005; Linquist *et al.* 2005). Therefore more participatory and adaptive research approaches are required to develop technologies suited to local conditions (Linquist 2005; Connel *et al.* 2005).

The implementation of the policies and goals within the NPEP and NGPES has had controversial effects on the livelihoods of rural people (Shoemaker & Baird 2005; IMF & IDA 2004). The effects policies are having are discussed in different studies such as Thomas (2003), Baird & Shoemaker (2005) and Evrard & Goudineau (2004). As noted by Baird & Shoemaker (2005) there are many studies demonstrating that the internal resettlement policy is having a negative impact on the social systems, livelihoods and cultures of many indigenous ethnic communities. Thomas (2003) also indicated that operational policies, centering on stabilizing shifting cultivation, eliminating opium production, land use allocation, land use planning and focal site development are disrupting the household livelihood systems in many upland communities. The land and forest allocation policy implemented in the upland is also restricting the land available for swidden agriculture forcing people to investigate alternative livelihood options. The government is aware of some of the negative impacts and is attempting to minimize some of the negative effects.

Literature also exists showing that the availability of and access to natural resources is changing. For example, according to the villagers in Ban Nong Hin, Champasak province, there has been a great decline in specific NTFPs available (Table 3).

Table 3: Decline in NTFPs from a villager's viewpoint in Ban Nong Hin Lao PDR, Champasak (Source: Foppes & Ketphanh, 2000)

NTFP	10 years ago	Today
Wildlife	Plenty of wildlife: turtles, monitor lizards, deer, snakes, jungle fowl, other birds. You could easily hunt them in your backyard. There was no outside market, no selling. Only our village hunted (9 families only).	Many species disappeared: turtle, deer, jungle fowl, birds. You can walk for 48 hours and find nothing. Market demand is big, prices are higher (1 mouse-deer costs 12,000 kip). Many outsiders come to hunt in our forest. Village has 57 families now.
Fish	You could catch 4-5 kg within 1 hour. There were only 9 families. No selling, no destructive methods used, only traps and nets.	You can not even get 0.5 kg in 1 hour. Not enough to feed all 57 families. Strong outside market (2,500 kip/kg). Destructive methods used by outsiders e.g. explosives. Stock has declined by 90%.
Rattan	In 1 day, you could get 300 stems, or as many as a man can carry. We used to also have big diameter rattan, now only small diameter species.	You can only get 20-30 stems in a day. Harvesting has intensified over the last 2 years. We know there is no quota but we need to sell anyhow. 90%decline in stock.

The above village also described the problems associated with access rights as a number of different users have been observed hunting and fishing illegally in the nearby forest which included high ranking Government officials from the provincial capital and surrounding village communities (Foppes & Ketphanh 2000). Other studies are also noting significant changes in natural resources available such as Alton & Rattanavong (2005).

Along with and partly as a result of the changes in resources available, it has also been observed that there is a corresponding change in livelihood strategies. Within Oudomxay, in the village of Tat Mouan in the La district a study reported a change of resource utilization. Originally, the main product sold was cardamom, which contributed to approximately 56% of the family cash income. However, four years later, it was estimated by villagers that their main cash income was no longer NTFPs but peanuts (*Arachis hypogea*) (Foppes 2004). Also, within Oudomxay province it has been noted that there has been a sharp increase in the amount of maize being produced as a cash crop. Since 2003, production of maize has increased greatly in Oudomxay and is mainly produced in Beng, Houn and Xai district (Phouyyavong and Talije 2006).

The changes in resource availability and livelihood options are occurring rapidly. A few investigations have been conducted to look at how the rural people are coping. Bouahom *et al.* (2004) conducted a study to determine how rural Lao households sustain, protect and develop their livelihoods within this rapidly changing context. Population growth, land scarcity, forest degradation and government policies were cited as being responsible for causing changes in the livelihood strategies and livelihood options of rural people in Laos. It was also observed that non-farm activities are also beginning to play a larger role in the people's livelihoods (Bouahom *et al.* 2004).

As there is considerable biophysical diversity, socio-economic diversity and market diversity in Oudomxay there is still information lacking concerning how the changing context in Oudomxay is affecting livelihood strategies and outcomes on a local and individual level in different regions. Yokoyama (2003) also indicates there is insufficient accumulation of regional data with regards to environmental and development issues with respect to rural communities. Another consideration is that many of the above mentioned studies are 'grey' literature sources including workshop proceedings and development project reports by international organizations, government institutions and NGOs. There is a lack of academic research within Laos and Oudomxay. The purpose of this thesis is to contribute to fill in some of these knowledge gaps in order to assist in the facilitation of effective development options. The focus of this thesis is to acquire site specific information on the interrelations between changing access to specific natural resources and rural livelihood strategies of villagers within different wealth categories and different genders within a specific village in Oudomxay.

2.2 Justification

After the implications of the Land Allocation Programme were discovered, the UNDP called for a more livelihood-friendly development policy within Laos (UNDP 2001). Policies by the government are now being reformed to address specific needs of women and ethnic minorities which make studies investigating the different livelihood strategies of women and ethnic minorities important (Lao PDR date unknown; ADB 2001). It has also been stated by the government that greater emphasis should be given to community consultations and involvement in development work. The information from this thesis can be used to have a

better understanding of how livelihoods strategies and access to natural resources are changing within a Khamu community on a community, household and individual level.

This thesis feeds back into the CIAT-BOKU research project described in section 1.5 and can be used to complement and corroborate the other studies being conducted within the project. The CIAT-BOKU project is currently working with Oudomxay government extension staff. This allows for practical transferring and sharing of knowledge between the two groups. Extension staff will be able to use the information gathered by the CIAT-BOKU project to assist in determining suitable development options. IFAD a partner within the CIAT-BOKU project may also be able to utilize this thesis in particular as Mang village is an IFAD target village.

This study has also been very beneficial to the researcher providing valuable experience on the process of collecting information in a remote community while working within a different culture and language.

3. Objectives

Overall objective: The overall objective of this research is to study the interrelations between changing access to specific natural resources and rural livelihood strategies of villagers within different wealth categories (poor, average and rich) and different genders in Mang village. The specific objectives and sub-objectives of the research are as follows:

Objective 1: To provide site specific information on the natural resources utilized for specific rural livelihood strategies of different wealth categories and genders.

- **Objective 1a**: To determine the most important livelihood strategies.
- **Objective 1b:** To determine if the most important livelihood strategies are different between wealth categories and gender.
- **Objective 1c:** To determine the specific natural resources which are important for specific rural livelihood strategies.
- **Objective 1d:** To determine if important natural resources are different depending on gender and wealth category.

Objective 2: To determine the choice of livelihood strategies upon a timeline considering the retrospective, current and prospective livelihood options and how the choice differs between wealth category and gender.

Objective 3: To determine if and why access to specific natural resources has changed over time (approximately 10 years).

- **Objective 3a:** To determine if access to specific important natural resources has changed over time.
- **Objective 3b:** To determine if access to natural resources is different within different wealth categories and genders.

Objective 4: To determine the livelihood outcomes of the natural resource based livelihood strategies upon a timeline.

4. Methodology

4.1 Conceptual Framework

The proposed research will be a participatory study conducted within the Sustainable Livelihoods Framework (SLF) (Figure 3).

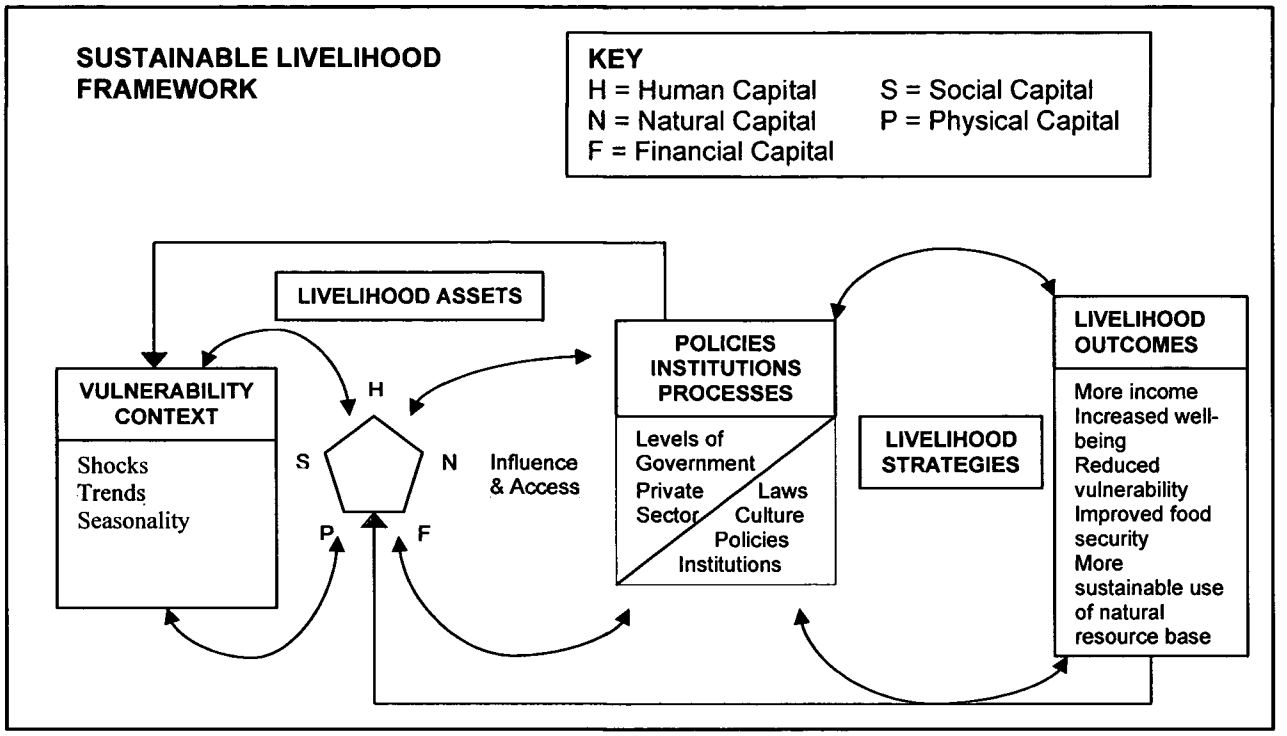

Figure 3: Sustainable Livelihoods Framework (DFID 2001)

Utilization of the SLF has been seen as important for poverty reduction by the Department for International Development (DFID). "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base" (Scoones 1998).

The sustainable livelihoods principles indicate that poverty focused development should be: people centred, responsive and participatory, multi-level, conducted in partnership, sustainable and dynamic (Carney date unknown). This research will work as much as possible within these principles; however the multi-level dimension is missing within the study as it is focused on the individual level in the community. Within the actual framework the research will focus on the natural capital component of the livelihood assets. With respect to this capital the trends, influence and access, institutional processes, livelihood strategies and livelihood outcomes as highlighted in yellow in Figure 3 were investigated. As the sustainable livelihoods framework is a holistic approach all other, assets, interrelations and components of the framework were kept in mind. The research was conducted with the understanding that it is embedded within a much larger context.

4.2 Secondary Data Collection

A comprehensive literature review was done prior to leaving for Laos and additional literature was reviewed once back in Austria. The International Fund for Agricultural Development

(IFAD) database, which has specific information on villages in Oudomxay, was thoroughly examined. The NAFRI (National Agriculture and Forestry Research Institute) website was looked at in depth as there are a variety of research reports and conference proceedings on this website[2]. Journal articles were accessed through the BOKU library scientific databases and the internet. Additional 'grey' literature was also investigated via the internet and while in Laos. Reports were reviewed at the IFAD office in Oudomxay as well as at the CIAT office in both Oudomxay and Vientiane. This constitutes the secondary data collection of the research.

4.3 Primary Data Collection

4.3.1 Study area

This study was conducted in the village of Mang in Beng district of Oudomxay, Laos (Appendix B & Figure 4). It is 20 minutes by car (14 km) along a dirt road from Beng district which is the closest major 'town'.

Figure 4: Mang village

The total population in Mang is approximately 1,060 people with 171 households. The village is divided up into an old section and a new section. Many people have moved to Mang within the last 20 years coming from other villages such as Cheu, Na lork, Keo, Tang Tou, Thang Chang, Bong and Kham Vang. Mang is different from other villages in Beng district because there is an IFAD technical centre located in the village with two DAFO staff living there and providing technical assistance. Within the last few years, infrastructure such as, small scale irrigation systems, water taps and a school have all been established through development projects. Around 2002/2003 the road between Mang and Beng district was expanded allowing vehicles to access the village. The original human made path was made around 1992. Certain other programs that are/were in the village include: a birth control project, a work for food program, a school feeding program and a rural financial services program.

[2] www.nafri.org.la

4.3.2 Sampling Method

The sampling frame is defined as the number of adults (over 18) within the village and was provided by the village headman and DAFO staff in the form of a list of households[3]. The number of people in the sample frame is 594. A wealth ranking within the community had already been facilitated by IFAD which enabled a stratified sampling of respondents for the semi-structured interviews and groups. The criteria used for this wealth ranking included things such as rice sufficiency, income, livestock and assets (for full details on criteria see Appendix D). The IFAD wealth ranking consists of 5 wealth groups which were consolidated into 3 groups for this research (IFAD wealth category (WC) 2 and 3 became in this study WC 2 and IFAD WC 4 and 5 became this study WC3). The wealth categories were consolidated due to time constraints and to be consistent with other CIAT-BOKU research projects being conducted in Oudomxay. The first strata, for this research is wealth categories, within which the second strata is gender. Equal size sampling within the strata occurred as opposed to proportional sampling. When individuals did not wish to participate, mainly due to illness, additional people were selected randomly from the remaining villagers within the specific stratums. Within the semi-structured interviews sampling was done on a household basis for gender but not wealth category. For example a man and a woman could be interviewed from the same household but not two women.

4.3.3 Research Methods

The research began working with six focus groups, each consisting of three people. There was both a male and female group for each wealth category (Table 1). For each of the male focus groups one participant did not attend due to either sickness or being busy working in the upland. The focus groups were an exploratory phase to obtain information to assist with the development of the questionnaire for the semi-structured interviews and to gain qualitative data. The questions discussed in the focus groups are provided in Appendix E. Each focus group took approximately one hour to complete and was conducted at the IFAD technical centre in the village. The focus groups took 3 days to complete with 2 focus groups per day; however this was conducted over a two week period due to the availability of the translator and time available to go to the village. The focus groups were done on October 5th, October 6th and October 12th of 2006 (Appendix F).

Table 4: Number of participants in focus groups

	Wealth Category 1 (Rich)	Wealth Category 2 (Medium)	Wealth Category 3 (poor)
Female	3	3	3
Male	2	2	2

Semi-structured interviews were then conducted to obtain a more individual perspective and to have more quantitative results regarding the differences and similarities between the different wealth categories and genders (Table 2). The semi-structured interviews took between 30 minutes to one hour to complete and the majority were conducted at the IFAD technical centre. 60 villagers were randomly selected for the semi structured interviews[4]. Within WC1 there are only 14 households therefore six respondents came from the same household as someone else.

[3] Three different household lists were provided. The first was a handwritten list, this was then typed out followed by an official list. The household lists were similar with some discrepancies. The final official list was used however, the sampling for the focus groups was done using the initial list.

[4] The formula for calculating the sample size (n) is: $n = (Z^2 [p(1-p)]N) / (Z^2 [p(1-p)]+(N-1)C_p^2)$, where $p = 0.5$ (most conservative estimate); $Z = 1.645$; $C_p = 0.1$); $N = 547$ (number of people in the total sampling frame) (formula from Rea and Parker 1997).

The semi-structured interviews were conducted from October 2006 until January 2007 (Appendix F).

Table 2: Number of participants in semi-structured interviews

	Wealth Category 1	Wealth Category 2	Wealth Category 3
Male	10	10	10
Female	10	10	10
Total # of Participants		60	

The semi-structured interview questions are provided in Appendix G. The semi-structured interview was pre-tested on four residents of Mang village to ensure questions were understandable and that the interview was not excessive in length. The questionnaire was then modified and adapted accordingly. The questionnaire was also modified during the interview process as new information emerged. During the semi-structured interview respondents were asked to list and rank their most important livelihood strategies for food and income. The rankings of these livelihood strategies were assisted by using Polaroid photographs of the different livelihood strategies (Appendix H). These photographs were taken by the researcher prior to commencing the semi-structured interviews based on the responses from the focus groups and trail interviews. Once respondents had ranked their livelihood strategies they were usually only asked further questions about their top 4 livelihood strategies. If respondents were tired or busy only the bolded questions in the questionnaire were asked or sometimes not all four livelihood strategies were discussed. Also, if interesting comments or topics were brought up by the respondent these were discussed, sometimes at the expense of asking all of the questions. During the semi-structured interviews it became apparent that a significant number of people had moved here within the last 10 years. For respondents who moved here within the last 10 years changes with respect to livelihood strategies and natural resources were asked between now and 10 years ago in their old village. This is a people perspective approach about how livelihood strategies and natural resources have changed. In total 23 out of the 60 respondents had moved here within the last 10 years. This should be kept in mind when interpreting the results unless it is specifically stated that the data used is only for people who have lived in Mang for more than 10 years.

Interviews were also done with DAFO, IFAD, and the Rural Financial Service (RFS) staff to get a better understanding of the situation in Mang and the development work being conducted there. In total two representatives were interviewed from the RFS, five from IFAD and two from DAFO (Appendix F).

4.3.4 Language/Translation

The language spoken in Mang village is Khamu with some residents also speaking Lao. Three interpreters were used for this research project. One interpreter translated directly from Khamu to English, or Lao to English depending on which language the respondent wished the interview to be conducted. 35 respondents were interviewed using the first interpreter. The second interpreter translated from Lao to English if the respondent was able to speak Lao; if not, a third translator (one of the DAFO staff) was required and double translation from Khamu to Lao and then Lao to English was necessary.

4.4 Data management and analysis

Data was initially collected on paper and the interviews were audio recorded. The data was then inputted into Excel, Word and/or Minitab depending on the type of data analysis required. Along with a comprehensive qualitative analysis of the information a quantitative statistical analysis has been completed. Within both the qualitative and quantitative data, the interactions between the different variables were analysed. Statistically significant differences between and within stratums are analyzed using, Two sample t-tests and Two proportional z-tests. If the p-values, resulting from the t-test or z-test procedure, are less than 0.05, then the evidence is considered statistically significant. A p value of less than 0.05 gives a 95% confidence of being correct. All details of the statistical analyses are available in the appendices. For questions which required a less, same or more response a value of -1, 0 and 1 was given for less, same and more respectively. The results were then graphed to get an idea of the overall change. Respondents were generally only asked about their top 4 livelihood strategies during the interviews. When this is important to consider for the interpretation of the results footnotes indicating how this could affect the data are provided in the results section.

4.5 Methodological Challenges

Some challenges were faced while conducting this research. Firstly, the fact that all of the interviews were being translated resulted in details being lost between translations and required that some questions be asked a few times to ensure the answer was adequately understood. Also, when double translation was necessary the time for translation took longer thus often not all questions were asked. There was also another masters student conducting research within the village therefore it was necessary to share the translator's time. This resulted in more time being required to get the number of interviews necessary.

In October and November the majority of the interviews had to be conducted either in the morning or in the evening due to the rice harvest. Therefore only approximately two interviews, one in the morning and one in the evening, could be done per day. In the morning interviews there was enough light, however, the evening interviews were often done by candlelight making it difficult to read and write. Also the generator was on at night for the TV which resulted in many – especially children – coming from the village to the IFAD centre to watch TV. Therefore it was often quite noisy between the generator, TV and people. Finally, six interviews were completed in the village and this often proved difficult as many people would gather around and assist with answers.

5. Results

The overall objective of this research is to study the interrelations between changing access to specific natural resources and rural livelihood strategies of villagers within different wealth categories (poor, average and rich) and different genders. The results for the specific and sub-objectives of the research are presented below.

5.1 Livelihood Strategies and Natural Resources in Mang Village

Objective 1 was to provide site specific information on the natural resources utilized for specific important rural livelihood strategies of different wealth categories and genders. This objective was broken down into determining important livelihood strategies in Mang and then determining important natural resources for these strategies.

5.1.1 Agricultural Livelihood Strategies

Objective 1a - To determine the most important livelihood strategies within Mang village

Within the focus group discussions (FGD) the most frequently mentioned important livelihood strategies were lowland rice, upland rice, maize, sesame and livestock. Posa, puak muak and rubber trees were also mentioned by a couple of participants in the FGD. During the semi-structured interviews (SSI) the above mentioned livelihood strategies plus fish ponds, job's tear and fruit trees were placed at least by one respondent within their top 4 livelihood strategies (Figure 5). Upland rice, lowland rice, maize and sesame were the livelihood strategies most frequently placed within the top four.

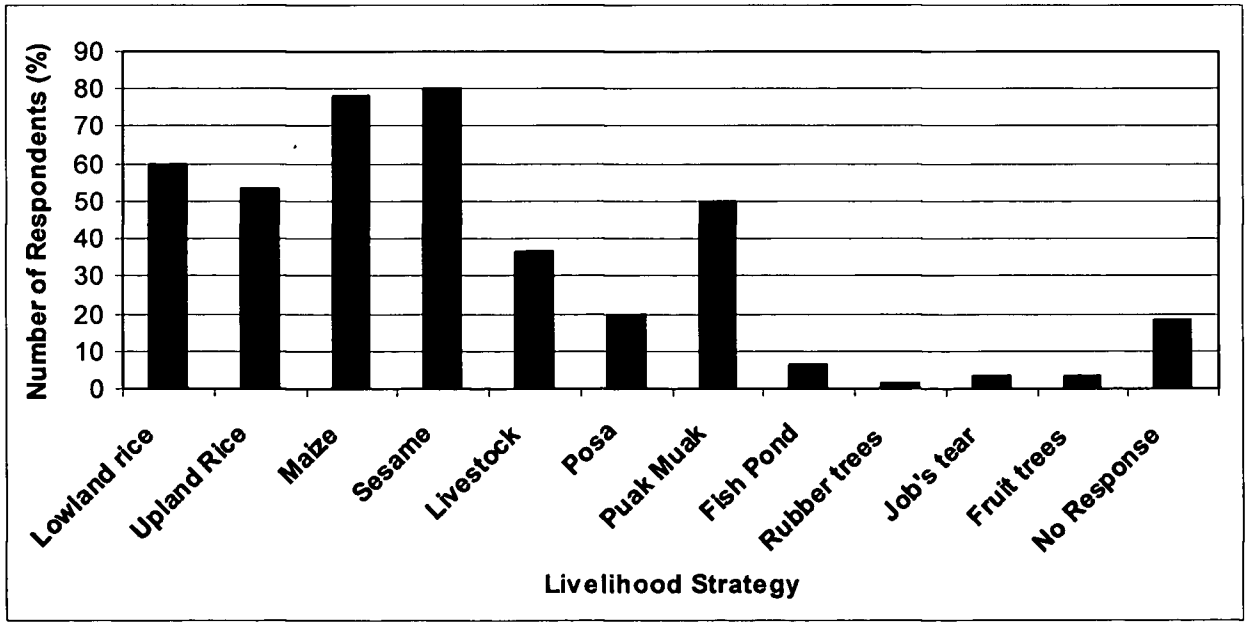

Figure 5: Percentage of respondents who placed a specific livelihood strategy within their top 4 strategies

Income generating cash crops were ranked most frequently within the top four livelihood strategies with 80% and 78% of respondents ranking sesame and maize respectively. This was followed by rice producing livelihood strategies with 60% of respondents including upland rice and 53% including lowland rice within their top four livelihood strategies. 50% of respondents selected puak muak and 37% selected livestock (Figure 5).

The livelihood strategies, ranked number 1 most frequently by respondents during the SSI, were: lowland rice, upland rice, maize and sesame (Figure 6). 68% of the respondents ranked either upland or lowland rice as their most important (Rank 1) strategy. These two strategies are mainly important for food as respondents indicated that most of the rice is grown for consumption within the family. 67% of the respondents selected either sesame or maize, income generating livelihood strategies, for Rank 2. For Ranks 3 and 4 many other livelihood strategies were selected such as puak muak, posa, fish ponds, rubber trees, job's tear and fruit trees.

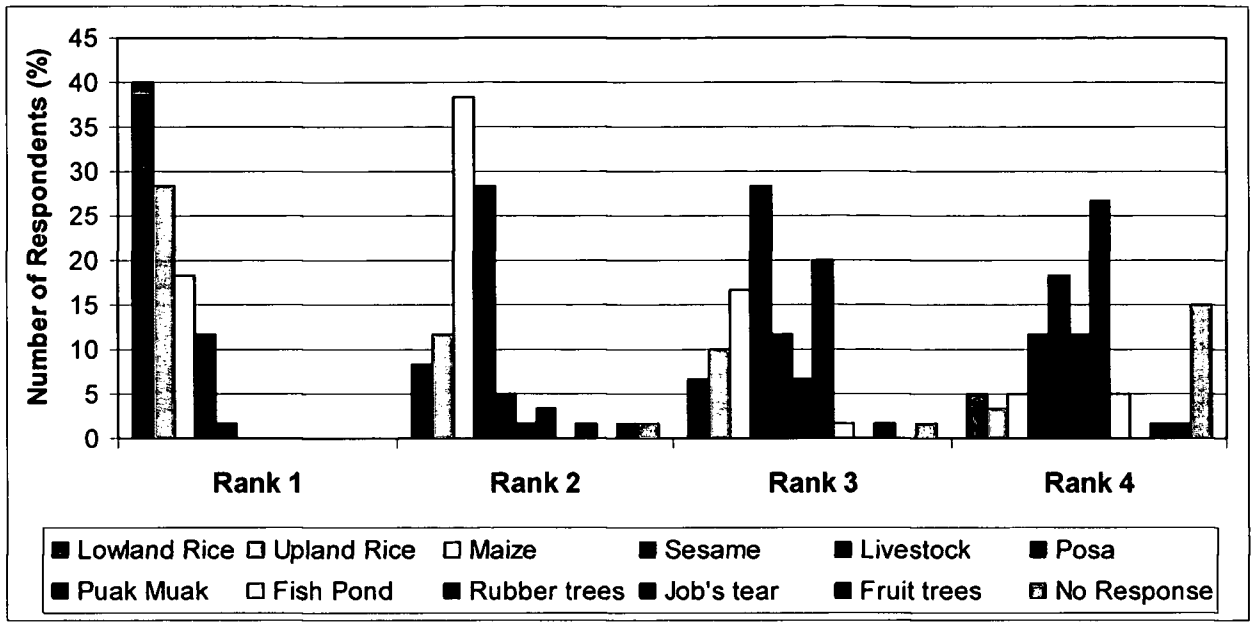

Figure 6: Top 4 livelihood strategies by rank of respondents in the semi-structured interviews

From these results it is shown that the most important top four livelihood strategies for food and income in Mang are upland rice, lowland rice, sesame and maize. Puak muak, posa, fish ponds, rubber trees, job's tear and fruit trees are additional supporting livelihood strategies conducted by the residents of Mang village.

Objective 1b - To determine if the most important livelihood strategies in Mang are different between wealth categories and gender

Although some strategies are equally important to all wealth categories there are certain strategies that are more important to a specific group. Figure 7, indicates the percentage of people within a certain wealth category who placed a specific livelihood strategy within their top four.

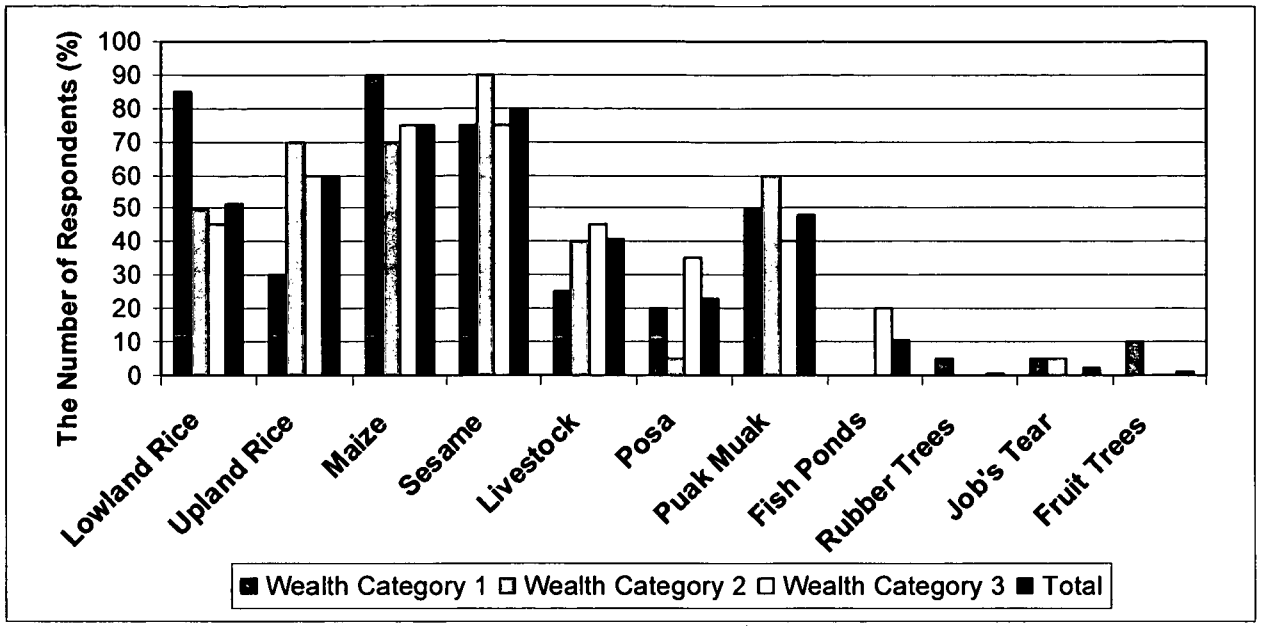

Figure 7: Comparison of the top 4 livelihood strategies, selected by the respondents, between the different wealth categories in Mang village[5]

Male and females also have slightly different views on which livelihood strategies are most important to them (Figure 8).

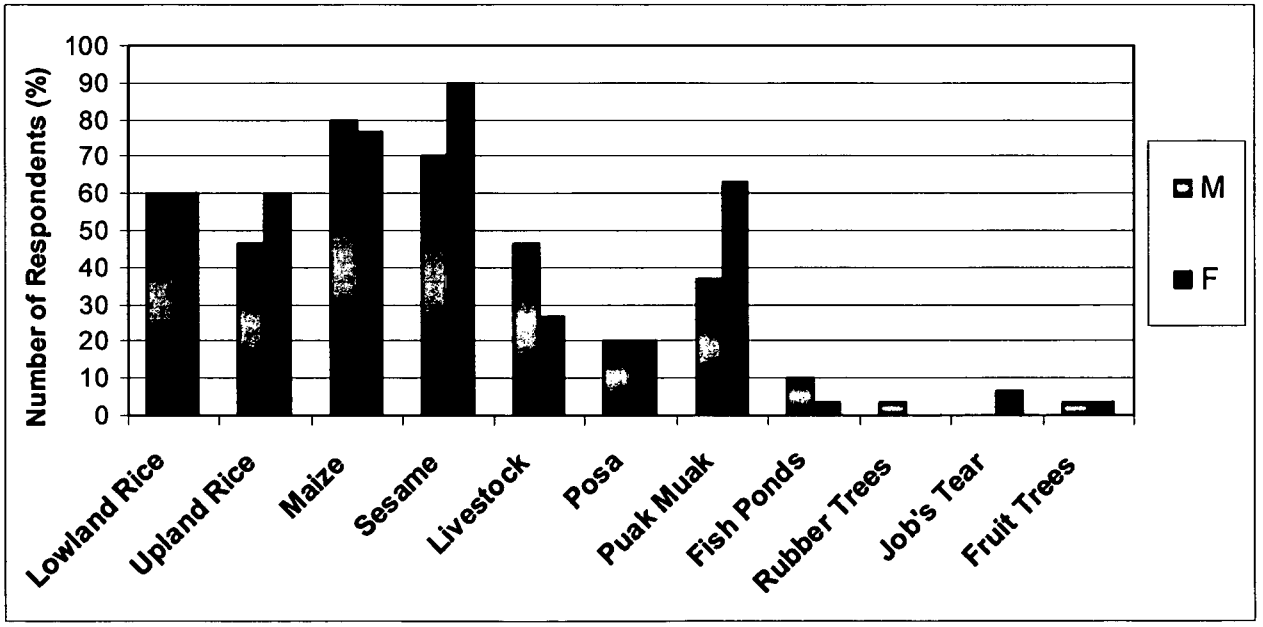

Figure 8: Comparison of top 4 livelihood strategies between the different genders in Mang village

5.1.1.1 Lowland Rice

Lowland rice is considered more important to wealth category (WC) 1 than it is to WC2 and WC3 (Figure 7). 85%, 50% and 45% of respondents for WC1, WC2 and WC3 respectively listed lowland rice within their top four livelihood strategies. There is strong statistical

[5] The total number of participants for the village is calculated by taking into account the stratified random sampling of the respondents and adjusting the figures to the proper representative proportions within the village.

evidence (p-value = 0.005; p= 0.002) that there is a significant difference between the proportion of respondents who listed lowland rice as important in WC1 to those in WC2 or WC3 (Appendix I). Residents in WC1 are more likely to find lowland rice important than the other two WCs. There was no difference between genders for finding lowland rice important (Figure 8).

5.1.1.2 Upland Rice

The opposite is true for upland rice with more respondents in WC2 and WC3 listing upland rice within their top four livelihood strategies than in WC1. 30%, 70% and 60% from WC1, WC2 and WC3 respectively listed upland rice in their top four livelihood strategies (Figure 7). There is strong statistical evidence (p-value = 0.003, p-value = 0.023) that this is a significant difference (Appendix I). Although slightly more women than men selected upland rice as one of their top four livelihood strategies (Figure 8) it is not a statistical significant difference (p = 0.148; Appendix I).

5.1.1.3 Maize

There is a tendency for WC1 to view maize as slightly more important than WC2 and WC3 (Appendix I). 90%, 70% and 75% from WC1, WC2 and WC3 respectively selected maize within their top four most important livelihood strategies (Figure 7). There is strong statistical evidence (p = 0.051) that this is true for the difference between WC1 and WC2 however the statistical evidence (p = 0.101) is not as convincing between WC1 and WC3.

5.1.1.4 Sesame

75%, 90% and 75% from WC1, WC2 and WC3 respectively listed sesame within their top four livelihood strategies (Figure 7). Statistically there is no significant difference although it appears WC2 may consider sesame slightly more important than the other two categories (p = 0.101). There is, however, a strong statistical difference existing (p = 0.023) between the number of males and the number of females selecting sesame as their most important livelihood strategy (Appendix I and Figure 8). Women perceive sesame to be a more important livelihood strategy than men.

5.1.1.5 Livestock

25%, 40% and 45% of WC1, WC2 and WC3 respectively placed livestock within their top four livelihood strategies (Figure 7). This does not result in a strong statistical difference (Appendix I) but does seem to show that WC1 may consider livestock less important than WC2 and WC3 (p= 0.152, 0.088, 0.374). 27% of females and 47% of males listed livestock within their top four most important livelihood strategies. There is strong statistical evidence (p = 0.05) to support that males consider livestock more important than females (Appendix I).

5.1.1.6 Posa

20%, 5% and 35% of WC1, WC2 and WC3 respectively placed posa within their top four livelihood strategies. WC3 and WC1 consider this strategy more important than WC2 (Appendix I; p = 0.07 and p = 0.011). There was no difference between the number of women and men selecting posa within their top four livelihood strategies (Figure 8)[6].

[6] Some participants considered posa and puak muak as one strategy. In this case both posa and puak muak was considered to be in that respondents top 4 livelihood strategies. This may have resulted in some error in the data.

5.1.1.7 Puak Muak

50%, 60% and 40% of WC1, WC2 and WC3 respectively consider puak muak as one of their most important livelihood strategies (Figure 7). This is not a statistically significant difference (Appendix I) although WC2 may find puak muak slightly more important than WC3. However, more females (63%) than males (37%) listed puak muak as one of their most important livelihood strategies resulting in a statistically significant difference ($p = 0.032$) (Figure 8).

5.1.1.8 Fish Ponds

Fish ponds were only selected by WC3 in the top four most important livelihood strategies (Figure 7). This is a statistically significant difference ($p = 0.013$). There was not a significant difference between gender and the selection of fishponds (Appendix I, Figure 8).

5.1.1.9 Job's Tear

Job's tear was selected by two people one in WC1 and the other in WC2. Both respondents were women. There is no statistical difference within this selection as it is a small number of respondents distributed across two WCs who consider this livelihood strategy important (Appendix H, Figure 7).

5.1.1.10 Fruit Trees

Fruit trees were selected by only two people who were in the WC1. This results in a fairly strong statistical case ($p = 0.068$) that fruit trees are most important to WC 1 (Appendix I). Both a male and a female listed this as one of their most important livelihood strategies.

5.1.2 Non-agricultural livelihood strategies

During the semi-structured interview when asked 'What are your most important livelihood strategies for both food and income?' respondents tended to indicate only agricultural strategies. When asked if any additional livelihood strategies were being employed other strategies emerged. There are three teachers in Mang village, two male and one female. All three are ranked in WC1. The amount of money that was made by one teacher was approximately $40/month (400,000 kip).

Six people also indicated they had a shop or someone in their household did. Of the people who mentioned they had a shop, four were in WC1 and two were in WC2. Also, two people mentioned they had rice mills and one mentioned selling gasoline; all were in WC1. Finally one man in WC1 mentioned being a trader. He buys corn, sesame, job's tear, puak muak and posa from Mang and other villages such Ban Bon and Tang Tou and sells to the district. One man in WC1 also mentioned that in the future he would like to study more and work for a corporation. These results indicate that people who tend to have additional livelihood strategies outside of agriculture tend to be in the higher wealth categories. The lower WCs do, however, sell more of their weaving. Weaving is still done by many women (77%) in the village. Only four of the woman respondents sold their weaving; three were from WC3 and one from WC2.

People in the village also work as paid labourers. 28 respondents (47%) said they did some or are currently doing some form of labour and 43% said they did not. The other 10% did not answer the question. The main types of labour in order of response frequency were:

1. Planting & weeding for the rubber company
2. Weeding for other people (residents of Mang) in the maize and upland fields, and
3. Sawing wood.

60% of respondents from WC3 indicated participating in some form of paid labour compared with 35% from both WC1 and WC2. Also more women (50%) than men (37%) participate in paid labour. These are statistically significant differences ($p = 0.007$, $p = 0.025$; Appendix I). One woman indicated that she made approximately 17,000 kip for one day's work at the Laoer rubber company.

Hunting is also still a livelihood strategy for the men in the village. Small birds, rats and mice are hunted with local tools. Guns are not used for hunting anymore due to the implementation of a gun law in which the government confiscated the majority of guns.

5.1.2 Important Natural Resources for Livelihood Strategies

Objective 1c. To determine the specific natural resources which are important to specific rural livelihood strategies.

Objective 1d. To determine if important natural resources are different depending on gender and wealth category.

In the FGD the specific natural resources that were mentioned to be important were land, water, soil quality and seeds. This did not change with respect to the different wealth categories and gender and basically remained the same with respect to different livelihood strategies. Therefore these natural resources were discussed in the semi-structured interviews. Additionally forests were asked about as this is where some puak muak and posa are being collected either for sale or to plant in a plot. Forests were not mentioned in the FGD. From this it appears that the most important natural resources were essentially the same between wealth category and gender.

Also during the FGD participants were asked to rank what was most important labour, money or natural resources for a particular livelihood strategy. For all of the livelihood strategies each group ranked natural resources as number one except for one group which said financial resources were the most important for maize because the seeds had to be bought.

5.2 Changes in Livelihood Strategies over Time

Objective 2: To determine the choice of livelihood strategies upon a timeline considering the retrospective, current and prospective livelihood options and how the choice differs between wealth category and gender

In the initial stages of the SSI respondents were asked 'What are your most important livelihood strategies for both food and income?' and 'What were your most important strategies 10 years ago?' When the respondents were asked about their past livelihood strategies most indicated that upland rice and livestock were their main livelihood strategies with a few people mentioning sesame, paper mulberry and puak muak. As can be seen from the results for Objective 1 many new livelihood strategies have emerged and have become more important within the last 10 years in Mang village.

For each of their important livelihood strategies the respondents were asked whether they do more or less of a particular livelihood strategy compared to 10 years ago and whether they will do more or less in the future. Respondents were also asked how many seeds they planted and when they started a particular livelihood strategy.

5.2.1 Lowland Rice

The planting of lowland rice is increasing overall for the village and will probably continue to increase in the future (Figure 9). This was determined through the questions 'Do you plant less the same or more paddy rice seeds than 10 years ago?' and 'Do you plan on planting less, the same or more paddy rice seeds in the future?'

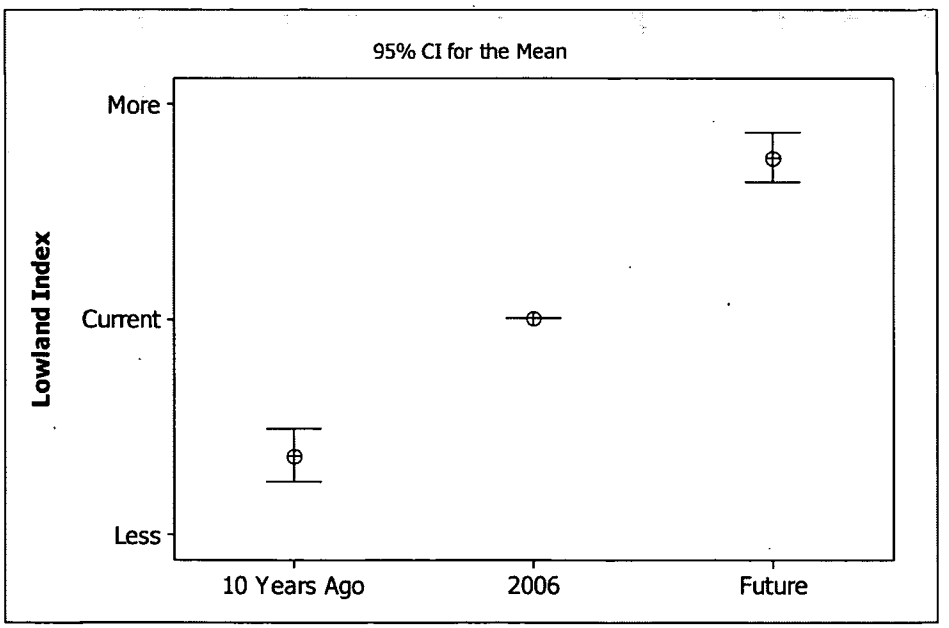

Figure 9: Interval plot of lowland rice grown in the past, present and anticipated future[7]

The following reasons, in order of response frequency, were given by the respondents for the increase in planting of lowland rice:

1. Lowland rice is easier to produce compared to shifting cultivation (i.e. not as much weeding is required and one does not have to travel as far);

[7] For respondents who indicated they had no land to grow paddy rice it was assumed that they would not grow any in the near future.

2. The Lao government has a policy to reduce shifting cultivation therefore alternative livelihood strategies are required;
3. The land within and surrounding Mang is suitable for lowland rice;
4. Lowland rice is cultivated in the same place and thus can be passed on in the family;
5. Rice sufficiency; and
6. Lowland rice gives a high yield.

The increase in lowland rice can also be seen in a more quantitative form by looking at the number of seeds planted 10 years ago versus today and the planned amount in the future (Figure 10).

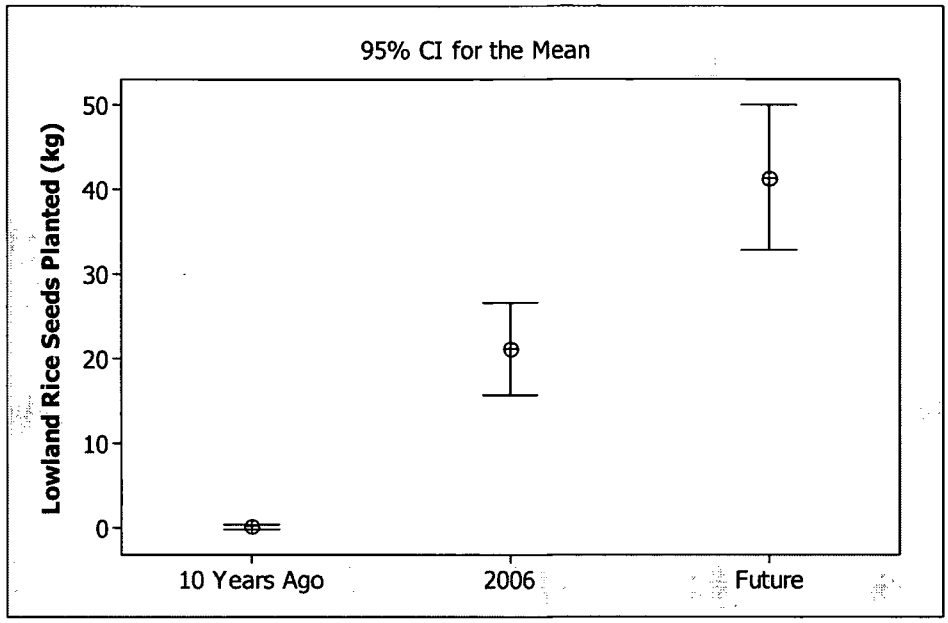

Figure 10: Interval plot of amount of lowland rice seeds planted over time (n = 60, 59, and 46) *For respondents who indicated they had no land to grow paddy rice a value of 0 was given for amount planted

Here it can be seen that 10 years ago very little lowland rice was planted in Mang. One woman from WC1 indicated her family was the first to plant lowland rice and this was around the year 1995. The family saw residents of Nga Ngoua village growing lowland rice and decided to try planting it. Currently, the average amount of seeds that are planted by the respondents is approximately 21 kg/person and the average planted in the future will be around 41 kg/person (Figure 10). If this is extrapolated for the entire community taking into account the proportional sampling then approximately 1,800 kg of lowland rice was planted in Mang in 2006[8].

Some respondents began planting lowland rice earlier than others. Respondents within WC1 started lowland rice before respondents within WC2 and WC3 (Figure 11).

[8] The questions pertaining to lowland rice were only asked to the people who placed lowland rice within their top 4 livelihood strategies. However, only one respondent who grew lowland rice did not place it within his top livelihood strategies because he had just started this year and only planted a tiny amount. Therefore the results are considered acceptable to be expanded to represent the entire village for the present. With respect to the question regarding the future some people were unsure how much more they would plant and others said they would start lowland rice next year but it was not asked how many seeds they would plant therefore the future mean value may be slightly inflated.

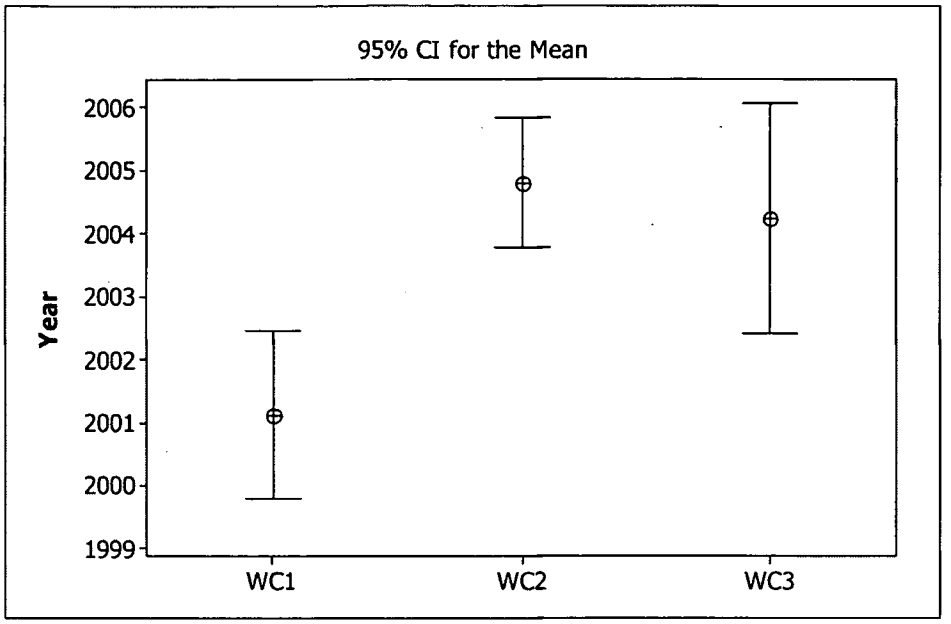

Figure 11: Interval plot of year lowland rice started versus wealth category

The average year that lowland rice was started by WC1 was 2001.12 and the average for WC2 and WC3 was 2004.80 and 2004.23 respectively. There is a statistically significant difference between when WC1 started upland rice compared with WC2 and WC3 ($p = 0.000$, $p = 0.003$). This is shown in the two-sample t-tests provided in Appendix J. There was no statistical difference between when women and men started planting lowland rice (Appendix J).

5.2.2 Upland Rice

While the amount of lowland rice being planted in Mang is increasing the amount of upland rice is decreasing over time with an expected continued decrease in the future (Figure 12).

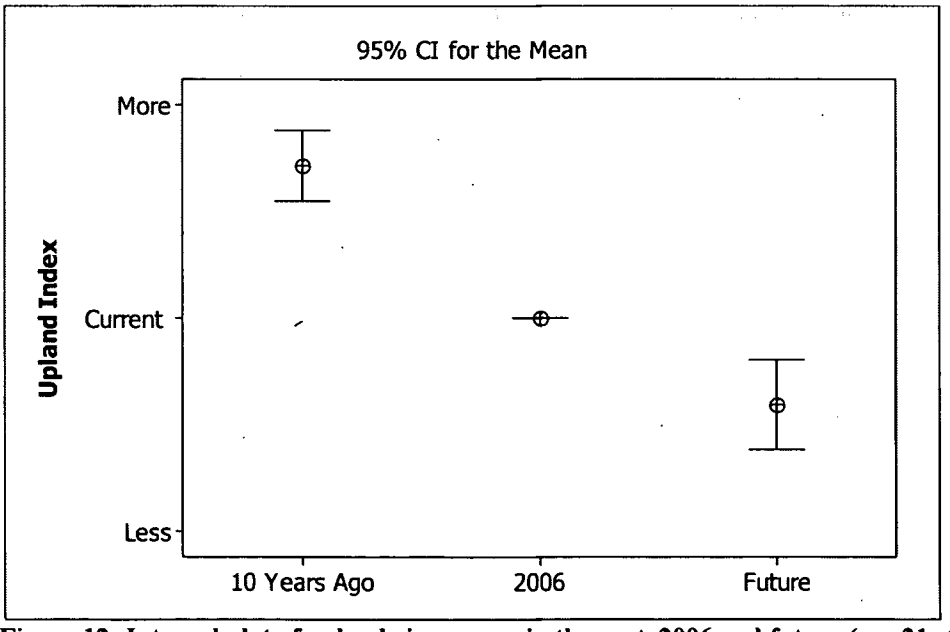

Figure 12: Interval plot of upland rice grown in the past, 2006 and future (n = 21, 42, 22)

The reasons, in order of response frequency, for the decrease in upland rice as indicated by the respondents are:

1. Respondents have other activities such as lowland rice, rubber trees and maize;
2. There is a lack of labour to plant more upland rice;
3. There are less people in the family;
4. Land was given to another person;
5. Not a high yield;
6. Does not give enough income;
7. There is a government policy to reduce shifting cultivation; and
8. Shifting cultivation is difficult and requires lots of weeding.

Although not the norm, there are a few people in the community who are increasing the amount of upland rice. The reasons for this increase in order of response frequency are:

1. They have a larger family now;
2. Rice does not grow as well anymore therefore more rice must be planted;
3. Families want household income;
4. Families want to have enough rice to eat in the household; and
5. They are afraid the insects will eat the rice and they will not have enough food. The insects are worse now than in the past.

Six respondents from WC1 have stopped shifting cultivation completely as compared with three and two respondents in WC2 and WC3 respectively.

A more quantitative perspective is to look at the number of upland seeds planted 10 years ago versus the number of seeds currently planted and the number expected to be planted in the future (Figure 13).

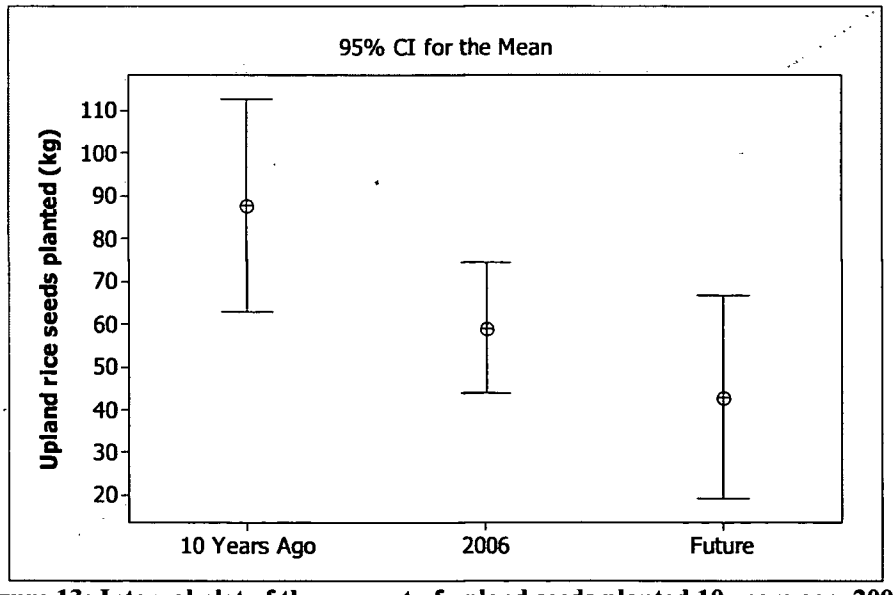

Figure 13: Interval plot of the amount of upland seeds planted 10 years ago, 2006 and future (n = 21, 42 and 22)[9]

[9] The present and future amounts may be inflated as the only people questioned on how much they planted are people who selected upland rice within their top four livelihood strategies. 17 respondents had upland rice but did not select it as one of their major livelihood strategies therefore it was assumed that these respondents are planting less than others thus resulting in inflated values. For instance people in WC1 indicated they only planted a little bit of lowland rice now and therefore did not include it in their top four livelihood strategies. A value of 0 was given for respondents who indicated they do not plant any upland rice. Finally, for the past many people were unsure how much they planted in the past therefore this graph shows the trend of number of seeds planted.

The average amount of upland seeds planted 10 years ago was approximately 90kg/person, the average today is approximately 60 kg/person and the expected amount in the near future is 40 kg/person.

5.2.3 Maize

The amount of commercial maize planted overall within Mang village has increased within the last 10 years and is expected to increase in the future (Figure 14).

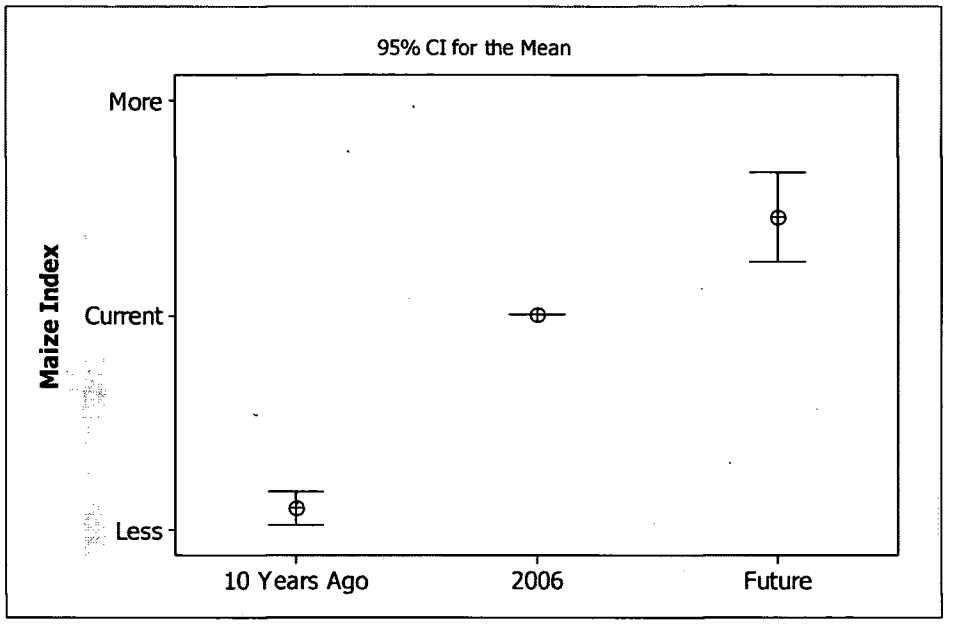

Figure 14: Interval plot of maize grown in the past, present and anticipated future

The reasons, in order of response frequency, for the increase in commercial maize are:

1. Respondents want household income;
2. Government told villagers to reduce shifting cultivation; and
3. Shifting cultivation is difficult and requires weeding three to four times per year whereas maize only requires weeding two times per year.

A more quantitative perspective of this is looking at the number of seeds planted now versus 10 years ago and the expected amount in the future (Figure 15).

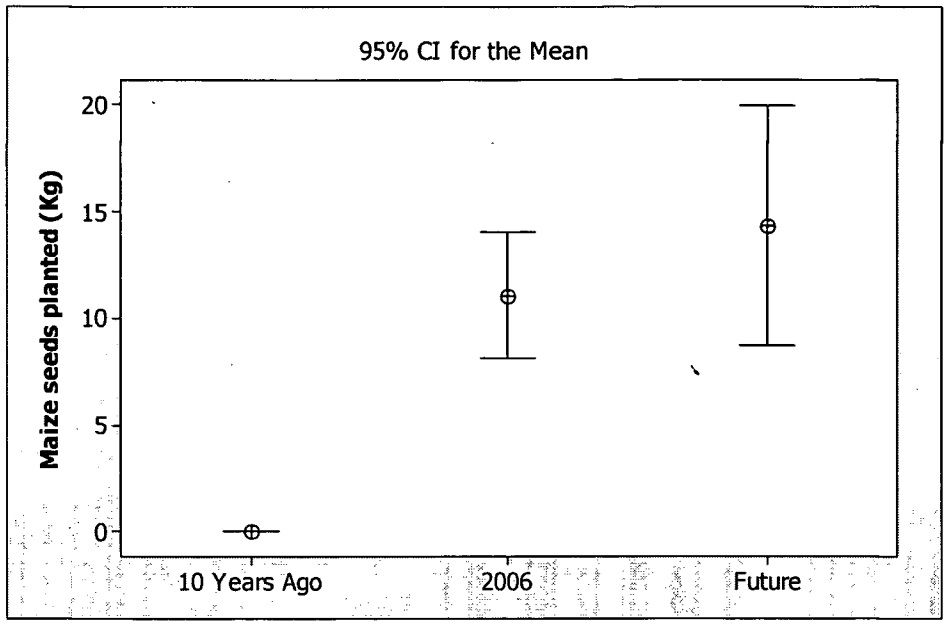

Figure 15: Interval plot of maize seeds planted in the past present and future (n = 30, 52, 31)

On average 11 kg/respondent of maize seeds are now being planted with an anticipated 14 kg/respondent being planted in the future.[10]

Two respondents in WC 1 indicated that in 1997 they were the first people to start growing commercial maize in a plot as a cash crop. There is no difference, however, between wealth categories or gender and the year when the average person started growing maize (Appendix J).

5.2.4 Sesame

Many respondents indicated that they planted sesame with upland rice 10 years ago but now with an increase in market access village residents have increased the amount they produce over time and now grow sesame in plots as well as in the uplands (Figure 16).

[10] It is important to note that 6 respondents mentioned having maize but where not asked the questions regarding maize because they did not list it within their top livelihood strategies. Also not everyone was sure how much they would plant in the future.

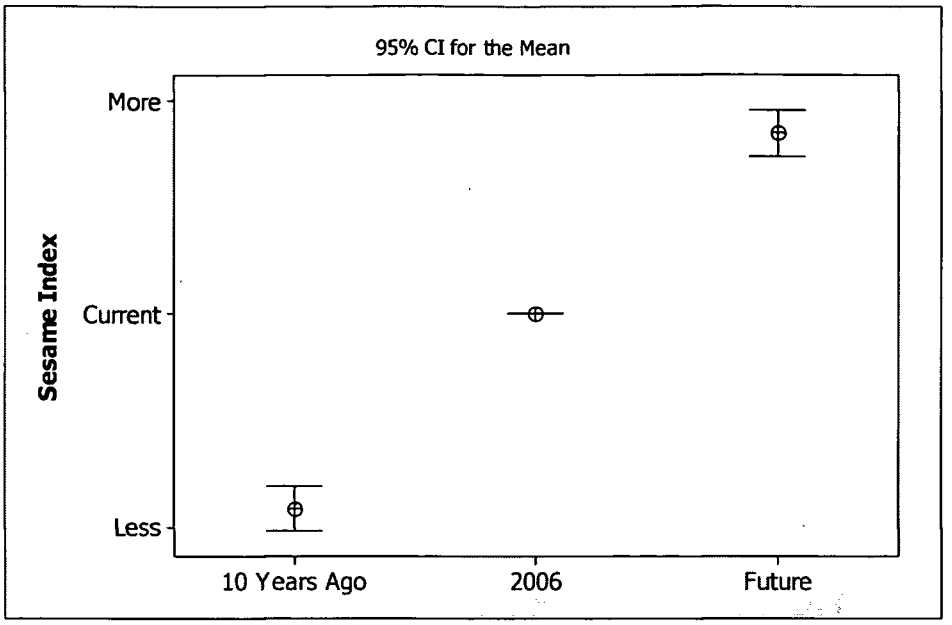

Figure 16: Interval plot of sesame grown in the past, present and anticipated future

The reasons, in order of response frequency, specified by respondents for the increase in the planting of sesame are:

1. The family needs more household income;
2. The Government told villagers to reduce shifting cultivation;
3. Traders have told the respondents that they want sesame; and
4. Sesame has a high price now

From a more quantitative point of view the amount of seeds being planted is also increasing (Figure 17).

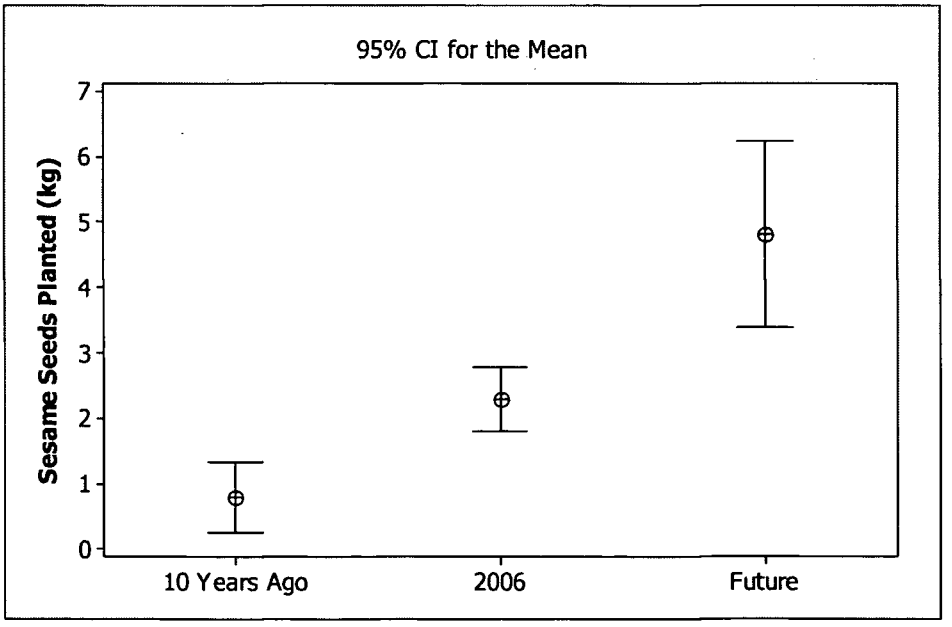

Figure 17: Interval plot of the average amount of sesame seeds planted 10 years ago, 2006 and the future (n = 16, 49 and 28)

An average of 2.3 kg of sesame seeds per respondent are now being planted with an anticipated 4.9 kg/respondent being planted in the future.[11]

Respondents began growing sesame in plots around 2003 and 2004. The earliest year someone mentioned growing sesame in a plot was in the year 2000. There was no difference between wealth category and gender as to when respondents started growing sesame on a plot (Appendix J).

5.2.5 Livestock

The main livestock respondents had was poultry, pigs, cattle, buffalo and goats. The main trend was that respondents had more livestock 10 years ago compared to 2006 but respondents thought they would have more livestock again in the future (Figure 18). The future question however was difficult as people did not really discern between how many animals they thought they would have and how many they would like to have.

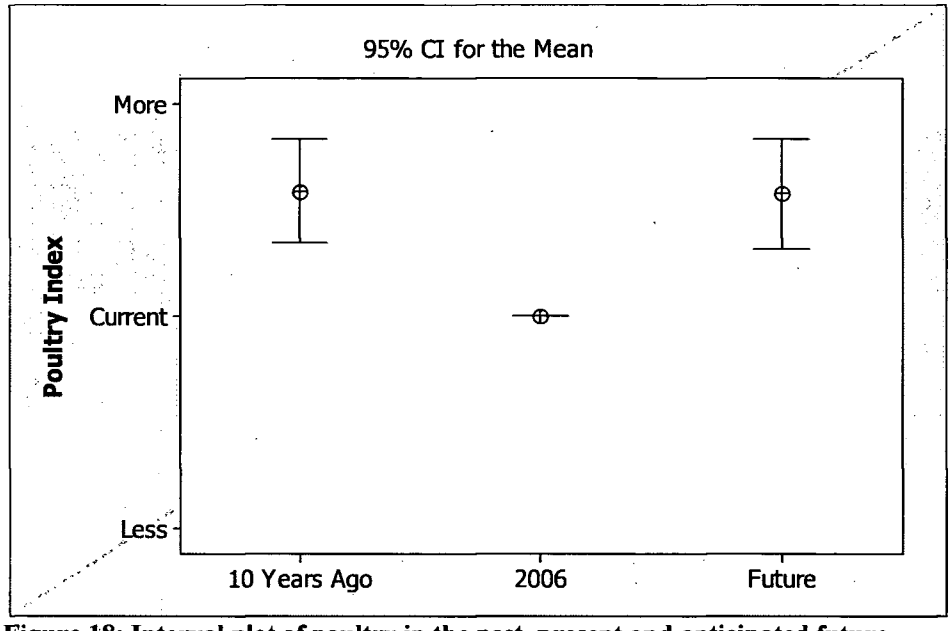

Figure 18: Interval plot of poultry in the past, present and anticipated future.

In the past people had an average of 45 poultry, now however, the average number of poultry is 13. This reduction in poultry numbers, indicated by the respondents in order of response frequency, is due to:

1. Death by disease;
2. Nobody is available to take care of the poultry;
3. The poultry was eaten;
4. The poultry was used for payment for help in the fields; and
5. The poultry was sold.

[11] It is important to note that 4 respondents mentioned having sesame but were not asked the questions regarding sesame because they did not list it within their top four livelihood strategies. Therefore the values of seeds planted today and in the future may be inflated slightly. Also only 28 respondents out of 60 indicated how many seeds they would plant in the future as many people where unsure and only 16 out of 60 people indicated how much they planted in the past because either the question was not asked or they did not know. Therefore these figures give an estimate and show the trend that is occurring.

Similar time trends (Figure 18) were noted for pigs, cattle, buffalo and goats. With reasons, in no particular order, for the decrease observed from 10 years ago to present including:

1. The cattle and Buffalo were sold to build houses after respondents moved to Mang;
2. The cattle and Buffalo were sold to buy rice mills or tractors;
3. The cattle and Buffalo were sold to take people to the hospital;
4. The cattle and Buffalo walked back home and either could not be found or were sold because they could not be controlled;
5. There was not enough labour available to take care of them;
6. Many of the animals died from disease; and
7. The animals were eaten.

Due to the fact that the cattle and buffalo did not like being moved a few respondents indicated that they left their cattle and buffalo in the old village and return to the old village in order to take care of the animals. Having cattle was mentioned as being important during times of emergency as animals are easy to sell for money when someone needs to go to the hospital. One man also indicated he was saving his buffalo to give to his daughters when they get married.

The average number of pigs 10 years ago was 4.9 compared to 1.6 pigs in 2006. The average number of cows 10 years ago was 6 cows versus 2.3 cows in 2006. The average number of buffalo 10 years ago was 5.7 versus 0.6 buffalo in 2006. Finally the average number of goats 10 years ago was and 3 compared to 1 goat in 2006.

The reasons the respondents gave, in no particular order, for thinking they will have more animals in the future are:

1. Now there are projects to support animal raising;
2. Medicine is available; and
3. There is access to money through the financial project in the village to buy animals.

5.2.6 Posa and Puak muak

Within the last few years, since approximately 2002, residents in Mang village started planting or cultivating posa and puak muak in plots which is replacing or supplementing the collection of posa and puak muak in the forest. Respondents indicated that if they have a plot they are going to the forest less. People who go to the forest are also collecting less because there are fewer trees in the forest now. Of the people who responded the mean number of puak muak trees on a plot was 1,269; this is for people who considered puak muak an important livelihood strategy. There was no difference between the wealth categories or gender as when puak muak or posa plots were started. For posa, only a few respondents (n = 8) answered the question regarding the number of trees on the posa plot but the number ranged from 20 to 750 trees. Most people indicated they would like to grow more posa and puak muak in the future. Respondents indicated that growing puak muak on a plot is seen as a longer term strategy than posa because puak muak takes approximately 4 years to grow whereas posa can be harvested in a short time period. This increase in growing posa and puak muak on a plot is partly due to project support and assistance where techniques for growing seedlings and getting cuttings from the forest are taught.

5.2.7 Fish Ponds

Due to the fact that only a few people mentioned that fish ponds were an important strategy for them limited data was collected. 12 respondents answered questions regarding fish ponds some even though it was not in their top 4 livelihood strategies. Of the 12 respondents fish ponds were being built and used since 2002 with some just starting in 2006. It was mentioned

by a few respondents that they have a fish pond but the fingerlings were lost due to flooding. Also one man mentioned he had a fish pond but would not use it this year because last year it was hit by lightening and this is considered a bad sign.

5.2.8 Rubber Trees

The planting of rubber trees just started in Mang village in 2006. The Laoer company set up a rubber nursery near Mang in 2005. The company provided the farmers with the rubber seedlings to grow on their own land. The rubber yield sharing arrangement is 70:30 for the farmers and the company respectively (Sisawat 2006). The seedlings are provided on a fixed contract and during an interview one man indicated the company told him he would get around 8,000 – 9,000 kip/kg for good quality oil. The company also owns land near Mang where rubber trees are cultivated and residents of Mang village work as hired labourers for weeding and planting of the rubber trees.

Only 4 respondents indicated that they do not grow rubber and/or will not grow rubber in the future. Many people have put together a family plan on how many rubber trees they will grow. Between 1 and 3 hectares of rubber trees will be planted by the families. A summary of the family plans provided by the village headman indicate that within the next few years approximately 368 ha of rubber trees will be planted with around 500 trees/ha. However, it was indicated that this may be underestimating the amount.

The reasons, in order of response frequency, listed by respondents for growing rubber trees are:

1. The Lao PDR government has a policy to reduce shifting cultivation therefore residents of Mang must do other activities;
2. They have a long term investment;
3. More household income is needed; and
4. The company told them it would improve their livelihoods.

Although the majority of people are going to grow rubber trees the reasons people gave for not growing rubber include:

1. There is not enough labour to do it. One woman indicated that the village has told her two times that she should grow rubber trees but she does not have the labour.
2. One man says he is too old to start rubber trees now because it is a long term investment.

5.2.9 Fruit

People in Mang have always collected fruit from trees and some have small gardens with fruit trees in them. It was not until 2003 that the first family in Mang started growing many types of fruit on a plot. This family grows a number of trees including banana, mango, pomello, lychee, galangal, longans, lemons, oranges, and peaches. The plot has approximately 400 fruit trees. The fruit tree plot was started with the assistance of a project and is now a demonstration plot. Initially the family cut trees in a protected forest area in order to do some upland rice. They received a 60,000 kip fine because they cut in the wrong place. The family was then told to grow vegetation similar to the forest (i.e. trees) so with the help of a project they started a fruit tree demonstration plot. They have since earned back the money they had to pay for the fine. For example, from the sale of galangal the family made approximately $50 (50,000 kip) and $80 (80,000 kip) last year and this year respectively. One other respondent indicated fruit trees as an important livelihood strategy. They grow mangos, longans, pomellos, lychees, peaches and jujube. Six other respondents mentioned they will start to grow or are interested in growing galangal in the future. One reason for this is people have been told that galangal grows well with rubber. One respondent from WC1 went on a galangal study tour to the province of

Luang Nam Tha in order to learn the proper techniques for growing galangal fruit. Other respondents mentioned having some fruit trees but did not indicate them as their most important livelihood strategies.

5.3 Changes in Access to Natural Resources

Objective 3. To determine if and why access to specific natural resources has changed over time
Objective 3a. Access to specific important natural resources has changed over time.

The natural resources examined were land, forest, soil quality, fish, water and seeds.

5.3.1 Land

In 2004, land allocation and land zoning were implemented changing the way land was accessed within Mang. The village boundary was first defined followed by land zoning and then land allocation. Temporary land certificates have been issued for certain plots but no permanent certificates have been issued yet. The land was zoned into sections such as: preserved forest, lowland rice plots, agricultural and garden plots (Appendix K).

25% of the population answered that land is easier to get now compared with 10 years ago; 37% indicated it is harder to get; 18% said it is the same and 20% did not answer the question. A response from one respondent said "Land is both easier and harder to acquire. It is easier to get land if you have money and harder if you do not" Another respondent indicated that upland and sesame fields are not as difficult to get as lowland rice fields. Other people indicated that it is more difficult to get land if you came to the village later unless you married into a family or have relatives to give you land. Labour was also mentioned by some respondents as a requirement for land. One woman indicated she did not have enough labour to cultivate all of her plots and therefore some land was given to another family.

Lowland rice fields are difficult to get within Mang village. The main reason respondents did not cultivate lowland rice was that no suitable land was available. People within the community are now purchasing lowland from their neighbours. One man bought 2 ha of lowland for 1,800,000 kip, another woman bought 0.5 ha for 300,000 kip. One man in WC1 bought three lowland rice plots. The 1st plot he bought for 1,200,000 kip; the 2nd plot for 600,000 kip; and a 3rd plot for 800,000 kip. A woman from WC3 also bought a lowland plot for 200,000 kip. The purchasing of land is not necessarily limited to lowland rice as a man in WC1 bought land for a fish pond.

According to the respondents, availability of land for the cultivation of upland rice is also decreasing. The majority of respondents indicated that less upland is available (Figure 19).

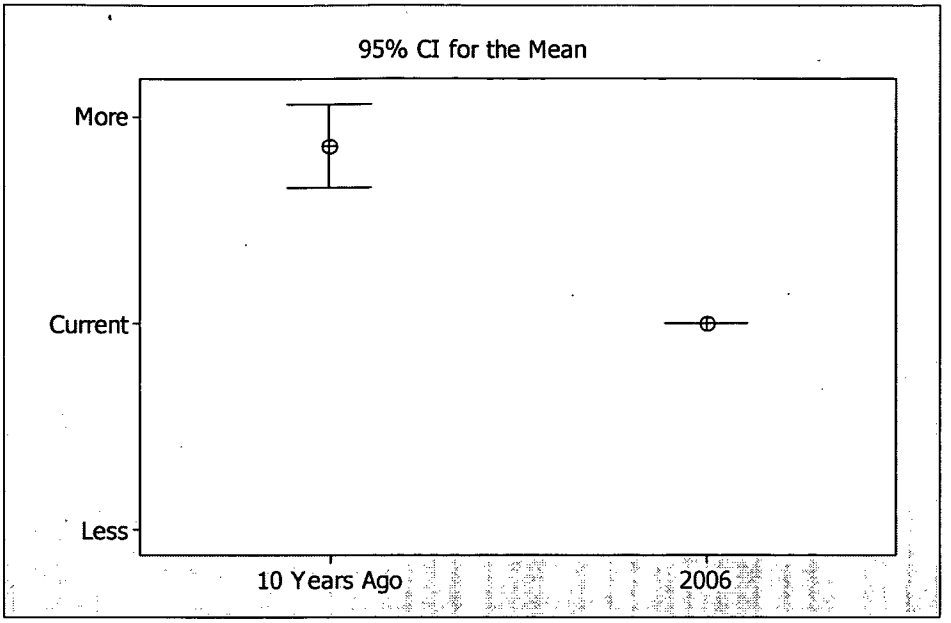

Figure 19: Interval plot on villager perception of amount of available land for clearing for upland rice

5.3.1.1 Land certificates

Temporary land certificates are now being given to the residents of Mang. Residents are more likely to have temporary certificates for their lowland rice, than for sesame, puak muak, maize or upland rice plots (Appendix L; $p = 0.000$, $p = 0.025$, $p = 0.062$). Residents are also more likely to have temporary certificates for their maize and puak muak fields than for their sesame and upland rice plots (Appendix L; $p = 0.001$, $p = 0.006$). This is because certificates are only given if the land is cultivated for 3 years.

5.3.1.2 Land Issues

Disputes over land were also noted. For example, in 2005 approximately 15 families lost some of their plots to the Laoer rubber company. The land was given to the company by the government. One woman indicated that her land (3 ha) was given to the company to grow rubber trees. She is still trying to get money back for the land and crops (such as puak muak trees) that were lost. Another example of land disputes is a man had a plot in Pou Yout village which was taken from him to give to a new family. Pou Yout village said if he wants to use the land again he will have to buy it back.

5.3.2 Forest

The majority of respondents indicate that the forest has decreased over the last 10 years. 79% of respondents indicated there is a decrease in forest. 10% indicated that there was an increase in forest and 11% did not answer the question. 100% of the respondents who were asked indicated that there is less puak muak and posa in the forest for collecting. The main reasons, in no particular order, respondents gave for the decrease in puak muak was:

1. 10 years ago there was a low price for puak muak 600-700 kip/kg now the price of puak muak according to respondents is 5,000-6,000 kip/kg therefore more people collect it now.
2. 10 years ago there was no road to the village and people had to carry the puak muak to sell therefore not as many people collected it in the past;
3. More people are collecting puak muak now either to sell or to plant in a plot; and
4. People do not know the proper harvesting techniques and the trees die.

The reasons given for the decrease in posa were very similar:

1. Many people are collecting posa now for sale and to plant in their plots;
2. 10 years ago there was not a big market for posa; and
3. People do not know the proper cutting techniques and cut the trees too short therefore the posa tree dies.

Respondents also indicated that the trees left in the forest are now much further away. Respondents indicated though that there are many more posa and puak muak trees in total because people are now growing them on a plot. The access, however, has changed from community owned to privately owned plots. One woman mentioned that she walks three to four hours back to her old village to collect posa and puak muak from the forest there.

5.3.3 Soil Quality

30% of respondents consider overall that their access to soil quality has decreased over the last 10 years. 20% feel it is the same and 12% feel it is better. 38% did not answer the question often stating that it depends on the amount of rainfall whether the soil quality is good or not.

What can be said conclusively is that the number of years an upland field is left to fallow has decreased substantially over the last 10 years (Figure 20). The changes are from almost 11 years of fallow to an average of 4 years fallow and a median of 3 years fallow.

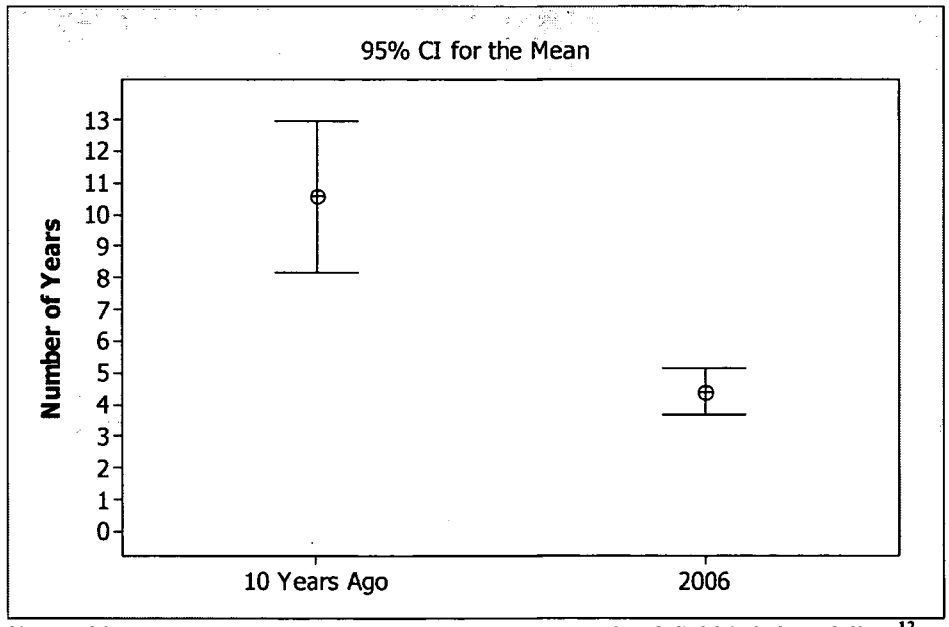

Figure 20: Interval plot of the number of years an upland field is left to fallow[12]

5.3.4 Fish

Only 13 people were asked about fishing and fish ponds. However of those respondents everyone except one person felt there was a decrease in fish in the river over the last 10 years. The reason indicated for this is there are now many people fishing in the rivers.

5.3.5 Water

There is now universal access to water from taps that were set up by a project within Mang village. Irrigation systems were also established in the village by a project in 2005; 22 families

[12] This graph represents the number of years an upland field is left to fallow. There are many permanent fields in Mang now with no fallow period.

now have access to a concrete irrigation system for their lowland rice fields. Some families have also set up their own bamboo irrigation systems for better access to water.

Most people indicated that the water quantity in the streams has decreased over the last 10 years. Some respondents indicated that it is now drier in the dry season than it was in the past. A few people also said that in the dry season the streams now dry up completely whereas in the past they did not. Some respondents indicated that the water quality in the streams has also decreased with one respondent citing the fact that there was too much shifting cultivation at the head of the stream. Respondents seemed optimistic, however, that the water quality would improve with new laws being implemented and increased knowledge such as knowing not to leave dead animals in the water.

5.3.6 Seeds

Respondents now have access to seeds from other places and countries. For instants one man said at the beginning he grew only black sesame which did not fetch a good price so he bought 'higher quality' seeds from Luang Prabang. Maize seeds are also brought in to Mang village from Vietnam and China. When receiving seeds or seedlings from outside sources as opposed to saving seeds sometimes less control is maintained as respondents indicated that the Laoer company delivered some of the rubber seedlings too late in the rainy season and many died because there was not enough rain.

Within the semi-structured interview for each crop respondents were asked whether they bought or saved their seeds. The majority of respondents buy lowland rice seeds for the first year of planting and then save the seeds for the following years. Upland seeds are almost always saved. Maize seeds are bought almost every year from DAFO, a trader or the market in Beng district and sesame seeds are also usually saved unless a new variety is desired.

When buying seeds one respondent indicated that it is cheaper to buy seeds from Beng district than in the village. Respondents who are able to buy seeds and select from a greater variety outside of the village may have an advantage over those buying in the village.

5.4 Differences in Access to Natural Resources between WCs and Gender

3b. Access to natural resources is different within different wealth categories and genders.

5.4.1 Distance to Land

5.4.1.1 Distance to Lowland Rice, Upland Rice, Maize and Sesame fields

For lowland rice, upland rice, maize and sesame fields the distance to the fields correlates with which WC the respondents are in (Figure 21). The closest land belongs to WC1 then WC2 and the furthest land belongs to WC3. This was analyzed using interval plots, which show the confidence intervals around the mean, and two sample t-tests (Appendix M). There is a statistically significant difference between WC1 with respect to WC2 and WC3 for all crop fields except maize (Appendix H). Even though the mean is higher for WC3 than WC2 there is not a statistical difference between the two wealth categories except for with maize (Appendix M).

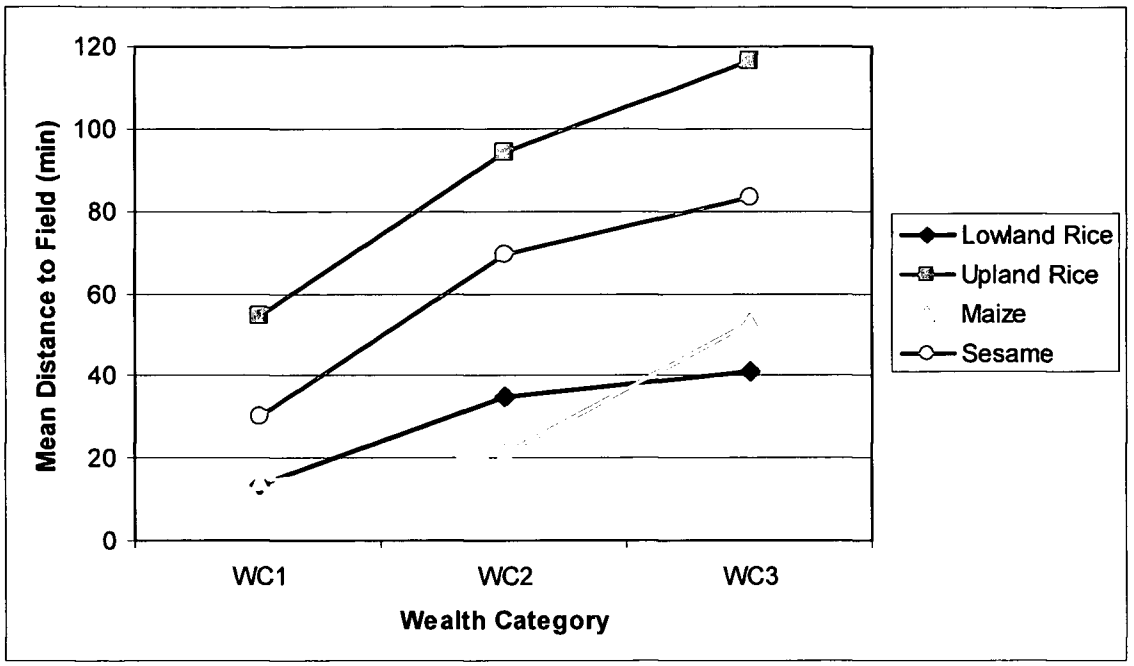

Figure 21: Mean distance to agriculture fields versus wealth category

Women also consistently indicated that their fields were further away, time wise compared with the men (Figure 22). The p-value was less than 0.05 for lowland rice and all p values were between 0.06 and 0.07 for upland rice, maize, and sesame therefore it is considered fairly strong statistical evidence (Appendix M).

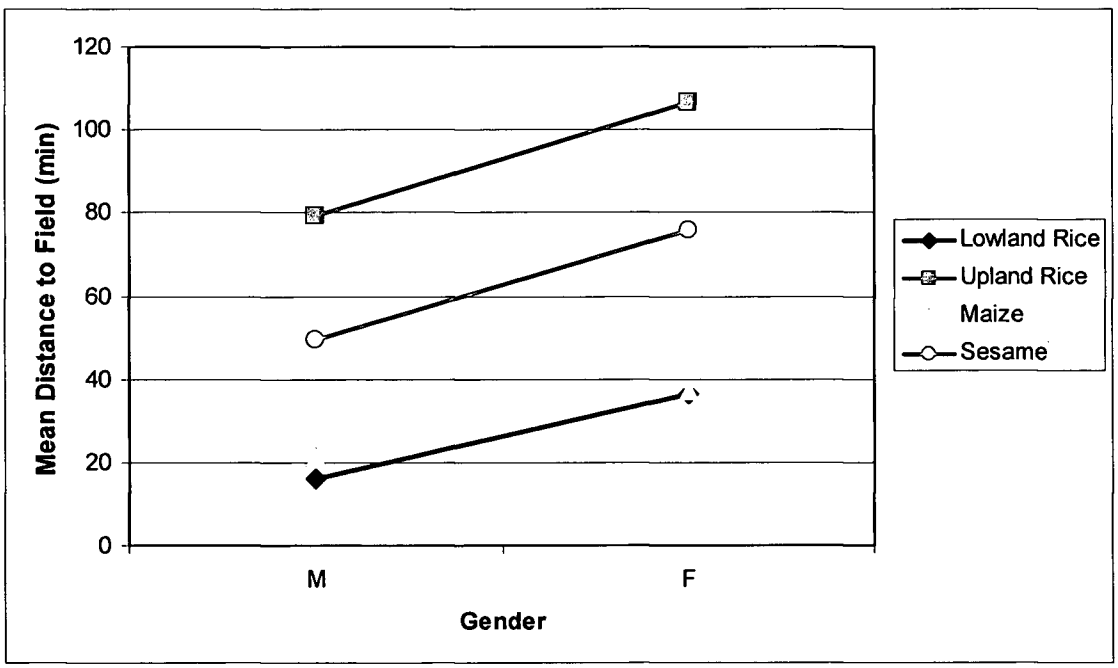

Figure 22: Mean distance to agricultural fields of respondents versus gender

5.4.1.2 Distance to Posa and Puak Muak Plots

The mean distance to posa and puak muak plots show a similar trend as the other agricultural fields with the mean values of WC1 being closer to the village than WC2 and WC3. However, because the standard deviation around the means is high and there is a low sample size there is not statistical evidence that there is a difference (Appendix M). It looks as though a similar

trend might occur but it can not be said conclusively (Appendix L). It is pretty clear from the standard deviations though that WC1 distances are consistently closer to the mean. As you move through the wealth categories there is a greater difference within the groups as to how far they need to walk to reach their fields. This is true for all cases except upland where the standard deviations are similar (Appendix M).

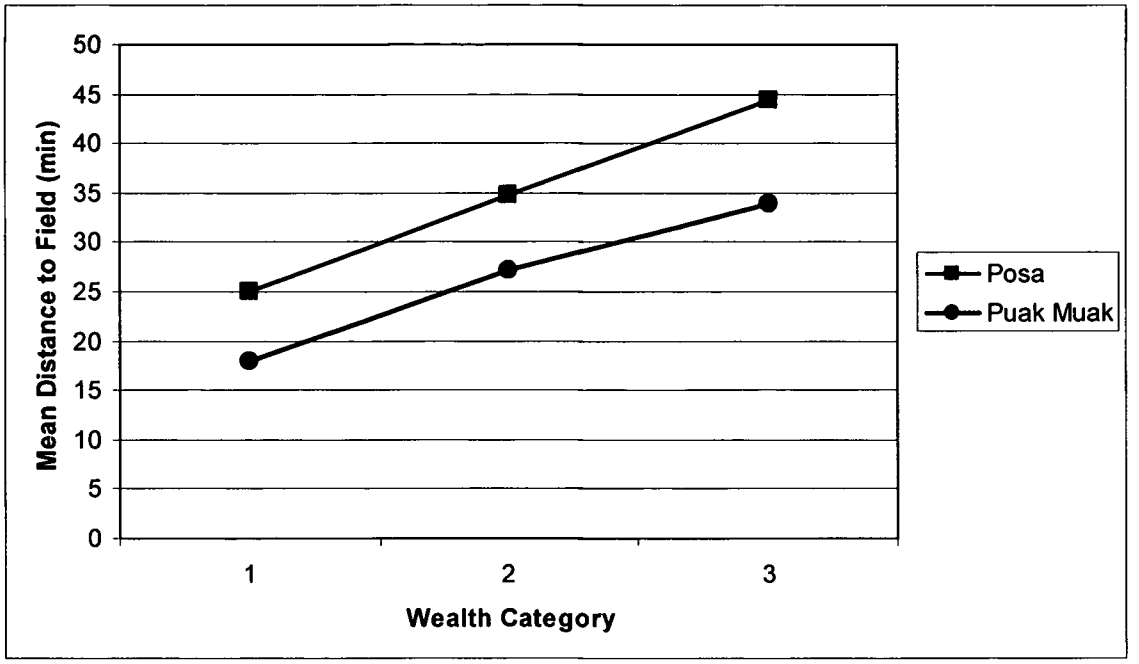

Figure 23: Mean distance to posa and puak muak fields versus wealth category

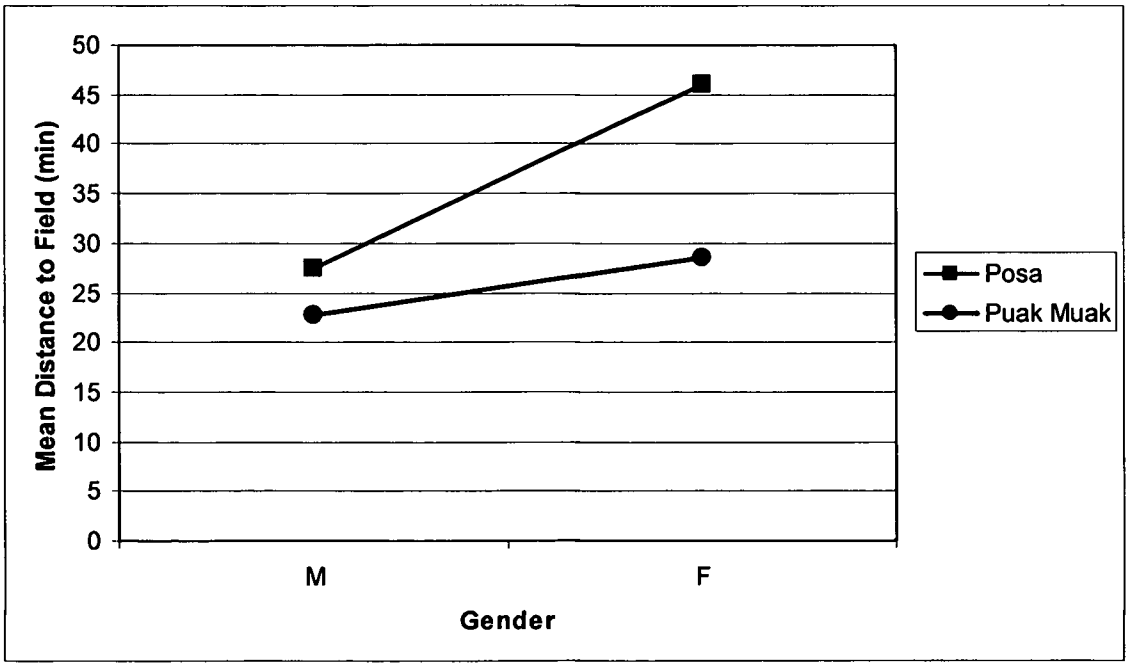

Figure 24: Mean distance to posa and puak muak fields versus gender

5.4.2 Amount of Land

Respondents were asked how much land they used for a particular crop to determine if there was a difference in the amount of land used between wealth categories. The results should give a general indication of the amount of land but often it was felt some respondents gave the answer for how much land they will use in total for the particular crop and not how much they currently use. Also many respondents gave an answer but were somewhat unsure of the exact amount and approximated. Therefore it is also useful to review the number of seeds planted in the next results section to get a better idea of the differences between the wealth categories and genders.

5.4.2.1 Lowland

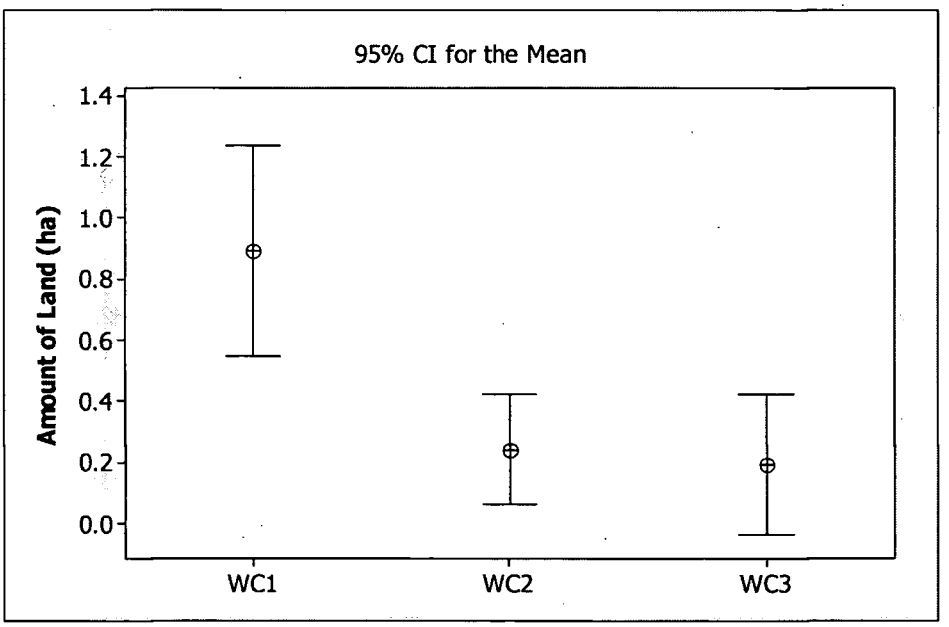

Figure 25: Interval plot of the mean amount of lowland versus wealth category

There is a general downward trend, from WC1 to WC3, for the amount of land that respondents owned for lowland rice.[13] There is a statistically significant difference between WC1 with WC2 and WC3 ($p = 0.001$) but not between WC2 and WC3 (Appendix N). It was also noted that the only people that mentioned they had two plots were in the WC1.

[13] A value of 0 was given to everyone that does not currently grow lowland rice even though they were not asked the questioned 'how much land do you use for lowland rice' Also even though some people mentioned that they have land and will start lowland rice next year a value of 0 was given as they are not currently cultivating the land.

5.4.2.2 Upland Rice

There appears to be not much difference in the quantity of upland that the different wealth categories cultivated. However, there was some data missing due to the fact that many people did not consider upland rice one of their top 4 livelihood strategies (Appendix N). A value of zero was given for those that did not grow upland rice.

5.4.2.3 Maize

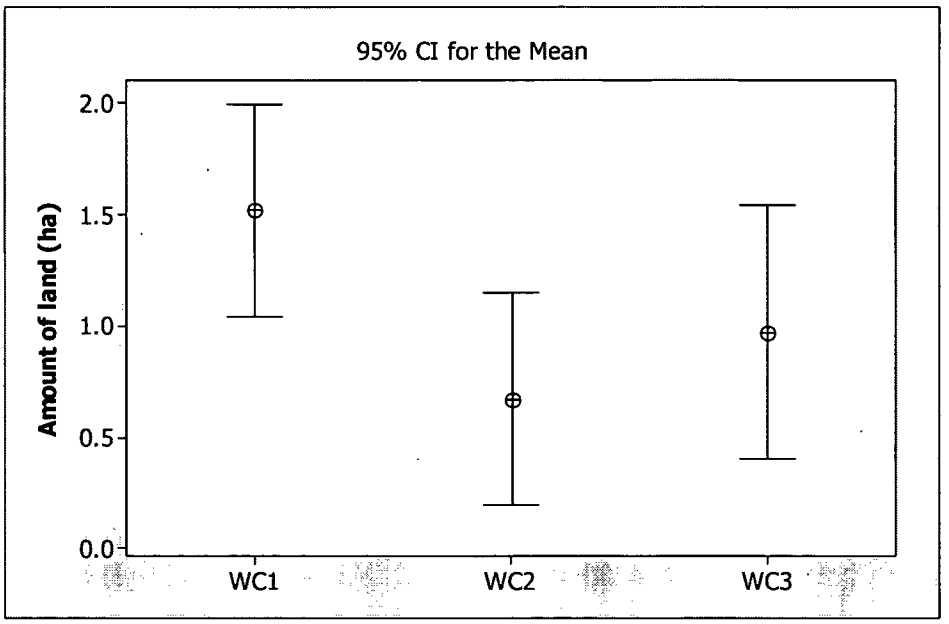

Figure 26: Amount of maize field land versus wealth category

WC1 cultivates more maize land than WC2 and WC3 (Appendix N). There was no statistical evidence of a difference between WC2 and WC3. There was also no statistical difference between gender (Appendix N).

5.4.2.4 Sesame

With respect to the amount of land cultivated for sesame the results could not be accurately analyzed because some respondents grow only sesame on plots and others mix the sesame with upland rice. The respondents who grow it with upland rice tended to give the entire area of the field therefore it is difficult to compare who cultivates more land for sesame. When analyzed (Appendix N) it appears WC3 and WC2 have cultivated more land for sesame than WC1; however, these WCs are also more likely to grow the sesame with upland rice therefore it is best to refer to the seeds section below to see if there is a difference in the amount grown.

5.4.3 Water

22 families in Mang have access to concrete irrigation for their lowland rice (DAFO Mueang Bang 2006). At least six (27%) of those families are in WC1 which is a larger percentage than WC1 represents in the community which is 8%.[14] One man in WC3 indicated that he had an area that would be good for lowland rice production but has not planted it because there is not enough water and he is waiting for an irrigation system.

[14] Unfortunately, only part way through the interviewing process was the question worded properly in which respondents were asked whether they had concrete or bamboo irrigation. There may be more families in WC 1 that have access to concrete irrigation but it was not asked.

5.4.4 Seeds

Respondents were asked how many seeds they planted for each livelihood strategy. The answers given where not how many seeds the respondents personally planted but how much was planted on the plot in total.

5.4.4.1 Lowland rice

The amount of lowland seeds planted is different within the different wealth categories. Respondents in WC1 planted more seeds than WC2 and WC3 (Figure 27; Appendix O; $p = 0.003$ & $p = 0.000$). There was no difference in the amount of lowland seeds planted between genders.

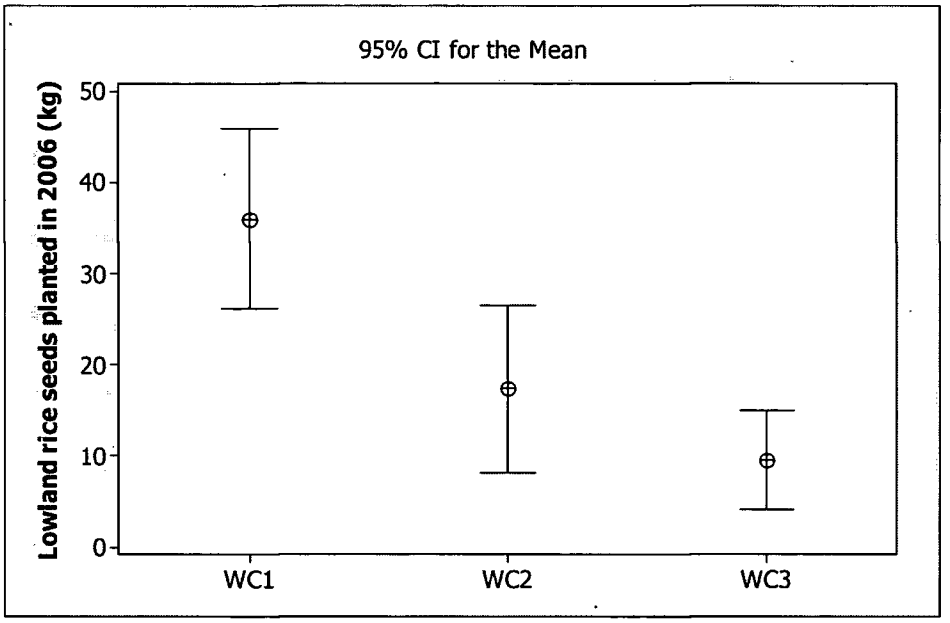

Figure 27: Interval plot of lowland rice seeds planted versus wealth category

If the number of seeds planted by respondents is analyzed excluding those who plant 0 seeds then we see a similar trend with WC1 planting more than WC2 and WC3. However there is not as strong a statistical difference between WC1 when compared with WC2 only between WC1 and WC2 when compared with WC3 (Appendix O).

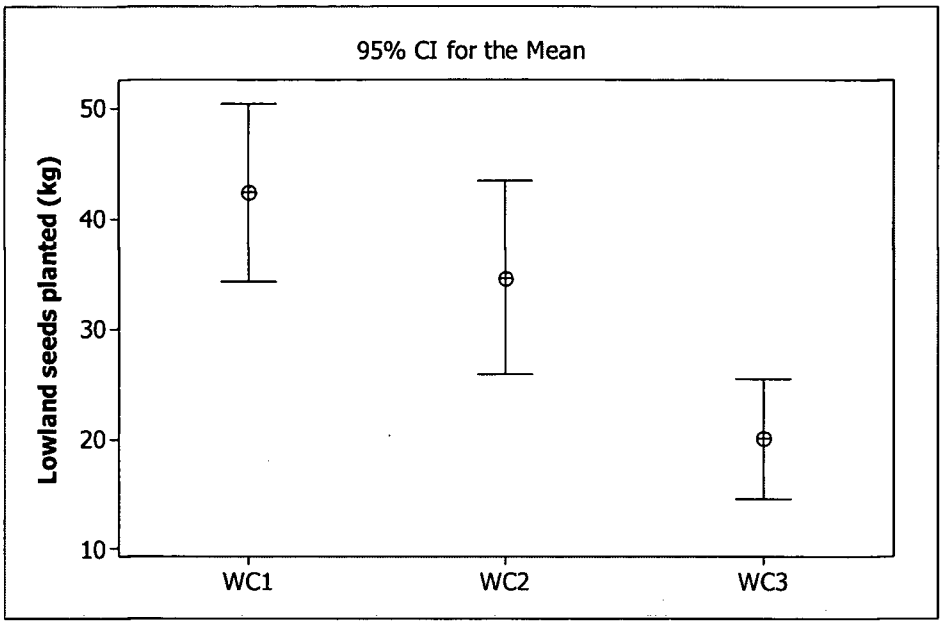

Figure 28: Interval plot of lowland seeds planted versus wealth category excluding those who plant no seeds

5.4.4.2 Upland Rice

When the number of upland rice seeds planted is analyzed including a 0 for those who do not plant it anymore there appears to be a trend of WC3 planting more than WC1 and WC2 (Appendix O; Figure 29).[15] When only those who consider upland within their top 4 livelihood strategies (i.e excluding those who plant nothing) there was no statistically significant difference between WCs in the number of seeds planted but the mean for WC1 is slightly more than the means of WC2 and WC3 (Appendix O).

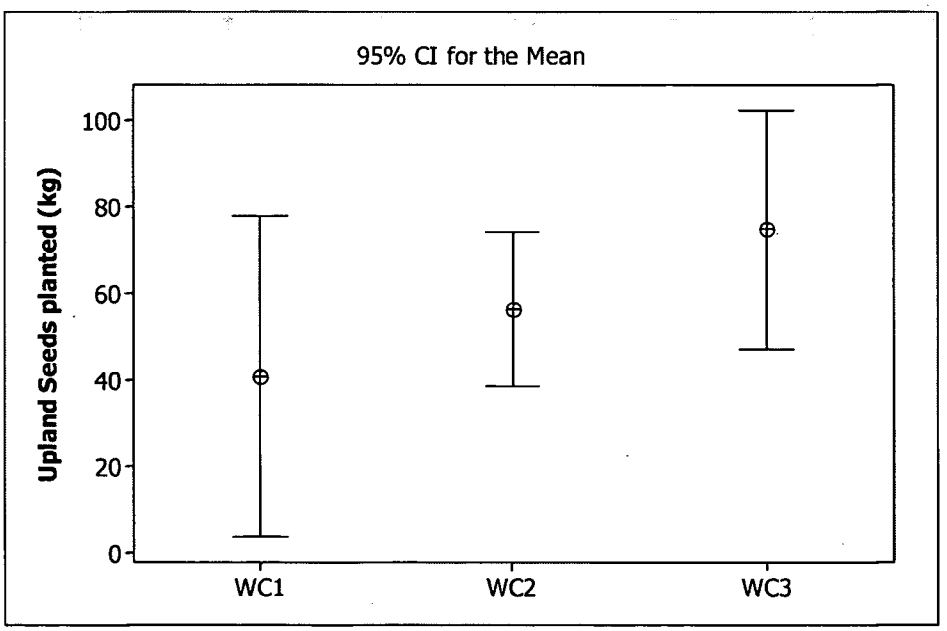

Figure 29: Interval plot of upland seeds planted versus wealth category

[15] For upland rice 18 responses were missing either because the respondents were unsure or it was not in their top four livelihood strategies.

5.4.4.3 Maize

There is a statistically significant difference between WC1 when compared to WC2 and WC3 with respect to the number of maize seeds planted (Appendix O; $p = 0.006$ & $p = 0.061$). Respondents in WC1 plant an average of 19.5 kg maize/respondent. A similar result occurs if only the people who put maize in their top 4 livelihood strategies are analyzed. Only 5 people who plant maize did not answer the question because it was not in their top 4 livelihood strategies.

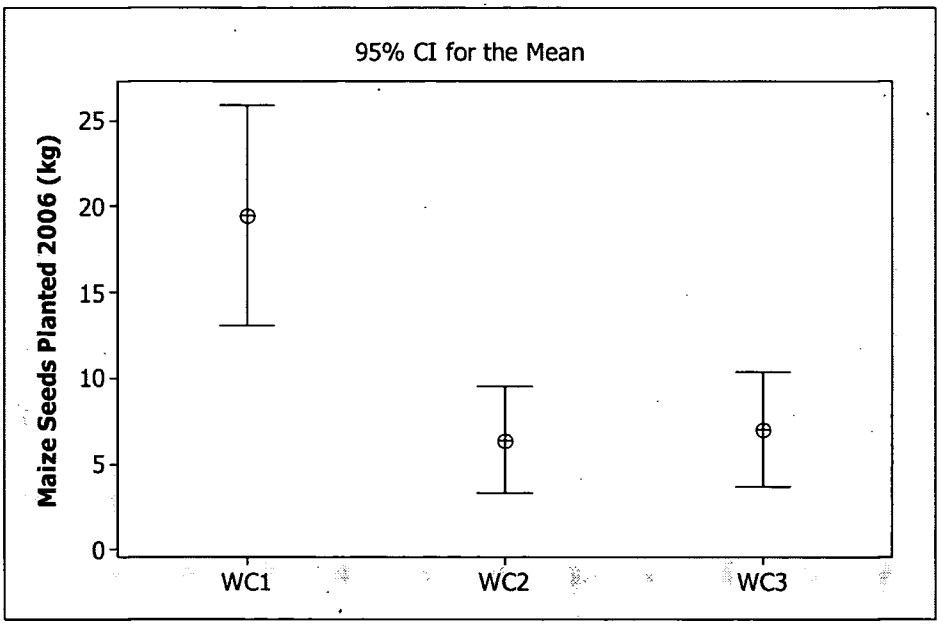

Figure 30: Interval plot of maize seeds planted versus wealth category

5.4.4.4 Sesame Seeds

There is no difference between the numbers of seeds planted between wealth categories or gender for sesame. This is true when the number planted is looked at with respect to only those placing sesame in their top 4 livelihood strategies and also when including those who do not grow it at all (Appendix O).

5.5 Livelihood Outcomes

Objective 4a. To determine the livelihood outcomes of the natural resource based livelihood strategies upon a timeline.

5.5.1 Wellbeing

Within the semi-structured interview respondents were asked 'Do you feel you are better off, the same or worse off than 10 years ago?' and 'Do you feel you will be better off, the same or worse off in the future?'

The majority of respondents indicated that they feel they are better off now compared with 10 years ago and that they feel they will be even better off in the future (Figure 31). Reasons cited for this increased feeling of wellbeing in no particular order included:

1. There are now support projects within the village;
2. There is a gravity feed water system and a school;

3. There is road access to the village;
4. In some old villages it was difficult to find and prepare food whereas in Mang rice mills are available;
5. It is easier to go places;
6. It is easier to sell and buy things;
7. If health problems arise the hospital is close by;
8. Money is not as hard to acquire in Mang village; and
9. Health is better because the knowledge of boiling water and using mosquito nets has been gained.

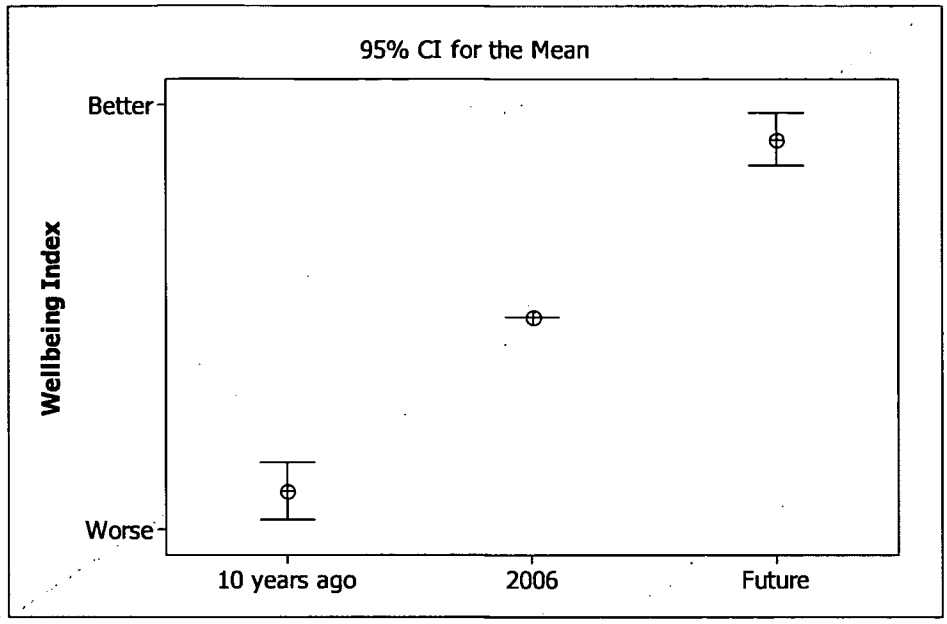

Figure 31: Interval plot of the wellbeing of Mang villagers 10 years ago, present and future

Only three respondents from WC3 indicated they were worse off now than in the past. The reasons they gave for being worse off are as follows:

1. One woman indicated she did not have enough land and did not have enough to eat;
2. One man said his wife passed away and now he has to take care of their two young children; and
3. One woman said she got married and left her parents house and this is more difficult for her.

One respondent also indicated that he feels life will be worse in the future and this is because his health is deteriorating.

5.5.2 Income

In the semi-structured interview respondents were asked 'Do you have less, the same or more income than 10 years ago?' and 'Do you think you will have less, the same or more income in the future?' Every respondent except one indicated that they have more income now compared to 10 years ago (Figure 32). This one person said they have about the same amount of money now compared with 10 years ago. The majority of people also indicated that they feel they will have more money in the future. Only six respondents said they thought they would have the same amount in the future as they do now. No one said they thought they would have less income in the future. However, some people indicated that although they have more money now they also need more money now.

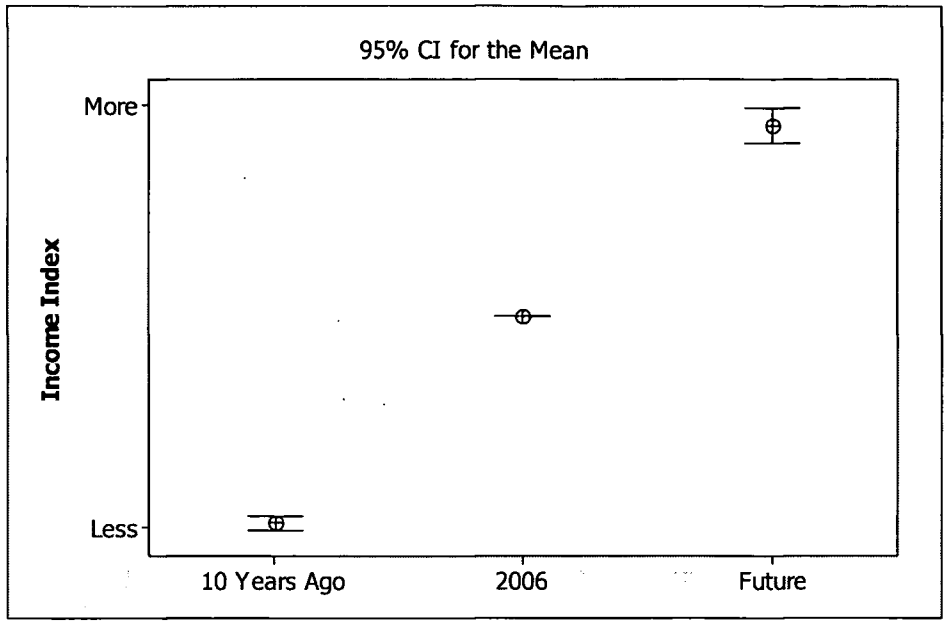

Figure 32: Interval plot of change in income in Mang village

It was observed in the village that there is now a rural financial service offered in the village through the OCISP where residents of Mang can save and borrow money. The following is a list of items residents purchased with the money they borrowed:

- Maize seeds;
- Poultry;
- Products for store;
- Tractor;
- Pigs;
- Buffalo;
- Sesame;
- Fish;
- Rice; and
- House

5.5.3 Food Security

In the semi-structured interview respondents were asked whether they had enough rice to eat 10 years ago, presently and whether they thought they would have enough rice to eat in the future. However, the results of this question are a bit questionable due to the fact that some people interpreted the question as do they grow enough rice. Therefore some people said they did not have enough rice but were easily able to buy more rice with their income. It was attempted as best as possible with the available information to only put those who had to borrow rice or do additional labour as not having enough rice to eat.

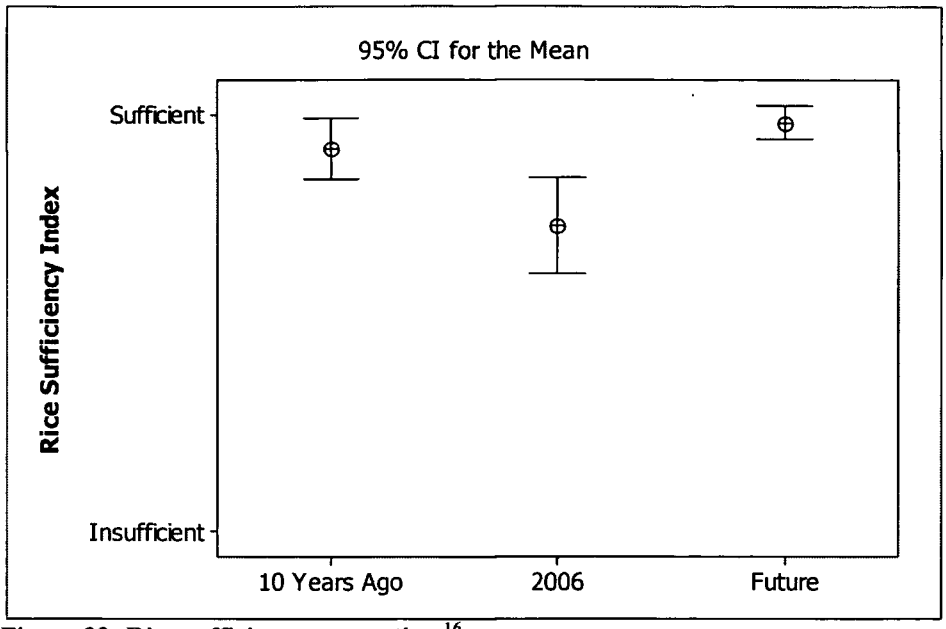

Figure 33: Rice sufficiency versus time[16]

It appears that respondents are less rice sufficient now than they were 10 years ago (Figure 33) but are optimistic; in the future many people feel that they will have enough rice. Although some people indicated that they could not predict the future.

5.6 Additional Results

Additional questions were asked within the semi-structured interviews to get a better idea of the overall context within the village and other factors that influence livelihood strategies and access to natural resources.

Many people moved to Mang within the last 10 years. The question 'Why did you move here?' was asked as well as 'Was the move difficult?' The main reasons the respondents gave for moving to Mang included:

- There is a government policy to move from a small village to a big village
- There is road access in Mang
- There is a school in Mang
- There is water supply in Mang
- There is technical support and projects in Mang
- It was difficult to buy and sell things in the old village
- Mang is near a hospital
- Their spouse is from Mang

Many people also found the initial move and settling phase difficult. Respondents mentioned that when they first moved to Mang they faced difficulties such as: they had a lack of rice; they had to walk far as their fields were still in the old village; there was not enough labour to build the house and work in the fields; they had no house in the beginning and had to sleep in the forest; land was difficult to acquire and it was difficult to transport everything to Mang.

[16] Figure 33 uses the data based on equal size sampling within the WCs in the village. If the proportion that the WCs represent in the village is taken into account there is a similar trend but there is less rice sufficiency for all times and there is a greater difference between the rice sufficiency in 2006 and 10 years ago. This is because the richest wealth category had a significantly greater representation in the study than in the community.

6. Discussion

Within the last 10 years, livelihoods in Mang village have evolved very rapidly and are expected to continue to evolve. There is a necessity for positive development interventions to be implemented which supports the community during these livelihood transitions. Addressing the priorities and capacities of the village as well as the different families and individuals is important to ensure sustainable livelihoods will be reached or maintained. The definition of a sustainable livelihood, as previously stated, is "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base" (Scoones 1998).

6.1 Important Livelihood Strategies & Changes in Livelihood Strategies

The cultivation of upland rice and the raising of livestock, although still important, have decreased; while strategies such as the cultivation of lowland rice, sesame and maize have increased. Other permanent strategies have also become important, such as the cultivation of puak muak, paper mulberry (posa) and rubber trees. The people within Mang are entering market based economies very quickly. With this transition comes the risk of fluctuating market prices. For example, in 2005, 90% of maize from Oudomxay was exported to China (Phouyyavong & Talije 2006); however, this trade was affected by trade policy changes in China in which an import quota was imposed. On a provincial or national level it is important to diversify the exporting markets to other countries such as Thailand and Vietnam as indicated by LSUARFP (2006). Within Mang however, where there is little control over the export markets. On a community and household level, a diversity of crops should be cultivated or alternative non- agricultural livelihood strategies employed in order to cope with the stresses of these fluctuating markets. As indicated in the sustainable livelihood framework it is these shocks and stresses that can affect the vulnerability context of a community (Figure 3). The capacity to cope with stresses is vital within the definition of a sustainable livelihood (Scoones 1998).

Sesame and maize are currently the most important livelihood strategies for income across all wealth categories and genders within Mang village (Figure 5, Figure 6 and Figure 7). The results show that residents will continue to grow and increase the quantity being produced (Figure 14, Figure 15, Figure 16 and Figure 17). This is consistent with studies such as Phouyyavong & Talije (2006) and Foppes (2004) which indicate that cash crops are becoming more important within the province of Oudomxay. Supporting the marketing and trading of these crops would be beneficial for the entire community and affect a large portion of the population. For example, a study in Namor district in Oudomxay province on the production and market conditions for maize showed that fungus and insects damaged the maize during storage. Recommendations included building sufficient storage facilities and promoting dialogue between farmers and traders to reduce storage time which would increase the quality of the maize and thus the income earned by farmers (Phouyavong & Talje 2006). Research would be necessary to determine the specific issues that need to be addressed, with respect to the maize and sesame supply chain within Mang village. In the context of a sustainable livelihood, hopefully this would not only increase the financial capital within the village but also increase the influence and access to markets.

Previous studies such as Foppes & Ketphanh (1997) and LSUAFP (2004) indicate that in some villages in Oudomxay the collection of NTFPs are the most important livelihood strategies for income. Although not ranked number one for importance, the NTFPs considered significant in Mang village are puak muak and posa[17] (Figure 5 and Figure 6). Some residents from Mang village still collect the bark of these trees from the forest; other respondents now have plantations or let the trees grow naturally in their upland fields and fallow lands. Mang village is transitioning from extractive to domesticated production of these trees. Thus puak muak and posa trees are changing from an NTFP to a cash crop. One of the reasons for this transition as stated by Aubertin (2004) is the Lao PDR government's policy to reduce shifting cultivation by allocating approximately three plots of land for cultivation thus encouraging farmers to intensify production for extra cash income. Another reason indicated by the respondents for this transition is that they have to walk quite far now to collect posa and puak muak from the forest; therefore, having the trees on a plot is much more convenient. Support in the growing techniques, domestication, and marketing of posa and puak muak would be beneficial to provide supplementary income in Mang in the event of maize and sesame crop failure. This again reduces the vulnerability of the community or individual through diversification. Workshops on posa planting and growing techniques as well as multi-stakeholder workshops within the posa supply chain have already occurred in Mang through the CIAT-BOKU project and respondents indicated that there was some support with growing puak muak from seedlings. Currently, respondents consider puak muak a more important livelihood strategy than posa mainly because it fetches a higher price.

The cultivation of both upland and lowland rice for consumption is very important within Mang (Figure 5, Figure 6 and Figure 7). If the trend of continued reduction of shifting cultivation in favour of cash crops and lowland rice continues (Figure 12, Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17) combined with the limited land available for lowland rice cultivation, residents in Mang will have to buy or borrow more rice in order to meet their food needs. Within the sustainability livelihood framework, improved food security is an important livelihood outcome and a sufficient food supply is essential in reducing the vulnerability of an individual or community. Currently only one household interviewed did not grow rice; they were in WC1 and the husband was a teacher maintaining a stable income which allowed the family to purchase rice. However, as it is mainly people within WC2 and WC3 who do not have land to cultivate lowland rice, it is especially important to ensure that these families and individuals have an adequate food supply while venturing into alternative livelihood strategies. As is indicated in the results, it appears that some respondents are less food secure now than 10 years ago (Figure 33). While the amount of upland rice cultivated is being reduced, the fallow periods are also being shortened which results in a reduction in upland rice yields (Saito *et al.* 2006) thus compounding the food security issue. Shifting cultivation is still a very necessary livelihood strategy in Mang village for food security. Therefore, not only is assistance with livelihood transitions to earn more income necessary but also improving the existing upland rice practices is important. For example, investigating improved fallow systems to restore the soil fertility and reduce the proliferation of insects and weeds is an option. Seidenberg *et al.* (2003), reports that in northern Laos farmers are beginning to adapt to the shorter fallow times. A study by Ducourtieux *et al.* (2005) also shows that it is possible to implement cash crops which are compatible with existing upland practices. Additional research into the possibilities for the enhancement of upland practices is necessary.

Livestock was listed as the 6th most important livelihood strategy (Figure 5) and respondents indicate that they want more livestock in the future (Figure 18). Traditionally livestock

[17] It is debatable if posa and puak muak bark fits within the traditional definition of an NTFP as both are timber products, however, for the purpose of this study the bark is being considered an NTFP.

provides cash income and is a safety net during difficult times. Livestock are often sold to pay for necessary things such as: going to the hospital, education, or building a new house (Millar & Photakoun 2006). Therefore, livestock is beneficial in reducing the vulnerability of the community thus making the community more resilient. In order to sustain the expected increase in livestock in Mang (Figure 18), support with growing forage crops would be beneficial to the community. During an interview one respondent mentioned that he grew some forage crops for his cattle. Stür & Horne (2001), Phengsavanh *et al.* (2005) and Millar & Photakoun (2006) offer more information about the different varieties and benefits of different forage varieties.

It was observed that there are some strategies that all WCs and genders find equally important for food and income. However, there are certain strategies that are more important to certain categories. It is important to be aware who is affected the most by any development interventions and if necessary implement targeted development strategies. For example, if working with lowland rice, more respondents in WC1 will be affected; the opposite is true for upland rice. Also, more males than females found livestock important while the opposite is true for puak muak. Perhaps the reason for this is there may be a gender division of labour with these livelihood strategies. Whatever the reason it is important to research which individuals are/will be affected by development strategies and who for example, will have an increase/decrease of work or will benefit the most.

Adoption disparities of certain livelihood strategies between wealth categories were also observed. The average family in WC1 adopted lowland rice prior to families in WC2 and WC3 and certain individuals within WC1 were the first to grow fruit trees and maize on a large scale. It is not clear whether the early adopters of these livelihood strategies became wealthy because they adopted earlier or were wealthy before. However, literature indicates that early adopters tend to have more formal education, are more likely to be literate and have higher social status with respect to variables such as wealth, occupation and class (Rogers 1995). There are risks and uncertainties that are taken when new livelihood strategies are introduced into a system in which the wealthier are more able to cope. It is important for the people implementing development strategies to understand who is likely to adopt new strategies and why, and to assist those who would like to adopt new strategies or technologies but are concerned about the risk. Identifying the reasons for lack of adoption and if there is an alternative is also important. For example, a study in Luang Prabang province and Xieng Khouang province on forages indicated that the households participating in the project were often able to take greater risks due to having sufficient land, livestock and lowland rice. It was also indicated in this study that poorer households may take longer to intensify livestock production (Millar & Photakoun 2006). Knowing the social networks of how new adoptions diffuse within the community is also beneficial when promoting an alternative option. Working with the desires and goals of the community and individual is very necessary when working within and assisting with new strategies the individual wishes to adopt.

Rubber is a new livelihood strategy which almost the entire village is adopting regardless of which WC they are in. The growth in rubber tree planting is occurring across Laos (Ketphanh *et al.* 2006). Rubber is seen within the village as a long term strategy as it takes approximately seven to eight years before the trees are ready to be tapped and has a life cycle of around 20 – 25 years. It is a concern that household food and cash needs may not be met during the initial growth period until the harvesting of rubber can occur. For instance, one person said they were too busy planting rubber trees to plant their lowland rice field and another person indicated they may not have sufficient rice this year due to rubber tree planting. Currently the price of rubber is higher than for maize and sesame. The land, however, due to the contract set up with

the rubber company, is locked into this livelihood strategy for a long time. There is no longer the ability to change the crops grown with the prevailing market demands (Ketphanh *et al.* 2006). Therefore, again it is advisable to have alternative income sources. The cultivation of rubber trees is also promoted by the government within the village as it is a permanent livelihood strategy thus it is important to ensure that this is the will of the individual farmer. Investigations into the effects of rubber tree plantations on the livelihoods of rural farmers would be good as well as comparing the differences of those who are contracted by the rubber company and those who are hired as paid labourers.

Alternative livelihoods strategies to farming are also emerging in the village in the form of shops, teachers and traders. It was noted that most of the respondents participating in non-farming activities were in the higher WCs. In order to supplement income it may be beneficial to support the families within the lower WCs in exploring alternative livelihood strategies if the labour is available. If the population growth continues, increasing the land pressure, alternative non-agricultural livelihood strategies will have to be developed. Paid labour, however, is mostly done by WC3 and women. A study conducted in Namo, Oudomxay also found that the poorer wealth categories more often work as paid labourers (LSUAFP 2004). However, their results show more men than women working as paid labourers. This study noted that households with rice insufficiency have to sell their labour in order to earn money to buy rice; resulting in a lack of time to work their own fields.

6.2 Changing Access to Natural Resources

Along with livelihood strategies changing, access to natural resources has also changed within Mang village. One of the biggest changes is in the access to land as land allocation was implemented in 2004 and the population is growing. This was also indicated as the most important natural resource by the respondents in the focus groups. Access to land is now based on different factors such as existing land claims, number of labourers and continuity of cultivation within a three year period (Lao Consulting Group 2002). This continuity of cultivation is giving an advantage to people who conduct permanent livelihood strategies over non-permanent or shifting ones. Land is now also being bought and sold within the village. As stated previously, there is a shortage of lowland rice fields. This shortage in lowland fields was also noted by Baird and Shoemaker (2004) when they did a review of studies completed on internal resettlement. Also a few respondents indicated the desire to grow maize or build fish ponds but stated there was not enough land available. As the population growth in Mang is expected to increase, land will become increasingly more valuable and scarce. The DAFO staff indicated that there is land set aside for new people but as there are already land conflicts occurring, land scarcity is becoming a major issue. Alternative livelihood strategies other than agriculture need to be available for newcomers to the village or for people with an insufficient amount of land to sustain a viable livelihood. Research into the development of possible alternative livelihood strategies is necessary.

Access to natural resources differs between wealth categories and/or genders. As stated previously, more people in WC1 own lowland rice fields than in WC2 or WC3. Also, the majority of the agricultural land of WC1 is located closer to the village than that of the other wealth categories (Figure 21). Women, also take longer than men to reach their fields (Figure 22). These differences need to be accounted for when implementing development strategies, especially because the majority of residents walk to their fields and carry their production home. Natural capital is one of the five livelihood assets within the sustainable livelihoods framework. Knowing the capacities of the families is important in ensuring sustainable livelihoods will be reached or maintained. Also noted is that access to the irrigation system

installed by a development project is proportionally available to more residents in WC1 than WC2 and WC3. While more irrigation could open up lowland rice fields for other residents in other wealth categories it is important to be aware of the group receiving these benefits.

Not undermining the natural resource base is vital to a sustainable livelihood. With the changes in livelihood strategies that are occurring in Mang, the landscape and the environment is also changing dramatically. As permanent agricultural systems are becoming more the norm and fallow periods are shortened, the soil fertility is reduced and will not have time to regenerate (Saito *et al.* 2006). Currently, it was not observed that fertilizers or chemicals were being used within Mang village. However, soils will deplete with continued use and strategies will need to be implemented to cope with this. Systems such as improved fallows, crop rotations, and intercropping could be implemented. Saito *et al.* (2006) indicate that improved crop and resource management technologies are necessary for sustainable production. Seidenberg (2003) noted that some farmers are adapting techniques to cope with shorter follows on their own. As animal husbandry is expected to increase, manure management strategies can also be established. It would be good to establish a self-sufficient system early, whereby nutrients capable of increasing soil fertility are identified, used, and reused locally. Further research is needed into the nutrient depletion and requirements of the soil and possible solutions.

The majority of respondents indicated that the forest has decreased, the water in the streams has decreased and the fish in the streams have also decreased over the last 10 years. Hopefully with the land allocation set up in 2004 and designated forest zones the forest will not continue its rate of decline. Part of the strategy for forest preservation is to increase the commercialization of NTFPs in which generally a quasi-forest structure is maintained which contributes to beneficial forest services like carbon storage and sequestration, nutrient cycling, erosion control and hydrological regulation. For example, posa trees accelerate the regeneration of soil fertility through their carbon fixing root systems and are capable of the rapid shading out of weeds due to quick growth (Aubertin 2004). Forests and home gardens managed for NTFP production can also contain large amounts of biodiversity, especially when compared with alternative agricultural land uses (Arnold & Pérez 2001). The NTFPs which are mainly being domesticated in Mang are puak mauk and posa. According to respondents there are very few of these trees left in the forest but lots on personal plots. Thus, personal plots are assisting in the conservation of these trees. The tree plots should provide some of the advantages of quasi-forest structures mentioned above. As is seen in Mang and other communities (Aubertin 2004), however, the cultivation of these trees is intensifying towards monoculture plots. Therefore, when looked at in regards to the conservation through commercialization theory it appears that the ability to conserve the natural forest through the commercialization of posa and puak muak is doubtful. Additional research into the benefits posa and puak muak trees provide to the environment and the possibility of using the trees within an agro-forestry context would be valuable.

With the growing of tree plots such as rubber, puak muak, paper mulberry, and fruit trees it is important to ensure that these plantations do not encroach upon the natural protected forest areas, as this trend has been observed in other parts of Laos (Ketphanh *et al.* 2006). As shown in the results, there is a family in WC1 growing fruit trees in the protected forest zone and were able to pay back the fine quite quickly. Growing production trees does not fulfill the same biodiversity, physical or spiritual needs provided by the natural forest. For example, there is still dependence in Mang on the forest for livelihood security; as one woman mentioned, when she did not have enough food she collected bamboo shoots and vegetables from the forest to sell in order to buy rice.

With respect to the decrease in water and fish; if further irrigation projects are going to be implemented, then not only do the conflicting uses of the stream (i.e. fishing versus irrigation) need to be investigated but also the environmental capacity to handle these diversions of water. Policy should be in place and implemented which protect these water resources. Some respondents indicated hope with respect to the water quality and quantity as they say more knowledge is available about how to maintain the water quality and regulations are being put in place. Further research monitoring both the water quality and quantity in the watershed would be beneficial to ensure this essential natural resource is not depleted or overused.

Overall, certain livelihood strategies and natural resources are changing and evolving differently for different genders and wealth categories within Mang. Therefore these variations in the capacities and desires of the specific groups should be taken into account in order to develop positive development strategies. There are some general correlations between changing livelihood strategies and natural resources. Those who are adopting permanent agricultural strategies are acquiring more temporary land permits for their land. Access to posa and puak muak trees has gone from community-based collection within the forest to more domesticated land plots, although some people still do travel far to collect it within the forest. This is due in part to the land allocation policies and in part to the reduction of trees in the forest. The development of fish ponds is changing how people are accessing their fish. There are many other factors involved in why natural resources and livelihood strategies are evolving such as policy changes, labour, and population growth.

6.3 Livelihood Outcomes

Within the sustainable livelihoods framework, livelihood outcomes is an integral component and includes variables such as income, wellbeing, vulnerability, food security, and a sustainable natural resources base (DFID, 2001). This was investigated very briefly within this study. Mang village is a consolidated village where residents from at least 12 other villages came to live over the past 20 years. Many people indicated that one of the main reasons they moved was due to a government policy which pressured villagers to move from smaller communities to bigger communities. There is a lot of research which shows that consolidation and relocation are having a mainly negative impact on the social systems, livelihoods, and cultures of many indigenous ethnic groups as shown in Baird & Shoemaker (2005), which reviews many case studies on relocation. Similarly, many residents in Mang indicated that the first few years after they moved were very difficult due to reasons such as illness, lack of land, the need to build or transport houses, and the death of animals. These problems associated with migration were also noted in LSUAFP (2004). Similar studies show that eradication and restriction of swidden agriculture which is tied in with the relocation policy can contribute to chronic food shortages, increased over-exploitation of forestry and fishery resources and increased soil degradation (Baird & Shoemaker 2005). It appears that some of these negative results are also occurring in Mang, such as the decrease in food security and the decrease in certain natural resources. However, the results show that the majority of the respondents feel happier and have a greater feeling of wellbeing now than 10 years ago (Figure 31), with 23 respondents moving to Mang within the last 10 years. Some of the reasons respondents gave for feeling better off were: they now are near to the hospital, road and market and they have a water supply and school (more details are available in the results section on page 52). Also, respondents have more income available to them now compared with 10 years ago (Figure 32). Thus there have been some advantages to relocation. Some of these benefits were also noted by villagers in LSUAFP (2004). Mang is a unique village though, compared with many other consolidated villages because technical support (DAFO staff) lives on-site and infrastructure

such as: an irrigation system, a school and a water system is in place which the respondents indicated make them happier. There are also many projects in Mang to support the residents of the village. This has not been the case in some other merged, relocated or consolidated villages (Baird & Shoemaker 2005). Another aspect which made the consolidation of Mang perhaps easier is that all of the merged villages were Khamu. Thus, there was not a merging of different ethnicities with different lifestyles.

6.4 The CIAT-BOKU Context

The objectives of this research were designed to fit within the CIAT-BOKU research project. The results, of this study complement a previous study within the CIAT-BOKU project entitled: 'Analysis of Fallow System Development in Laos using Historical Satellite Images (Forster 2007). From the satellite images Mang village was found to be located in a high pressure zone indicating a high frequency of slash and burn events and intense agriculture production (Appendix C). Forster (2007) showed that Mang is in a high pressure zone compared to many other villages in Oudomxay due in part to its location near a road which connects the village to larger markets. The results presented in Section 6 above, concur with these findings of increasing intensive agriculture production and decreasing fallow times while also providing some additional reasons for the changes and the types of intensive agriculture which are occurring. The results from this thesis can also be used in conjunction with the other studies currently being completed within the livelihoods analysis section, such as the CLSAD approach to compare and contrast the livelihood changes within different villages in Oudomxay. Finally, the information and trends observed with respect to posa and puak muak can be utilized within the market chain analysis component of the CIAT-BOKU research project. As this thesis focuses on one village in Oudomxay province it is implicit that the results and recommendations should be evaluated within the larger provincial context. When determining development strategies for the province the cumulative knowledge gained through the studies conducted within and external to the CIAT-BOKU project should be utilized.

7. Conclusions

This research was conducted within the sustainable livelihoods framework using research methods such as, time trend analyses and photographic ranking within focus groups and semi-structured interviews in Mang village, Oudomxay. The interrelations between changing access to specific natural resources and rural livelihood strategies of villagers within different wealth categories and different genders were studied.

The results show that livelihood strategies and the access to natural resources are changing rapidly within Mang village. The main changes in livelihood strategies which have occurred over the past 10 years are:

- There has been a decrease in upland rice cultivation and animal husbandry;
- There has been an increase in lowland rice, maize, and sesame cultivation;
- There has been an increase in the domestication and cultivation of paper mulberry and puak muak;
- There has been an increase in rubber tree planting; and
- There has been a recent emergence of new strategies such as fruit tree plantations, fish ponds, and non-farming activities.

The main changes in the access to natural resources over the past 10 years are:

- There is now access within the village to water through communal tap stands;
- There is now partial access to irrigation systems;
- Land is now acquired through land allocation and through payment;
- Temporary land certificates are now being issued after the land is cultivated for three consecutive years;
- There is increasing land scarcity;
- There is a decrease in forests;
- There is a decrease in the number of posa and puak muak trees located in the forest; and
- There is a decrease in water and fish in the streams.

While there are definite interrelations between these changes, many other factors also affect the livelihoods selected and the access to natural resources such as labour, wealth, migration and government policies.

Certain livelihood transitions are occurring at different rates and in different directions between wealth categories. The access to certain natural resources is also different between wealth categories (WC) and gender. These differences need to be addressed when implementing development options.

This study contributes towards a project in Lao PDR by the Centre for International Tropical Agriculture (CIAT). The goal of this project is the site-specific identification, delivery and implementation of intervention strategies that will lead to equitable and sustainable improvement of the livelihoods of rural communities in Northern Lao PDR

Recommendations from this study to CIAT include:

- Targeted development strategies should be implemented in certain instances as different WCs have access to different resources and partake in different livelihood strategies;
- A diversity of livelihood strategies should be supported to cope with fluctuating markets;

- Support for non-farming livelihood strategies such as teachers, shops, and traders especially within the poorer WCs is needed;
- Improvement of the supply chain for maize and sesame should be supported as the majority of the village across all WCs participates in these livelihood strategies;
- Being aware of which groups are receiving the benefits of any development strategies is important;
- Being aware of the adoption disparities between WCs is also important;
- Support sustainable land management strategies with improved fallows, crop rotations and intercropping; and
- With the expected increase in livestock, ensuring land can sustain this increase is important.

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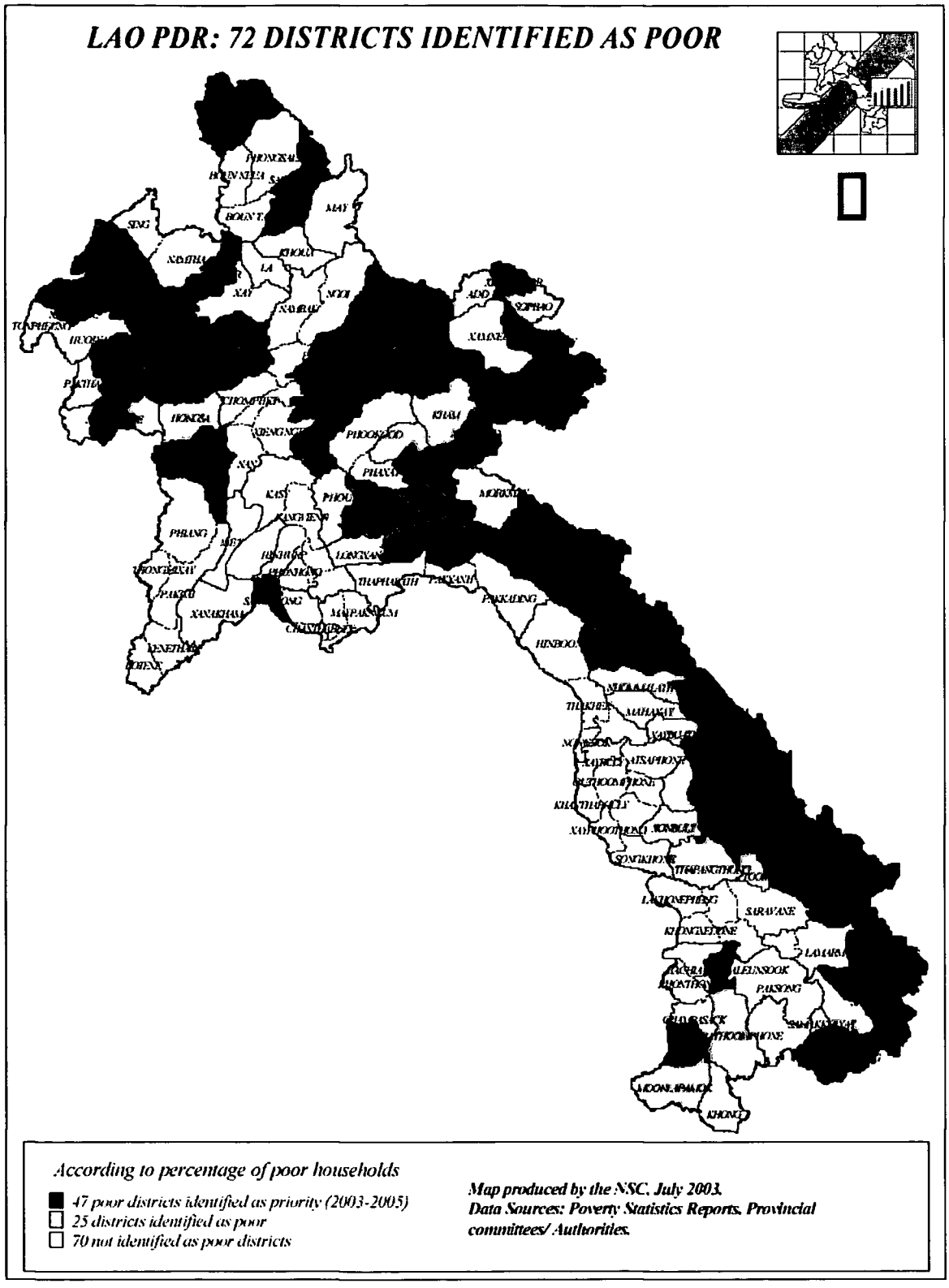
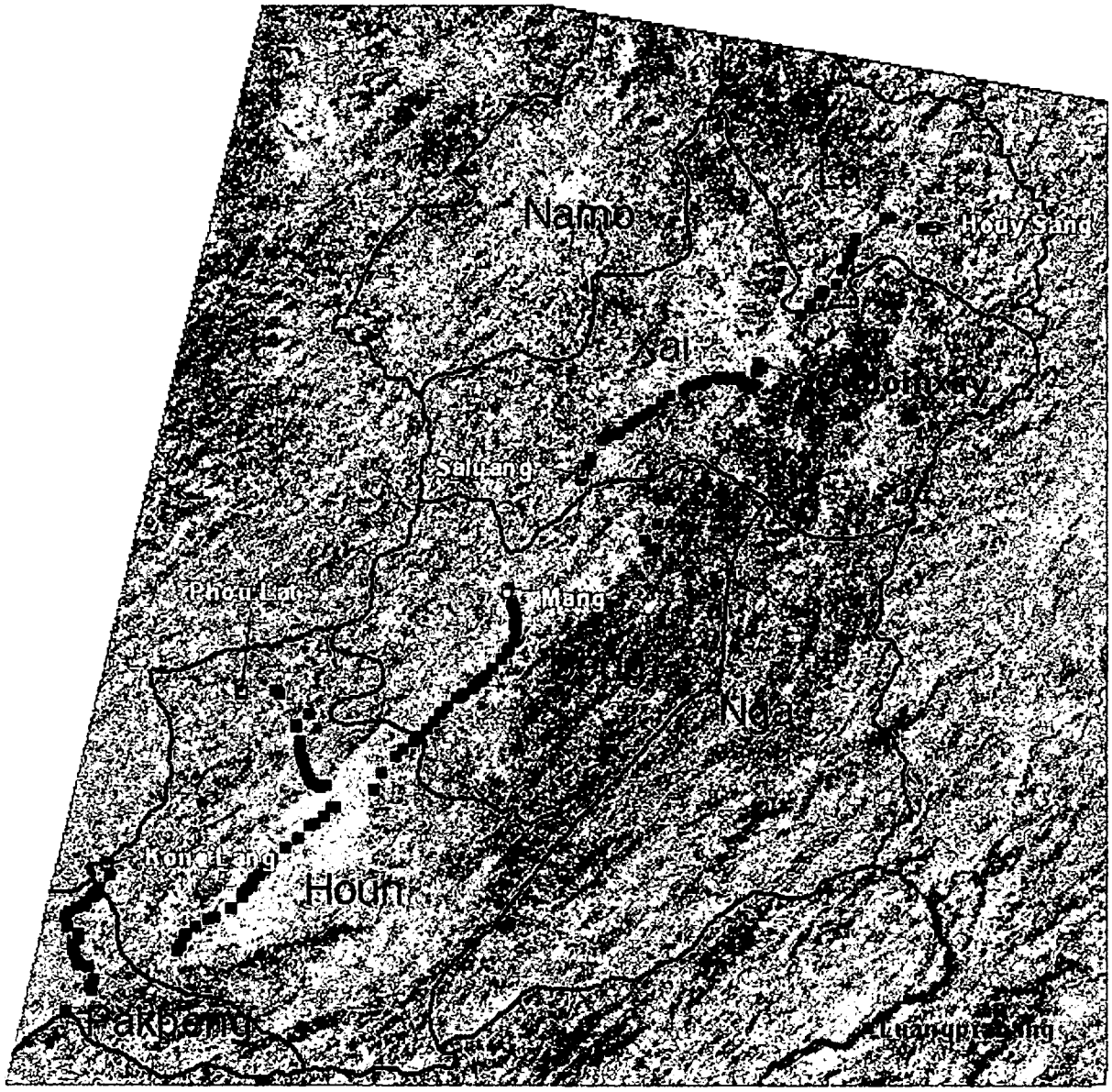
APPENDIX A: Identified Poor Districts Under the NGPES



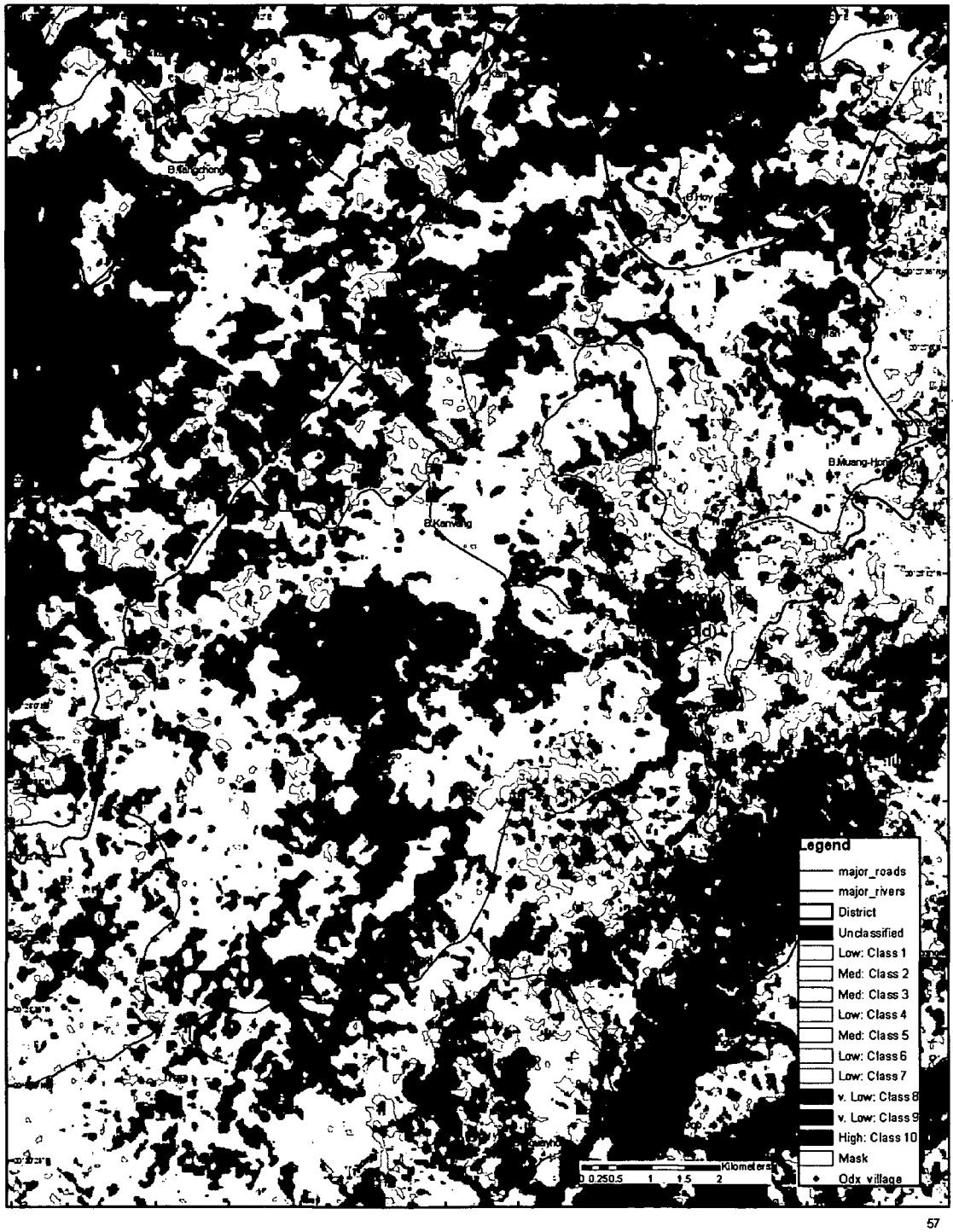
(LAO PDR)

APPENDIX B: Village Site



Appendix C: Land Pressure Map of Mang Village

Land Pressure Map (2001-2003)
Ban Mang, Beng District, Northern Laos



[57]

(Forster, 2007)

Appendix D: IFAD Wealth Ranking Criteria

Wealth ranking definitions are copied verbatim from the IFAD Project Poverty Criteria. The list was obtained from IFAD, Oudomxay Laos.

Wealth Category 1: **1.** Surplus of rice, sell and lend to others, **2.** Sell cash crops (corn, sesame, job's tears), NTFPs and cattle for 500,000-700,000 kip/year, **3.** Own cattle more than 8 heads, small animals (pigs, goats) more than 10 heads, poultry more than 30, **4.** Own assets (tractor, TV, rice mill, solar energy, small hydroelectricity) **5.** Own a lot of agricultural land, **6.** Children go to school and ill household members and afford medical treatment, have enough clothes **7.** have permanent house

Wealth Category 2: **1.** Have a surplus of rice, **2.**Sell cash crops (corn, sesame, job's tears), NTFPs and cattle for 300,000-500,000 kip/year, **3.** Own cattle 5-8 heads, small animals (pigs, goats) 5-10 heads, 20-30 poultry, **4.** don't have assets (TV, solar energy, small hydroelectricity) **5.** Own enough agricultural land, **6.** Children go to school and ill household members can afford medical treatment, have enough clothes, **7.** Have half permanent house

Wealth category 3: **1.** Rice sufficiency for whole year, **2.** Sell cash crops, NTFPs and cattle for 200,000-300,000 kip/year, **3.** Own 2-5 cattle, 2-5 small animals (goats, pigs), 10-20 poultry **4.** Don't have assets (TV, solar energy, small hydroelectricity) **5.** Own some agricultural land, **6.** Children go to school and ill household members can afford medical treatment, own some clothes **7.** Have a half permanent house

Wealth Category 4: **1.** Not enough rice to eat for 1-3 months/year, **2.** Sell cash crops, NTFPs and cattle for 50,000-100,000 kip/year, **3.** Own 0-1 cattle, 0-1 small animals (goats, pigs), 5-10 poultries. **4.** Don't have assets (tractor, TV, rice mill, solar energy, small hydroelectricity) & have to go for wage labor for money **5.** don't have enough agricultural land **6.** Children cannot go to school; ill household members cannot afford medical treatment: don't have enough clothes **7.** have a temporary house

Wealth Category 5: **1.** Don't have enough rice to eat for more than 6 months a year, **2.** Don't have a regular annual income from sale of cash crops, NTFPs and cattle, **3.** Don't have any livestock **4.** Don't have assets (tractor, TV, rice mill, solar energy, small hydro electricity) & have to go for wage labor (for money & meals) **5.** Own no or very little agricultural land, **6.** Children cannot go to school, ill household members cannot afford medical treatment, have no or very little clothes, **7.** Have a temporary house.

APPENDIX E: Focus Group Questions

Focus Group Questions

Interpreter: Date: Interviewee:
Wealth Ranking: Gender: Photo #'s:
Time started: Time ended: Total time:

Time

Make a list of important livelihood strategies that the group participates in. Make list on flip chart. What are the most important livelihood strategies that you participate in? (e.x. How do you earn income? What do you grow for food?)

Livelihood Strategies

Livelihood Strategy is

Do you practice this _____ (livelihood strategy) more, less or the same then 5 - 10 years ago?

Livelihood Strategy	Less	Same	More

Why?

Do you anticipate doing this _____ (livelihood strategy) more, less or the same in the future?

Livelihood Strategy	Less	Same	More

Why?

What is necessary to carry out this livelihood strategy?

Is there anything else from nature required?

What is the most important labour, financial or natural resources for the livelihood strategy?

Capital	Rank
Financial	
Labour	
Natural Resources	

What are the most important natural resources required?

Do you have more or less of a natural resource then 10 years ago?

Natural Resources	Less	Same	More

Do you anticipate having more or less of a natural resource in the future?

Natural Resources	Less	Same	More

Why? What are the reasons for this change in natural resources availability?

Questions (Livelihood Outcomes)
Why is this livelihood strategy important (cash or food)?

What makes you happy and have a feeling of wellbeing?

Appendix F: Details of Interviews and Focus Groups

Date	Translator	Type of Activity	Occupation	Location	WC	Gender
05/10/2006	Phonesavanh Sesawat	FG	Farmer	IFAD Centre	1	F
05/10/2006	Phonesavanh Sesawat	FG	Farmer	IFAD Centre	1	M
06/10/2006	Phonesavanh Sesawat	FG	Farmer	IFAD Centre	2	F
06/10/2006	Phonesavanh Sesawat	FG	Farmer	IFAD Centre	2	M
12/10/2006	Phonesavanh Sesawat	FG	Farmer	IFAD Centre	3	F
12/10/2006	Phonesavanh Sesawat	FG	Farmer	IFAD Centre	3	M
17/10/2006	Somsamouth	TI	Farmer	IFAD Centre	2	M
17/10/2006	Somsamouth	TI	Farmer	IFAD Centre	3	M
18/10/2006	Somsamouth	TI	Farmer	IFAD Centre	3	F
19/10/2006	Somsamouth	TI	Farmer	IFAD Centre	2	F
24/10/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	M
25/10/2006	Somsamouth	SSI	Farmer	IFAD Centre	2	M
25/10/2006	Somsamouth	SSI	Farmer	IFAD Centre	2	M
01/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	2	M
02/11/2006	Somsamouth	SSI	Farmer	Village	2	M
02/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	M
02/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	M
03/11/2006	Somsamouth	I	DAFO Staff	IFAD Centre	-	M
03/11/2006	Somsamouth	I	Women's Union Office & IFAD CDT	IFAD Centre	-	F
03/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	M
03/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	M
03/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	M
04/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	1	M
08/11/2006	Somsamouth	SSI	Farmer	Village	1	M
08/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	2	M
09/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	1	M
09/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	1	M
10/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	2	M
14/11/2006	Somsamouth & Phonesavanh	I	IFAD staff	IFAD Office Beng District		F
14/11/2006	Somsamouth & Phonesavanh	I	Vice - Director of DAFO	IFAD Centre		M
14/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	2	F
15/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	1	M
15/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	F
15/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	F
16/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	1	F
17/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	F
17/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	M
20/11/2006	Somsamouth	I	3 IFAD officials	IFAD Oudomxay		2M 1F
20/11/2006	Somsamouth	I	2 Rural Financial Employees: Head of Rural	Rural Financial Office Oudomxay		2 M

			Financial Service; National Technical Advisor			
22/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	F
23/11/2006	Somsamouth	SSI	Farmer	Village	2	F
23/11/2006	Somsamouth	SSI	Farmer	Village	2	F
23/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	2	F
23/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	F
23/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	F
24/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	1	F
24/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	1	M
24/11/2006	Somsamouth	SSI	Farmer	Village	1	F
24/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	F
25/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	1	F
25/11/2006	Somsamouth	SSI	Farmer	IFAD Centre	3	F
27/11/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	M
28/11/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	F
28/11/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	M
28/11/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	M
28/11/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	M
28/11/2006	Phonesavanh	SSI	Farmer	Village	2	M
28/11/2006	Phonesavanh	SSI	Farmer	IFAD Centre	3	M
29/11/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	F
05/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	M
06/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	F
06/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	F
06/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	F
06/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	3	F
07/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	M
07/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	F
07/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	F
07/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	3	M
07/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	3	M
08/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	1	F
08/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	F
08/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	F
08/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	F
09/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	2	F
09/12/2006	Phonesavanh	SSI	Farmer	IFAD Centre	3	F
06/01/2007	Phonesavanh	SSI	Farmer	IFAD Centre	1	M

FG = Focus Group, TI = Trial Interview, SSI = Semi-Structured Interview, I = Interview

APPENDIX G: Semi-Structured Interview

Interpreter: Interviewer: Date:

Respondent: Wealth Ranking: Gender:

Background Information:

How old are you?

Do you live in the new or old part of the village? ☐new ☐ old

Did you move here?

When did you move here?

Where did you move from?

☐ Pou	☐ Thong Khan	☐ Tang Chang	☐ Khanvang
☐ Na lork	☐ Cheu	☐ Tan Ro	☐ Kam
☐ Tang tou	☐ Mak ka	☐ Bong	☐ Other

Why did you move here? Whose idea was it?

Was it difficult for you after you moved here?

Was it easy to get land?

How many labourers are in your household? _____

What are your most important livelihood strategies for both food and income? (*i.e. How do you earn income? What do you grow or raise for food? We have discussion about this*)
☐ **Upland rice** ☐**Paddy field Rice** ☐ **Maize** ☐**Sesame** ☐**Rubber trees** ☐**livestock**
☐ **Posa** ☐**puak muak** ☐ **Fish ponds** ☐**Job's tear** ☐ **Cassava** ☐**fruit trees**

Rank 1._____
2. _____
3. _____
4. _____

What were you most important strategies 10 years ago?
☐ **Upland rice** ☐**Paddy field Rice** ☐**livestock** ☐ **Posa** ☐**Puak muak** ☐ **Fish ponds**
☐**fruit trees**

Rank 1._____
2. _____
3. _____

Do you have plans to do anything else in the future?
☐ **Upland rice** ☐**Paddy field Rice** ☐ **Maize** ☐**Sesame** ☐**Rubber trees** ☐**livestock**
☐ **Posa** ☐**puak muak** ☐ **Fish ponds** ☐**Job's tear** ☐ **Cassava** ☐**fruit trees**

Upland Rice

What are the activities that you participate in with respect to upland rice?

☐cutting ☐burning ☐clearing ☐fencing ☐planting ☐weeding ☐harvesting ☐post harvest activities _____

Do you plant anything else with this crop?

☐ cucumber ☐ sweet potato ☐ cassava ☐pumpkin ☐ sesame ☐ soybean ☐ job's tear ☐ sweet maize ☐ taro ☐ other _____

How far away is your field? _____ (km or hour)

How do you get the seeds? ☐buy ☐save ☐borrow

From who? _____

Do you consume or sell the rice or both? ☐ consume ☐ sell ☐ both

Do you plant less, the same or more upland rice seeds than 10 years ago? ☐ less ☐ same ☐ more

Why? _____

Do you plan on planting less, the same or more upland rice seeds in the future? ☐ less ☐ same ☐ more

Why? _____

How many seeds did you plant this year for upland rice? _____

What was the yield? _____

(If not harvested yet last year: seeds _____ yield _____)

(Sometimes answer in sacks of rice: # of sacks? _____(usually 30 – 40) weight sack ___)

How many seeds did you plant in the past (~ 10 years ago)? _____

Do you use less, the same or more land for upland rice than 10 years ago? ☐ less ☐ same ☐ more

How much land do you use for upland rice? _____

How much land did you use10 years ago for upland rice? _____

How did you get the land you use? _____

Do you have a temporary certificate for the land? ☐Yes ☐No

Whose name is on the certificate? (their own, spouse's name etc..) _____

Do you plan on using less the same or more land for upland rice in the future? ☐ less ☐ same ☐ more

How much more? _____

How will/did you get the land? _____

How many more seeds will you plant? _____

Was there enough rain for your upland rice this year? ☐Yes ☐No ☐ Sometimes

Was there enough rain around 10 years ago? ☐Yes ☐No ☐ Sometimes

Is the field close to the river? ☐Yes ☐No

Is the upland soil quality worse, same or better than 10 years ago? ☐ w ☐s ☐b

Why? _____

Do you think the upland soil quality will be worse, same or better in the future? ☐ worse ☐same ☐better

Why?_____

How many years do you leave the field to fallow now? _____

How many years did you leave the field to fallow in the past? _____

Is there less same or more land to choose from for clearing for upland rice compared with 10 years ago? ☐ less ☐ same ☐ more

Is your upland rice terraced? ☐Yes ☐No

Would you consider your land good quality land? ☐1 – excellent ☐2-medium ☐3-poor

Do you have enough labour for the upland rice? ☐Yes ☐No

Do you use labour exchange for your upland rice? ☐Yes ☐No

Do you pay for labour for the upland rice? ☐Yes ☐No

Paddy Rice

What year did you start growing paddy field rice? _____ year

What are the activities that you participate in with respect to paddy rice?

☐ burning/clearing, ☐ Harrowing, ☐seeding, ☐planting ☐weeding, ☐harvesting,☐ post harvest activities) _____

Do you plant anything else with this crop? _____

How far away is your field? _____ (km/hour)

How do you get the seeds? ☐buy ☐save ☐borrow

From who? _____

Do you consume or sell the rice or both? ☐ consume ☐ sell ☐ both

Do you plant less the same or more paddy rice seeds than 10 years ago? ☐ less ☐ same ☐ more

Why? _____

_____

Do you plan on planting less, the same or more paddy rice seeds in the future? ☐ less ☐ same ☐ more

Why?_____

_____

How many seeds did you plant this year for this crop? _____

What was the yield? _____

(If not harvested yet last year: seeds _____ yield _____)

(Sometimes answer in sacks of rice: # of sacks? _____(usually 30 – 40) weight sack _____)

How many seeds did you plant in the past (~ 10 years ago) _____

Do you use less, the same or more land for paddy field rice than 10 years ago? ☐ less ☐ same ☐ more

How much land do you use for this crop? _____

How did you get the land you use? _____

How much land did you have 10 years ago for paddy rice? _____

Do you have a temporary certificate for the land? ☐Yes ☐No

Whose name is on the certificate? (their own, spouse's name etc..) _____

Do you plan on using less the same or more land for paddy rice in the future? ☐ less ☐ same ☐ more

How much more? _____

How will/did you get the land? _____

How many more seeds will you plant? _____

Do you have enough water for paddy rice? ☐Yes ☐No ☐Sometimes

Do you have an irrigation system? ☐Yes ☐No

Will you have an irrigation system in the future ☐Yes ☐No

Is the field close to the river? ☐Yes ☐No

Do you think you will have enough water in the future for this paddy rice? ☐Yes ☐No

Is the paddy field soil quality worse, same or better than 10 years ago? ☐ w ☐s ☐b

Why? _____

Do you think the paddy field soil quality will be worse the same or better in the future? ☐ worse ☐same ☐better

Why? _____

_____

Is your paddy field terraced? ☐Yes ☐No

Would you consider your land good quality land? ☐1 – excellent ☐2-medium☐3-poor

Do you have enough labour for the paddy field rice? ☐Yes ☐No

Do you use labour exchange for your upland rice? ☐Yes ☐No

Do you pay for labour for the paddy field rice? ☐Yes ☐No

Maize

What year did you start growing Maize? _____ year

What are the activities that you participate in with respect to maize? ☐cutting ☐burning ☐ clearing ☐fencing ☐planting ☐weeding ☐harvesting ☐post harvest activities

_____

Do you plant anything else with this crop?

☐ cucumber ☐ sweet potato ☐ cassava ☐pumpkin ☐ sesame ☐soybean ☐ job's tear ☐ other _____

How far away is your field? _____ (km or hour)

How do you get the seeds? ☐buy ☐save ☐borrow

Where did you get the seeds? _____

Do you consume (for animals) or sell the maize or both? ☐ consume ☐ sell ☐ both

Do you plant less the same or more maize seeds than 10 years ago? ☐ less ☐ same ☐ more

Why? _____

_____

Do you plan on planting less, the same or more maize seeds in the future? ☐ less ☐ same ☐ more

Why? _____

_____

How many seeds did you plant this year for this crop? _____

What was the yield? _____

Do you use less, the same or more land for maize than 10 years ago? ☐ less ☐ same ☐ more

How much land do you use for this crop? _____

How much land did you have 10 years ago for maize? _____

How did you get the land you use? _____

Do you have a temporary certificate for the maize land? ☐Yes ☐No

Whose name is on the certificate? (their own, spouse's name etc..) _____

Do you plan on using less the same or more land for maize in the future? ☐ less ☐ same ☐ more

How much more land will you use? _____

How will/did you get this land? _____

How many more seeds will you plant? _____

Do you have enough water for the maize? ☐Yes ☐No

Is the field close to the river? ☐Yes ☐No

Do you think you will have enough water in the future for the maize? ☐Yes ☐No

Is the maize field soil quality worse, same or better than 10 years ago? ☐ w ☐s ☐b

Why? _____

_____

Do you think the maize field soil quality will be worse the same or better in the future? ☐ worse ☐same ☐better

Why? _____

_____

Would you consider your land good quality land? ☐1 – excellent ☐2-medium ☐3-poor

Do you grow maize on the same plot every year (find out about crop rotations)? ☐Yes ☐No

Do you have enough labour for the maize? ☐Yes ☐No

Do you use labour exchange for your maize? ☐Yes ☐No

Do you pay for labour for the maize? ☐Yes ☐No

Sesame

What year did you start growing Sesame? _____ year

What are the activities that you participate in with respect to Sesame? ☐cutting ☐burning ☐ clearing ☐fencing ☐planting ☐weeding ☐harvesting ☐post harvest activities

_____

Do you plant anything else with this crop?

☐ cucumber ☐ sweet potato ☐ cassava ☐pumpkin ☐ sesame ☐soybean ☐ job's tear ☐ other _____

How far away is your field? _____ (km/hour)

How do you get the seeds? ☐buy ☐save ☐borrow

Where did you get the seeds? _____

Do you consume or sell the sesame? ☐ consume ☐ sell ☐ both

Do you plant less the same or more sesame seeds than 10 years ago? ☐ less ☐ same ☐ more

Why? _____

_____

Do you plan on planting less, the same or more sesame seeds in the future? ☐ less ☐ same ☐ more

Why?_____

How many seeds did you plant this year for this crop? _____

What was the yield? _____

How many seeds did you plant in the past (~ 10 years ago) _____

Do you use less, the same or more land for sesame than 10 years ago? ☐ less ☐ same ☐ more

How much land do you use for this crop? _____

How much land did you have 10 years ago for sesame? _____

How did you get the land you use? _____

Do you have a temporary certificate for the land? ☐Yes ☐No

Whose name is on the certificate? (their own, spouse's name etc..)_____

Do you plan on using less the same or more land for sesame in the future? ☐ less ☐ same ☐ more

How much more? _____

How will you get this land? _____

How many more seeds will you plant? _____

Do you have enough water for the sesame? ☐Yes ☐No

Do you think you will have enough water in the future for the sesame? ☐Yes ☐No

Do you have an irrigation system? ☐Yes ☐No

Is the field close to the river? ☐Yes ☐No

Is the sesame field soil quality worse, same or better than 10 years ago? ☐ w ☐s ☐b

Why? _____

_____

Do you think the sesame field soil quality will be worse the same or better in the future? ☐ worse ☐same ☐better

Why? _____

_____

Would you consider your land good quality land? ☐Yes ☐No ☐1 – excellent ☐2-medium☐3-poor

Do you grow sesame on the same plot every year? ☐Yes ☐No

Do you have enough labour for the sesame? ☐Yes ☐No

Do you use labour exchange for your sesame? ☐Yes ☐No

Do you pay for labour for the sesame? ☐Yes ☐No

Rubber Trees

What year did you start growing rubber trees? _____ year
Do you plant anything else with this crop? _____
How far away is your field? _____ (km/hour)
Did you buy the trees? _____
How many trees do you have? _____
How much land do you use for the trees? _____
How did you get the land you use? _____
What did you used to grow on the land? _____
Do you have a temporary certificate for the land? ☐**Yes** ☐**No**
Whose name is on the certificate? (their own, husband's name wife's name) _____
Do you plan on planting more rubber trees in the future (next 10 years)? ☐**Yes** ☐**No**
How much more land do you plan on using? _____
How many more trees do you plan on planting? _____
Why? _____
_____
How did you get the land? _____
Do you have enough water for the trees? ☐**Yes** ☐**No**
Do you think you will have enough water in the future for the trees? ☐**Yes** ☐**No**
Do you have an irrigation system? ☐**Yes** ☐**No**
Do you think the soil quality will be worse the same or better in the future? ☐ **worse** ☐ **same** ☐**better**
Why? _____
_____
Will you have enough labour for the rubber trees? ☐Yes ☐No

If they want to grow rubber trees (a number of people do)
When will you start to grow rubber trees? _____
Why are you planning on growing rubber trees? _____
How much land will you use? _____
Do you have the land already? _____
What do you grow on the land right now? _____
Where did you get the idea? _____
Where will you get the trees? _____

What are the benefits to growing rubber trees? _____
What are the drawbacks? _____

Fruit Trees

What year did you start growing fruit trees? _____ year

What type of fruit trees do you grow? ☐ banana ☐mango ☐ pomelo ☐ lychee ☐ papaya ☐ longan ☐jujube ☐other _____

Do you plant anything else with the trees? _____

How far away is your field? _____ (km/hour)

Did you buy the trees? _____

How many trees do you have? _____

How much land do you use for the trees? _____

How did you get the land you use? _____

Do you have a temporary certificate for the land? ☐Yes ☐No

Whose name is on the certificate? (their own, husband's name wife's name) _____

Do you plan on planting more fruit trees in the future? ☐Yes ☐No

How much more land do you plan on using? _____

How many more trees do you plan on planting? _____

Why? _____

How did you get the new land? _____

Do you have enough water for the trees? ☐Yes ☐No

Do you think you will have enough water in the future for the trees? ☐Yes ☐No

Do you have an irrigation system? ☐Yes ☐No

Do you think the soil quality will be worse the same or better in the future? ☐ worse ☐ same ☐better

Why? _____

_____

Do you have enough labour for the rubber trees? ☐Yes ☐No

What are the benefits to growing fruit trees? _____

What are the drawbacks? _____

Livestock	Poultry	Pigs	Cattle	Buffalo	Goats
How many do you have?					
Do you have the same more or less than 10 years ago?	☐ less ☐ same ☐ more	☐ less ☐ same ☐ more	☐ less ☐ same ☐ more	☐ less ☐ same ☐ more	☐ less ☐ same ☐ more
How many did you have 10 years ago?					
Why					
Do you plan to have the same, more or less in the future?	☐ less ☐ same ☐ more	☐ less ☐ same ☐ more	☐ less ☐ same ☐ more	☐ less ☐ same ☐ more	☐ less ☐ same ☐ more
Why					
Is there enough forest for the cattle and buffalo to graze					
How do you participate within this livelihood strategy?					

☐**Fish Ponds** ☐**Fishing in the River**

Fish Pond

When did you get your fish pond? _____ Year

How large is your fish pond? _____

How far away from the village is the fish pond? _____ (km/hours)

What are the activities that you participate in with respect to the fish pond?

☐ making fish net ☐ catching fish ☐cleaning fish

Do you have more, less or the same # of ponds compared to 10 years ago? ☐ less ☐ same ☐ more

Do you plan on having more fish ponds in the future? ☐Yes ☐No

Do you already have the land for this? ☐Yes ☐No

How many fish were you able to collect from the fish pond this year? _____

Do you have a temporary certificate for the land the fish pond is on? ☐Yes ☐No

Whose name is on the certificate? _____

Do you consume or sell the fish or both? ☐ consume ☐ sell ☐ both

Fishing

Do you go fishing in the river? ☐Yes ☐No Did you go fishing in the river ☐ Yes ☐No How often do you go fishing?

How far away is the place at the river where you go fishing? _____ (km/hours)

What are the activities that you participate in with respect to fishing? (i.e. making fish net, clean the fish etc…) _____

Are there less, the same or more fish now in the river compared to 10 years ago?

☐ less ☐ same ☐ more

Why?_____

Do you think there will be less, the same or more fish in the future? ☐ less ☐ same ☐ more

Why? _____

How many fish did you collect this year?_____

How many fish did you collect in the past (~ 10 years ago)? _____

Is the water quality of the river worse, same or better than 10 years ago? ☐ worse ☐ same ☐ better

Do you think the water quality will be worse, same or better in the future? ☐ worse ☐ same ☐ better

Do you consume or sell the fish? ☐ consume ☐ sell ☐ both

NTFPS	Posa	Puak Muak
Do you collect it from a plot or in the forest or both?	☐**plot** ☐**forest** ☐**both**	☐**plot** ☐**forest** ☐**both**
What are the activities do you personally participate in with respect to .....? Collecting debarking, selling etc...		
Plot		
Do you have less, same or more trees than 10 years ago?	☐ **less** ☐ **same** ☐ **more**	☐ **less** ☐ **same** ☐ **more**
Did you seed it?		
Is the plot your old fallow land?		
When did you start the plot?		
How much do you collect now? (kg)		
How much land do you use?		
How many trees do you have on your plot		
Do you grow anything else on this land?		
Do you have a certificate for your land?		☐**Yes** ☐**No**
Whose name is on the certificate?		
How much land did you use 10 years ago?		
How far away is your plot?		
Do you think you will have less, the same or more trees, in the future?	☐ **less** ☐ **same** ☐ **more**	☐ **less** ☐ **same** ☐ **more**
Why?		
If more: Do you have more land ?	☐**Yes** ☐**No**	☐**Yes** ☐**No**
How will/did you get this land?		
Did you use to collect it in the forest?		
Forest		
Do you collect less, same or more than 10 years ago?	☐ **less** ☐ **same** ☐ **more**	☐ **less** ☐ **same** ☐ **more**
How much do you collect now? (kg)		
How much did you collect 10 years ago? (kg)		
Do you think you will collect less, same or more, in the future?	☐ **less** ☐ **same** ☐ **more**	☐ **less** ☐ **same** ☐ **more**
Why?		
Is there more, less or the same amount in the forest?	☐ **less** ☐ **same** ☐ **more**	☐ **less** ☐ **same** ☐ **more**
Why		

Labour

Have you ever been a labourer to earn some income? ☐Yes ☐No

What did you do?

When where you a labourer?

Do you do less, more or the same work as a labourer than 10 years ago? ☐ less ☐ same ☐ more

Do you plan on doing less more or the same labour work in the future? ☐ less ☐ same ☐ more

Hunting

Within the last 10 years did you hunt before the gun law came in? ☐Yes ☐No

What did you hunt? _____

Do you still hunt with local tools? ☐Yes ☐No

What do you hunt? _____

Do you hunt more or less, same or more than 10 years ago? ☐ less ☐ same ☐ more

Are there less, same or more wild animals in the than 10 years ago? ☐ less ☐ same ☐ more

Weaving

Do you do any weaving? ☐Yes ☐No

Do you sell your weaving? ☐Yes ☐No

Do you do less, same or more weaving than 10 years ago? ☐ less ☐ same ☐ more

Do you want to have/grow? (just to review for me)

Paddy Rice ☐Yes ☐No

Why don't you? _____

Maize ☐Yes ☐No

Why don't you? _____

Sesame ☐Yes ☐No

Why don't you? _____

Rubber trees ☐Yes ☐No

Why don't you? _____

Fish ponds ☐Yes ☐No

Why don't you? _____

livestock ☐Yes ☐No

Why don't you? _____

Posa or Puak Muak ☐Yes ☐No

Why don't you? _____

Within the last 10 years did you grow/have (just to review for me)

Paddy Rice ☐Yes ☐No

Why did you stop? _____

Maize ☐Yes ☐No

Why did you stop? _____

Sesame ☐Yes ☐No

Why did you stop? _____

Rubber trees ☐Yes ☐No

Why did you stop? _____

Fish ponds ☐Yes ☐No

Why did you stop? _____

More livestock ☐Yes ☐No

Why did you stop? _____

Posa or Puak Muak ☐Yes ☐No

Why did you stop? _____

Livelihood Outcomes
Did your household have enough rice to eat this past year? ☐Yes ☐No
If NO, rice deficient for _____ months
Did you buy some of the rice? ☐Yes ☐No
Did your household have enough rice to eat 10 years ago? ☐Yes ☐No
If NO, rice deficient for _____ months
Do you think you will have enough rice to eat in the next few years?

Do you have less, the same or more income than 10 years ago? ☐ less ☐ same ☐ more
Do you think you will have less, the same or more income in the future? ☐ less ☐ same ☐ more

Have borrowed money before ☐Yes ☐No
Why?_____
From whom did you borrow the money? _____
What year did you borrow the money _____

Do you feel you are better off, the same or worse off than 10 years ago?
☐worse ☐same ☐better
Do you feel you will be better off, same or worse off in the future?
☐worse ☐same ☐better

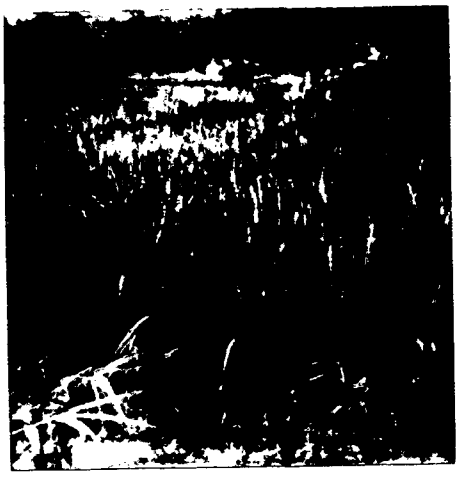
Overall Resources
Overall is land easier the same or harder to get compared with 10 years ago?
☐easier ☐same ☐harder
Overall do you have less, the same or more land than 10 years ago?
☐less ☐same ☐more
Overall is the soil quality here worse, same or better than 10 years ago?
☐worse ☐same ☐better
Overall is there less same or more forest here compared with 10 years ago?
☐less ☐same ☐more

Climate

How has the climate changed over the last 10 years? How has the rain changed?

Hydrology
How have the rivers and streams changed over the last ten years?

Appendix H: Semi-structured Interview Photographs



Lowland Rice

Rubber Trees

Posa

Cattle

Sesame

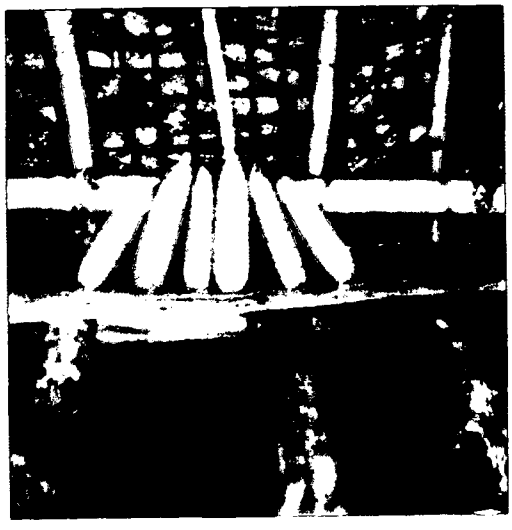
Goats

Cassava

Chickens

Ducks

Fishpond



Maize

Job's Tear

Puak Muak

Upland Rice

APPENDIX I: Statistical analysis for top four livelihoods strategies

Lowland Rice

There is a statistical difference in the importance of lowland rice with respect to certain WCs but not gender (Box 1). This is shown by the following two proportion Z-tests (Box 1, Box 2 and Box 3). For each variable, WCs or gender, the null hypothesis is that there is no difference between the variables in the proportion of respondents who rank lowland rice within their top 4 livelihood strategies i.e. the importance of lowland rice is the same for both variables. The p-value for WC1 compared with WC2 is less than 0.05; therefore the null hypothesis is rejected (Box 1). There is strong statistical evidence that a higher proportion of respondents in WC 1 ranked lowland rice as one of their top 4 livelihood strategies when compared with WC2. Similarly, when comparing WC1 with WC3 the resulting p-value is 0.002 (Box 2). However, when comparing WC2 with WC3 the p-value is 0.751. The conclusion is that the average of the importance of lowland rice is not the same for the wealth categories. A higher proportion of respondents in WC1 consider lowland rice more important than WC2 or WC3. However, there is no difference between WC2 and WC3. Gender was not analyzed because the same number of males and females selected lowland rice in their top 4 livelihood strategies. The rest of the analysis in Appendix G uses the same statistical analysis.

```
Variable                          X   N   Sample p
Importance of lowland rice W1    17  20   0.850000
Importance of lowland rice W2    10  20   0.500000

Difference = p (Paddy Field 2_W1) - p (Paddy Field 2_W2)
Estimate for difference:  0.35
95% lower bound for difference:  0.124020
Test for difference = 0 (vs > 0):  Z = 2.55 P-Value = 0.005
```

Box 1: Two proportion z-test WC1 versus WC2 for percentage of respondents placing lowland rice within their top four livelihood strategies

```
Variable                          X   N   Sample p
Importance of lowland rice W1    17  20   0.850000
Importance of lowland rice W3     9  20   0.450000

Difference = p (Paddy Field 2_W1) - p (Paddy Field 2_W3)
Estimate for difference:  0.4
95% lower bound for difference:  0.174769
Test for difference = 0 (vs > 0):  Z = 2.92  P-Value = 0.002
```

Box 2: Two proportion z-test WC1 versus WC3 for percentage of respondents placing lowland rice within their top four livelihood strategies

```
Variable                          X   N   Sample p
Importance of lowland rice W2    10  20   0.500000
Importance of lowland rice W3     9  20   0.450000

Difference = p (Paddy Field 2_W2) - p (Paddy Field 2_W3)
Estimate for difference:  0.05
95% lower bound for difference:  -0.209423
Test for difference = 0 (vs > 0):  Z = 0.32 P-Value = 0.376
```

Box 3: Two proportion z-test WC2 versus WC3 for percentage of respondents placing lowland rice within their top four livelihood strategies

Gender was not analyzed as the number of respondents was exactly the same for both men and women.

Upland Rice

```
Variable                          X   N  Sample p
Importance of upland rice WC1     6  20  0.300000
Importance of upland rice WC2    14  20  0.700000

Difference = p (Upland_WC1) - p (Upland_WC2)
Estimate for difference:  -0.4
95% upper bound for difference:  -0.161638
Test for difference = 0 (vs < 0):  Z = -2.76 P-Value = 0.003
```

Box 4: Two proportion z-test WC1 versus WC2 for percentage of respondents placing upland rice within their top four livelihood strategies

```
Variable                          X   N  Sample p
Importance of upland rice WC1     6  20  0.300000
Importance of upland rice WC3    12  20  0.600000

Difference = p (Upland_WC1) - p (Upland_WC3)
Estimate for difference:  -0.3
95% upper bound for difference:  -0.0532720
Test for difference = 0 (vs < 0):  Z = -2.00  P-Value = 0.023
```

Box 5: Two proportion z-test WC1 versus WC3 for percentage of respondents placing upland rice within their top four livelihood strategies

```
Variable                          X   N  Sample p
Importance of upland rice WC2    14  20  0.700000
Importance of upland rice WC3    12  20  0.600000

Difference = p (Upland_WC2) - p (Upland_WC3)
Estimate for difference:  0.1
95% CI for difference:  (-0.193995, 0.393995)
Test for difference = 0 (vs not = 0):  Z = 0.67  P-Value = 0.505
```

Box 6: Two proportion z-test WC2 versus WC3 for percentage of respondents placing upland rice within their top four livelihood strategies

```
Variable                        X   N  Sample p
Importance of upland rice F    18  30  0.600000
Importance of upland rice M    14  30  0.466667

Difference = p (Upland_F) - p (Upland_M)
Estimate for difference:  0.133333
95% lower bound for difference:  -0.0766437
Test for difference = 0 (vs > 0):  Z = 1.04  P-Value = 0.148
```

Box 7: Two proportion z-test females versus males for percentage of respondents placing upland rice within their top four livelihood strategies

Maize

```
Variable                    X   N  Sample p
Importance of Maize WC1    18  20  0.900000
Importance of Maize WC2    14  20  0.700000

Difference = p (Maize 2_1) - p (Maize 2_2)
Estimate for difference:  0.2
95% lower bound for difference:  -0.00145260
Test for difference = 0 (vs > 0):  Z = 1.63 P-Value = 0.051
```

Box 8: Two proportion z-test WC1 versus WC2 for percentage of respondents placing maize within their top four livelihood strategies

```
Variable                    X   N  Sample p
Importance of Maize WC1    18  20  0.900000
Importance of Maize WC3    15  20  0.750000

Difference = p (Maize 2_1) - p (Maize 2_3)
Estimate for difference:  0.15
95% lower bound for difference:  -0.0437509
Test for difference = 0 (vs > 0):  Z = 1.27  P-Value = 0.101
```

Box 9: Two proportion z-test WC1 versus WC3 for percentage of respondents placing maize within their top four livelihood strategies

```
Variable                    X   N  Sample p
Importance of Maize WC2    14  20  0.700000
Importance of Maize WC3    15  20  0.750000

Difference = p (Maize 2_2) - p (Maize 2_3)
Estimate for difference:  -0.05
95% upper bound for difference:  0.181889
Test for difference = 0 (vs < 0):  Z = -0.35  P-Value = 0.361
```

Box 10: Two proportion z-test WC2 versus WC3 for percentage of respondents placing maize within their top four livelihood strategies

Gender was not analyzed because the proportions were very close (80% vs. 77%).

Sesame

```
Variable                    X   N  Sample p
Importance of Sesame WC1   15  20  0.750000
Importance of Sesame WC2   18  20  0.900000

Difference = p (Sesame 2_WC1) - p (Sesame 2_WC2)
Estimate for difference:  -0.15
95% upper bound for difference:  0.0437509
Test for difference = 0 (vs < 0):  Z = -1.27  P-Value = 0.101
```

Box 11: Two proportion z-test WC1 versus WC2 for percentage of respondents placing sesame within their top four livelihood strategies

```
Variable                    X   N  Sample p
Importance of Sesame WC2   18  20  0.900000
Importance of Sesame WC3   15  20  0.750000

Difference = p (Sesame 2_WC2) - p (Sesame 2_WC3)
Estimate for difference:  0.15
95% lower bound for difference:  -0.0437509
Test for difference = 0 (vs > 0):  Z = 1.27  P-Value = 0.101
```

Box 12: Two proportion z-test WC2 versus WC3 for percentage of respondents placing sesame within their top four livelihood strategies

```
Variable                 X   N  Sample p
Importance of Sesame F  27  30  0.900000
Importance of Sesame M  21  30  0.700000

Difference = p (Sesame 2_F) - p (Sesame 2_M)
Estimate for difference:  0.2
95% lower bound for difference:  0.0355146
Test for difference = 0 (vs > 0):  Z = 2.00 P-Value = 0.023
```

Box 13: Two proportion z-test females versus males for percentage of respondents placing Sesame within their top four livelihood strategies

Livestock

```
Variable                     X   N  Sample p
Importance of Livestock WC1  5  20  0.250000
Importance of Livestock WC2  8  20  0.400000

Difference = p (Livestock2_1) - p (Livestock2_2)
Estimate for difference:  -0.15
95% upper bound for difference:  0.0904808
Test for difference = 0 (vs < 0):  Z = -1.03  P-Value = 0.152
```

Box 14: Two proportion z-test WC1 versus WC2 for percentage of respondents placing livestock within their top four livelihood strategies

```
Variable                     X   N  Sample p
Importance of Livestock WC1  5  20  0.250000
Importance of Livestock WC3  9  20  0.450000

Difference = p (Livestock2_1) - p (Livestock2_3)
Estimate for difference:  -0.2
95% upper bound for difference:  0.0425811
Test for difference = 0 (vs < 0):  Z = -1.36  P-Value = 0.088
```

Box 15: Two proportion z-test WC1 versus WC3 for percentage of respondents placing livestock within their top four livelihood strategies

```
Variable                     X   N  Sample p
Importance of Livestock WC2  8  20  0.400000
Importance of Livestock WC3  9  20  0.450000

Difference = p (Livestock2_2) - p (Livestock2_3)
Estimate for difference:  -0.05
95% upper bound for difference:  0.206803
Test for difference = 0 (vs < 0):  Z = -0.32 P-Value = 0.374
```

Box 16: Two proportion z-test WC2 versus WC3 for percentage of respondents placing livestock within their top four livelihood strategies

```
Variable                    X   N  Sample p
Importance of Livestock F   8  30  0.266667
Importance of Livestock M  14  30  0.466667

Difference = p (Livestock2_F) - p (Livestock2_M)
Estimate for difference:  -0.2
95% upper bound for difference:  0.000205208
Test for difference = 0 (vs < 0):  Z = -1.64  P-Value = 0.050
```

Box 17: Two proportion z-test females versus males for percentage of respondents placing livestock within their top four livelihood strategies

Posa

```
Variable                X   N  Sample p
Importance of Posa WC1  4  20  0.200000
Importance of Posa WC2  1  20  0.050000

Difference = p (Posa 2_1) - p (Posa 2_2)
Estimate for difference:  0.15
95% lower bound for difference:  -0.0175411
Test for difference = 0 (vs > 0):  Z = 1.47 P-Value = 0.070
```

Box 18: Two proportion z-test WC1 versus WC2 for percentage of respondents placing Posa within their top four livelihood strategies

```
Variable                X   N  Sample p
Importance of Posa WC1  4  20  0.200000
Importance of Posa WC3  7  20  0.350000

Difference = p (Posa 2_1) - p (Posa 2_3)
Estimate for difference:  -0.15
95% upper bound for difference:  0.0789539
Test for difference = 0 (vs < 0):  Z = -1.08  P-Value = 0.141
```

Box 19: Two proportion z-test WC1 versus WC3 for percentage of respondents placing Posa within their top four livelihood strategies

```
Variable                X   N  Sample p
Importance of Posa WC2  1  20  0.050000
Importance of Posa WC3  7  20  0.350000

Difference = p (Posa 2_2) - p (Posa 2_3)
Estimate for difference:  -0.3
95% CI for difference:  (-0.529826, -0.0701739)
Test for difference = 0 (vs not = 0):  Z = -2.56 P-Value = 0.011
```

Box 20: Two proportion z-test WC2 versus WC3 for percentage of respondents placing Posa within their top four livelihood strategies

Puak Muak

```
Variable        X   N  Sample p
Puak Muak 2_2  12  20  0.600000
Puak Muak 2_3   8  20  0.400000

Difference = p (Puak Muak 2_2) - p (Puak Muak 2_3)
Estimate for difference:  0.2
95% lower bound for difference:  -0.0548196
Test for difference = 0 (vs > 0):  Z = 1.29  P-Value = 0.098
```

Box 21: Two proportion z-test WC2 versus WC3 for percentage of respondents placing Puak Muak within their top four livelihood strategies

```
Variable                   X   N  Sample p
Importance of Puak Muak F  19  30  0.633333
Importance of Puak Muak M  11  30  0.366667

Difference = p (Puak Muak 2_F) - p (Puak Muak 2_M)
Estimate for difference:  0.266667
95% CI for difference:  (0.0227989, 0.510534)
Test for difference = 0 (vs not = 0):  Z = 2.14 P-Value = 0.032
```

Box 22: Two proportion z-test females versus males for percentage of respondents placing Puak Muak within their top four livelihood strategies

Fish Ponds

```
Variable                X   N  Sample p
Importance of Fish Pond WC1  0  20  0.000000
Importance of Fish Pond WC2  4  20  0.200000

Difference = p (Fish Pond 2_1) - p (Fish Pond 2_3)
Estimate for difference:  -0.2
95% upper bound for difference:  -0.0528798
Test for difference = 0 (vs < 0):  Z = -2.24 P-Value = 0.013
```

Box 23: Two proportion z-test WC1 vs. WC2 for percentage of respondents placing Fish ponds within their top four livelihood strategies

```
Variable                      X   N  Sample p
Importance of Fish Pond WC2 0  20  0.000000
Importance of Fish Pond WC3 4  20  0.200000

Difference = p (Fish Pond 2_2) - p (Fish Pond 2_3)
Estimate for difference:  -0.2
95% upper bound for difference:  -0.0528798
Test for difference = 0 (vs < 0):  Z = -2.24 P-Value = 0.013
```

Box 24: Two proportion z-test WC2 versus WC3 for percentage of respondents placing Fish ponds within their top four livelihood strategies

```
Variable                    X   N  Sample p
Importance of Fish Pond F  1  30  0.033333
Importance of Fish Pond M  3  30  0.100000

Difference = p (Fish Pond 2_F) - p (Fish Pond 2_M)
Estimate for difference:  -0.0666667
95% upper bound for difference:  0.0383218
Test for difference = 0 (vs < 0):  Z = -1.04 P-Value = 0.148
```

Box 25: Two proportion z-test females versus males for percentage of respondents placing Fish ponds within their top four livelihood strategies

Job's Tear

```
Variable                      X   N  Sample p
Importance of Jobs tear WC1  1  20  0.050000
Importance of Jobs tear WC3  0  20  0.000000

Difference = p (Jobs tear_1_1) - p (Jobs tear_1_3)
Estimate for difference:  0.05
95% lower bound for difference:  -0.0301603
Test for difference = 0 (vs > 0):  Z = 1.03 P-Value = 0.152
```

Box 26: Two proportion z-test WC1 versus WC3 for percentage of respondents placing fruit trees within their top four livelihood strategies

Fruit Trees

```
Variable                      X   N  Sample p
Importance of Fruit Tree WC1  2  20  0.100000
Importance of Fruit Tree WC2  0  20  0.000000

Difference = p (Fruit Tree 2_1) - p (Fruit Tree 2_2)
Estimate for difference:  0.1
95% lower bound for difference:  -0.0103401
Test for difference = 0 (vs > 0):  Z = 1.49 P-Value = 0.068
```

Box 27: Two proportion z-test WC1 versus WC2 for percentage of respondents placing fruit trees within their top four livelihood strategies

```
Variable                        X   N  Sample p
Importance of Fruit Tree WC1    2  20  0.100000
Importance of Fruit Tree WC3    0  20  0.000000

Difference = p (Fruit Tree 2_1) - p (Fruit Tree 2_3)
Estimate for difference:  0.1
95% lower bound for difference:  -0.0103401
Test for difference = 0 (vs > 0):  Z = 1.49 P-Value = 0.068
```

Box 28: Two proportion z-test WC1 versus WC3 for percentage of respondents placing fruit trees within their top four livelihood strategies

Labour

```
Variable                X   N  Sample p
Amount of Labour WC1    7  19  0.368421
Amount of Labour WC3   12  16  0.750000

Difference = p (Labour 2_1) - p (Labour 2_3)
Estimate for difference:  -0.381579
95% upper bound for difference:  -0.126943
Test for difference = 0 (vs < 0):  Z = -2.46 P-Value = 0.007
```

Box 29: Two proportion z-test WC1 versus WC3 for percentage of respondents conducting paid labour

```
Variable                X   N  Sample p
Amount of Labour WC2    7  19  0.368421
Amount of Labour WC3   12  16  0.750000

Difference = p (Labour 2_2) - p (Labour 2_3)
Estimate for difference:  -0.381579
95% upper bound for difference:  -0.126943
Test for difference = 0 (vs < 0):  Z = -2.46 P-Value = 0.007
```

Box 30: Two proportion z-test WC2 versus WC3 for percentage of respondents conducting paid labour

```
Variable              X   N  Sample p
Amount of Labour F   15  24  0.625000
Amount of Labour M   11  30  0.366667

Difference = p (Labour 2_F) - p (Labour 2_M)
Estimate for difference:  0.258333
95% lower bound for difference:  0.0407001
Test for difference = 0 (vs > 0):  Z = 1.95 P-Value = 0.025
```

Box 31: Two proportion z-test females versus males for percentage of respondents doing paid labour

APPENDIX J: Statistical Analysis for changes in livelihood strategies

Lowland Rice

```
                            N     Mean  StDev  SE Mean
Year Lowland started WC1   17  2001.12   2.60     0.63
Year Lowland started WC2   15  2004.80   1.86     0.48

Difference = mu (Lowland started_1) - mu (Lowland started_2)
Estimate for difference:  -3.68235
95% upper bound for difference:  -2.33570
T-Test of difference = 0 (vs <): T-Value = -4.65 P-Value = 0.000 DF = 28
```

Box 32: Two-sample t-test for when respondents in WC1 began planting lowland rice versus when respondents in WC2 began planting lowland rice

```
                            N     Mean  StDev  SE Mean
Year Lowland started WC1   17  2001.12   2.60     0.63
Year Lowland started WC3   13  2004.23   3.03     0.84

Difference = mu (Lowland started_1) - mu (Lowland started_3)
Estimate for difference:  -3.11312
95% upper bound for difference:  -1.31291
T-Test of difference = 0 (vs <): T-Value = -2.96 P-Value = 0.003 DF = 23
```

Box 33: Two-sample t-test for when respondents in WC1 began planting lowland rice versus when respondents in WC3 began planting lowland rice

```
                          N     Mean  StDev  SE Mean
Year Lowland started F   23  2003.52   3.04     0.63
Year Lowland started M   22  2002.95   2.97     0.63

Difference = mu (Lowland started_F) - mu (Lowland started_M)
Estimate for difference:  0.567194
95% CI for difference:  (-1.241193, 2.375581)
T-Test of difference = 0 (vs not =): T-Value = 0.63 P-Value = 0.530 DF = 42
```

Box 34: Two-sample t-test for when female respondents began planting lowland rice versus when male respondents began planting lowland rice

Maize

```
                           N     Mean  StDev  SE Mean
Year Maize started WC1    18  2002.11   2.17     0.51
Year Maize started WC2    14  2002.29   2.09     0.56

Difference = mu (Year start Maize production_1) - mu (Year start Maize
    production_2)
Estimate for difference:  -0.174603
95% upper bound for difference:  1.113225
T-Test of difference = 0 (vs <): T-Value = -0.23  P-Value = 0.410  DF = 28
```

Box 35: Two-sample t-test for when respondents in WC1 began planting maize versus when respondents in WC2 began planting maize

```
                          N     Mean  StDev  SE Mean
Year Maize started WC1   18  2002.11   2.17     0.51
Year Maize started WC3   15  2002.80   1.26     0.33

Difference = mu (Year start Maize production_1) - mu (Year start Maize
     production_3)
Estimate for difference:  -0.688889
95% upper bound for difference:  0.342196
T-Test of difference = 0 (vs <): T-Value = -1.14  P-Value = 0.133  DF = 28
```

Box 36: Two-sample t-test for when respondents in WC1 began planting maize versus when respondents in WC3 began planting maize

```
                          N     Mean  StDev  SE Mean
Year Maize started F     22  2002.59   1.76     0.38
Year Maize started M     25  2002.20   2.00     0.40

Difference = mu (Year start Maize production_F) - mu (Year start Maize
     production_M)
Estimate for difference:  0.390909
95% CI for difference:  (-0.715492, 1.497310)
T-Test of difference = 0 (vs not =): T-Value = 0.71  P-Value = 0.480  DF = 44
```

Box 37: Two-sample t-test for when female respondents began planting maize versus when male respondents began planting maize

Sesame

```
                          N     Mean  StDev  SE Mean
Year Sesame started WC1  12  2003.50   1.31     0.38
Year Sesame started WC2  10  2003.30   2.31     0.73

Difference = mu (Year start Sesame plot_1) - mu (Year start Sesame plot_2)
Estimate for difference:  0.200000
95% lower bound for difference:  -1.258613
T-Test of difference = 0 (vs >): T-Value = 0.24  P-Value = 0.406  DF = 13
```

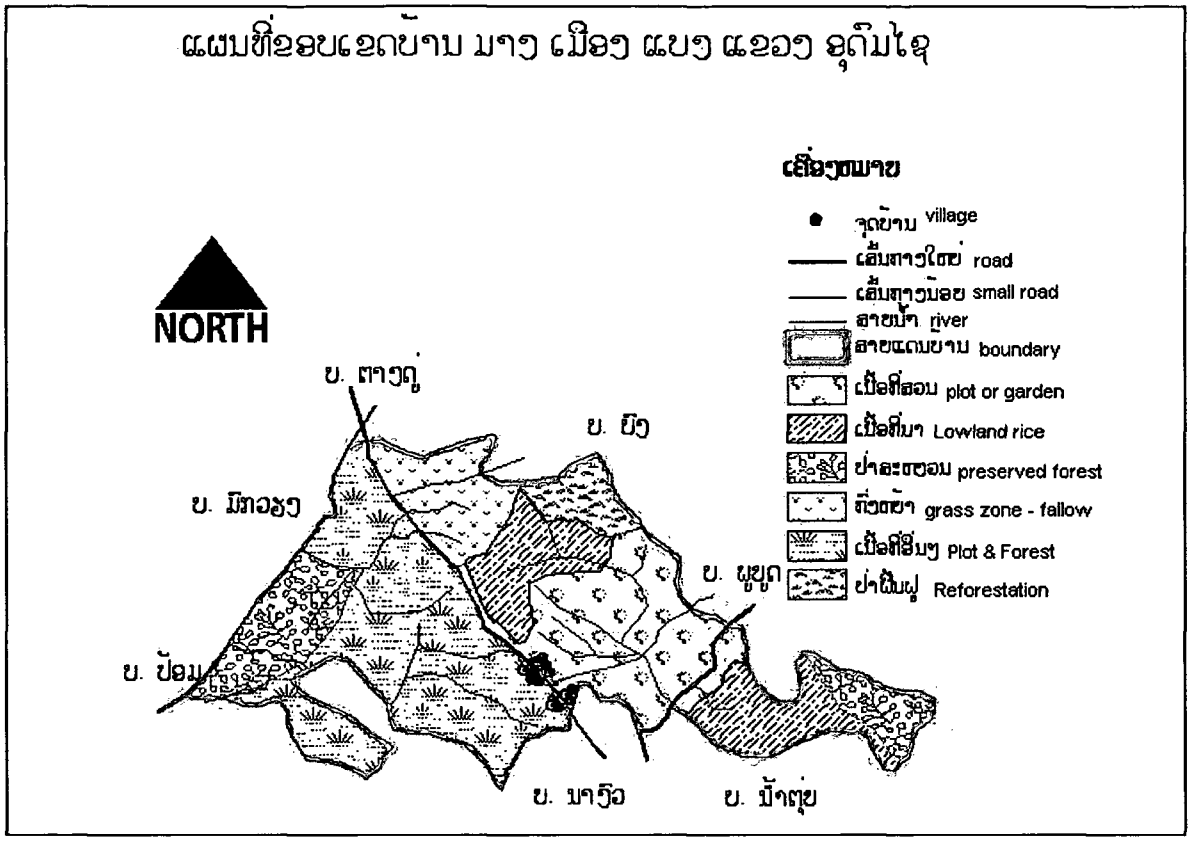
Box 38: Two-sample t-test for when respondents in WC1 began planting sesame versus when respondents in WC2 began planting sesame

```
                          N     Mean  StDev  SE Mean
Year Sesame started WC1  12  2003.50   1.31     0.38
Year Sesame started WC3   8  2004.13   1.73     0.61


Difference = mu (Year start Sesame plot_1) - mu (Year start Sesame plot_3)
Estimate for difference:  -0.625000
95% upper bound for difference:  0.656150
T-Test of difference = 0 (vs <): T-Value = -0.87  P-Value = 0.201  DF = 12
```

Box 39: Two-sample t-test for when respondents in WC1 began planting sesame versus when respondents in WC3 began planting sesame

Appendix K: Land Use Plan



Appendix L: Statistical Analysis for livelihood strategies with land permits

```
Variable              X   N  Sample p
Lowland rice fields  32  35  0.914286
Sesame fields        20  42  0.476190

Difference = p (Paddy Field) - p (Sesame)
Estimate for difference:  0.438095
95% lower bound for difference:  0.289348
Test for difference = 0 (vs > 0):  Z = 4.84 P-Value = 0.000
```

Box 40: Two proportional z-test for respondents who have land permits for lowland rice vs. sesame

```
Variable               X   N  Sample p
Lowland rice fields   32  35  0.914286
Puak muak plots       26  35  0.742857

Difference = p (Paddy Field) - p (PM)
Estimate for difference:  0.171429
95% lower bound for difference:  0.0271233
Test for difference = 0 (vs > 0):  Z = 1.95 P-Value = 0.025
```

Box 41: Two proportional z-test for respondents with land permits for lowland rice vs. puak muak

```
Variable              X   N  Sample p
Lowland rice fields  32  35  0.914286
Maize fields         35  44  0.795455

Difference = p (Paddy Field) - p (Maize)
Estimate for difference:  0.118831
95% lower bound for difference:  -0.00790739
Test for difference = 0 (vs > 0):  Z = 1.54  P-Value = 0.062
```

Box 42: Two proportional z-test for respondents with land permits for lowland rice vs. maize

```
Variable   X   N  Sample p
Maize     35  44  0.795455
Sesame    20  42  0.476190

Difference = p (Maize) - p (Sesame)
Estimate for difference:  0.319264
95% lower bound for difference:  0.157794
Test for difference = 0 (vs > 0):  Z = 3.25  P-Value = 0.001
```

Box 43: Two proportional z-test for respondents with land permits for maize versus sesame

```
Variable   X   N  Sample p
PM        26  35  0.742857
Sesame    20  42  0.476190

Difference = p (PM) - p (Sesame)
Estimate for difference:  0.266667
95% lower bound for difference:  0.0910705
Test for difference = 0 (vs > 0):  Z = 2.50  P-Value = 0.006
```

Box 44: Two proportional z-test for respondents with land permits for puak muak vs. sesame

Upland rice certificates were not analyzed because no respondent had a certificate for an upland rice field.

Appendix M: Statistical Analysis for Distance to Fields

Lowland

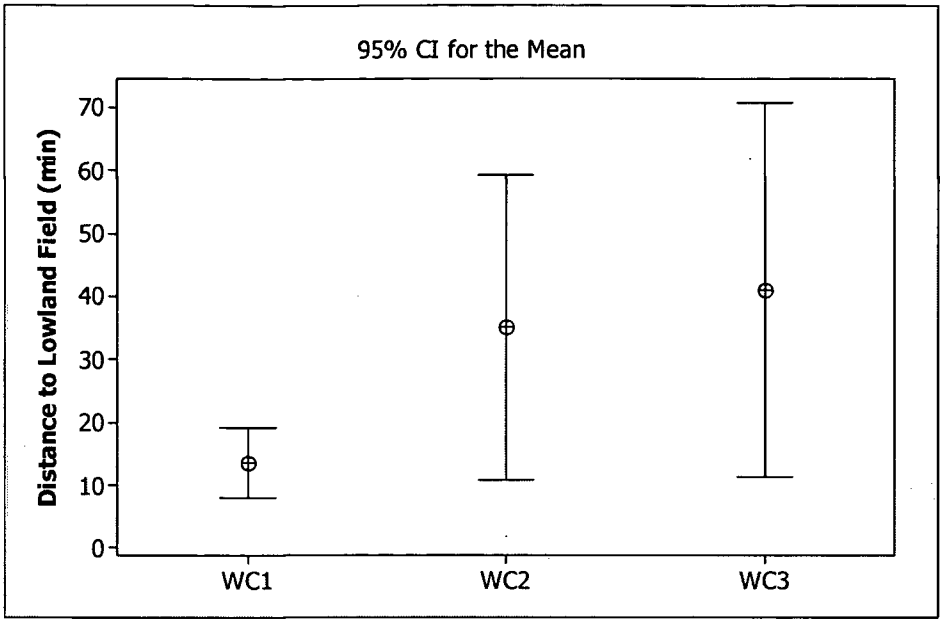


Figure 34: Interval plot for distance of lowland rice fields from village versus wealth ranking

Lowland rice fields are closer for the residents within WC1 than they are for residents in WC2 and WC3. The mean distance is 13.4 minutes for WC1, 35 minutes for WC2 and 41 minutes for WC3 (Figure 34). This difference between WC1 and the other two categories is backed up by strong statistical evidence (Box 45 & Box 46). There is no statistical difference between WC2 and WC3 with respect to distance to lowland fields (Box 47). Women also describe their fields as being further away than the men with the average time being 36.5 minutes for women and 16 minutes for men. This is also a statistically significant difference (Box 48). Within the analysis if respondents had two plots the average distance of the two plots was inputted. When this was compared with all plots inputted however there was no significant change in the results.

```
                          N  Mean  StDev  SE Mean
Distance to lowland WC1  17  13.4   10.9      2.6
Distance to lowland WC2  10  35.0   34.0       11

Difference = mu (Distance from village (min)_1) - mu (Distance from village
(min)_2)
Estimate for difference:  -21.6176
95% upper bound for difference:  -1.5515
T-Test of difference = 0 (vs <): T-Value = -1.95 P-Value = 0.040 DF = 10
```

Box 45: Two sample t-test for the distance (min) to lowland rice fields for WC1 versus the distance (min) to lowland rice fields for WC2

```
                          N  Mean  StDev  SE Mean
Distance to lowland WC1  17  13.4   10.9      2.6
Distance to lowland WC3   9  40.9   38.8       13

Difference = mu (Distance from village (min)_1) - mu (Distance from village
(min)_3)
Estimate for difference:  -27.5065
95% upper bound for difference:  -2.9637
T-Test of difference = 0 (vs <): T-Value = -2.08 P-Value = 0.035 DF = 8
```

Box 46: Two sample t-test for the distance to lowland rice fields for WC1 versus WC3

```
                          N  Mean  StDev  SE Mean
Distance to lowland WC2  10  35.0   34.0     11
Distance to lowland WC3  40.9   38.8    13

Difference = mu (Distance from village (min)_2) - mu (Distance from
village(min)_3)
Estimate for difference:  -5.88889
95% upper bound for difference:  23.46764
T-Test of difference = 0 (vs <): T-Value = -0.35 P-Value = 0.365 DF = 16
```

Box 47: Two sample t-test for the distance to lowland rice fields for WC2 versus WC3

```
                         N  Mean  StDev  SE Mean
Distance to lowland F   18  36.5   36.1      8.5
Distance to lowland M   18  16.0   15.1      3.6

Difference = mu (Distance from village (min)_F) - mu (Distance from village
(min)_M)
Estimate for difference:  20.5278
95% lower bound for difference:  4.6808
T-Test of difference = 0 (vs >): T-Value = 2.22 P-Value = 0.018 DF = 22
```

Box 48: Two sample t-test for the distance to lowland rice fields for Females versus Males

For the distance from lowland 36 out of 60 people responded to the question regarding the distance to lowland fields. 14 people did not give a response because they do not cultivate lowland rice, 8 people did not respond because they do not grow it now but will grow it next year. One respondent grew it last year but not this year because she was busy with planting rubber trees and one respondent just started and only cultivated a small amount.

Upland Rice

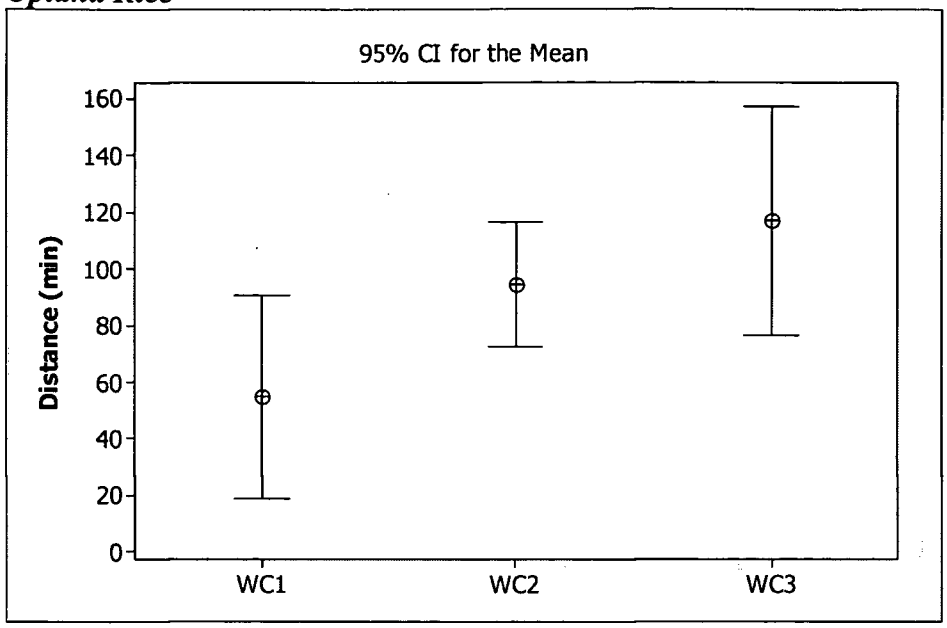


Figure 35: Interval plot for distance of upland rice fields from the village versus wealth ranking for respondents who indicated upland rice within their top 4 livelihood strategies

Upland rice fields are closer for the residents within WC1 than they are for residents in WC2 and WC3. The mean distance is 54.6 minutes for WC1, 94.3 minutes for WC2 and 116.6 minutes for WC3 (Figure 35). This difference between WC1 and the other two categories is statistically significant (Box 49 & Box 50). There is no statistical difference between WC2 and WC3 with respect to distance to lowland fields (Box 51). Women also describe their fields as being further away than the men with the average being 106.6 minutes for women and 79.1 minutes for men. Although the p value for gender is not less than 0.05 it is close to this value and given the other crop difference it can still be considered a significant difference (Box 52).

```
                              N  Mean  StDev  SE Mean
Distance to Upland Rice WC1   8  54.6   42.9    15
Distance to Upland Rice WC2  15  94.3   39.9    10

Difference = mu (Upland Rice Dis from village_1) - mu (Upland Rice Dis from
village_2)
Estimate for difference:  -39.7083
95% upper bound for difference:  -7.2695
T-Test of difference = 0 (vs <): T-Value = -2.17 P-Value = 0.025 DF = 13
```

Box 49: Two sample t-test for the distance to upland rice fields for WC1 versus the distance to upland rice fields for WC2 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                              N   Mean  StDev  SE Mean
Distance to Upland rice WC1   8   54.6   42.9    15
Distance to Upland rice WC3  16  116.6   76.0    19

Difference = mu (Upland Rice Dis from village_1) - mu (Upland Rice Dis from
village_3)
Estimate for difference:  -61.9375
95% upper bound for difference:  -20.1347
T-Test of difference = 0 (vs <): T-Value = -2.55 P-Value = 0.009 DF = 21
```

Box 50: Two sample t-test for the distance to upland rice fields for WC1 versus WC3 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                                N   Mean  StDev  SE Mean
Distance to Upland rice WC2 15   94.3   39.9    10
Distance to Upland rice WC3 15  116.3   78.6    20

Difference = mu (Upland Rice Dis from village_2) - mu (Upland Rice Dis from
village_3)
Estimate for difference:  -22.0000
95% upper bound for difference:  17.2515
T-Test of difference = 0 (vs <): T-Value = -0.97 P-Value = 0.173 DF = 20
```

Box 51: Two sample t-test for the distance to upland rice fields for WC2 versus WC3 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                                N   Mean  StDev   SE Mean
Distance to Upland rice F   23  106.6   70.5    15
Distance to Upland rice M   16   79.1   41.4    10

Difference = mu (Upland Rice Dis from village_F) - mu (Upland Rice Dis from
village_M)
Estimate for difference:  27.5462
95% lower bound for difference:  -2.7980
T-Test of difference = 0 (vs >): T-Value = 1.53 P-Value = 0.067 DF = 36
```

Box 52: Two sample t-test for the distance to upland rice fields for females versus males for respondents who indicated upland rice within their top 4 livelihood strategies

For the, distance from upland fields, analysis there were 39 responses for the question. 10 respondents did not answer the question as they do not participate in shifting cultivation and 11 did not indicate it within their top 4 livelihood strategies.

Maize

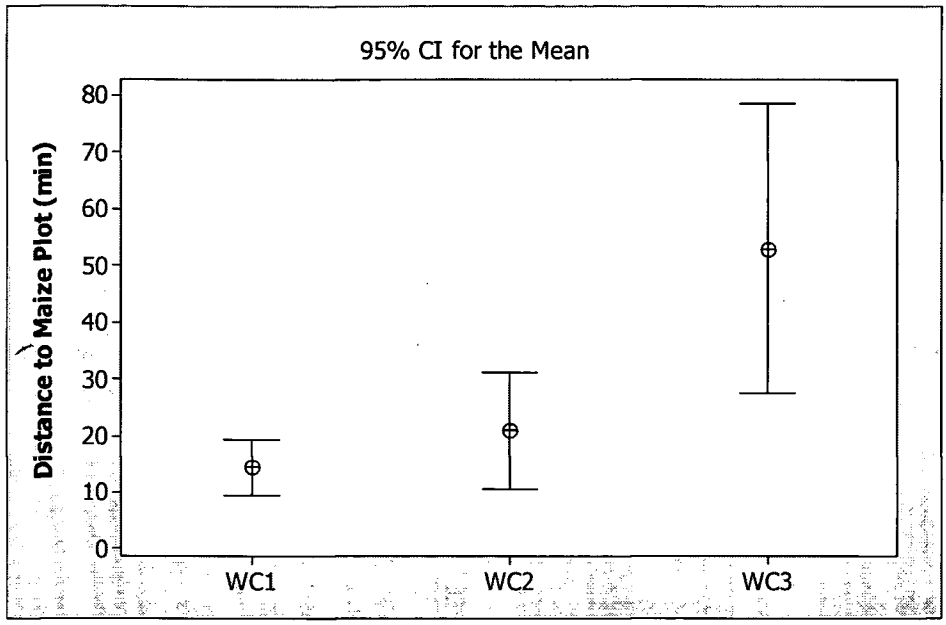


Figure 36: Interval plot for distance of maize fields from village versus wealth ranking

Maize fields are closer for the residents within WC1 and WC2 than they are for residents in WC3. The mean distance is 14.38 minutes for WC1, 20.8 minutes for WC2 and 52.9 minutes for WC3 (Figure 36). This difference between WC1 and WC2 with WC3 is backed up with strong statistical evidence (Box 53, Box 54 & Box 55). Women also describe their fields as being further away than the men with the average being 37.1 minutes for women and 21.4 minutes for men. This is also a statistically significant difference (Box 56).

```
                                N   Mean  StDev  SE Mean
Distance to Maize fields WC1   17  14.38   9.58      2.3
Distance to Maize fields WC2   14   20.8   17.8      4.7

Difference = mu (Dis from village Maize (min)_1) - mu (Dis from village Maize
(min)_2)
Estimate for difference:  -6.40336
95% upper bound for difference:  2.73089
T-Test of difference = 0 (vs <): T-Value = -1.21 P-Value = 0.120 DF = 19
```

Box 53: Two sample t-test for the distance to maize fields for WC1 versus WC2 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                                N  Mean  StDev  SE Mean
Distance to Maize fields WC2   14  20.8   17.8      4.7
Distance to Maize fields WC3   15  52.9   46.3       12

Difference = mu (Dis from village Maize (min)_2) - mu (Dis from village
Maize(min)_3)
Estimate for difference:  -32.1476
95% upper bound for difference:  -9.8528
T-Test of difference = 0 (vs <): T-Value = -2.50 P-Value = 0.011 DF = 18
```

Box 54: Two sample t-test for the distance to maize fields for WC1 versus WC3 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                                  N   Mean  StDev  SE Mean
Distance to Maize fields WC1     17  14.38   9.58      2.3
Distance to Maize fields WC3     15   52.9   46.3       12

Difference = mu (Dis from village Maize (min)_1) - mu (Dis from village
Maize(min)_3)
Estimate for difference:  -38.5510
95% upper bound for difference:  -17.2103
T-Test of difference = 0 (vs <): T-Value = -3.17 P-Value = 0.003 DF = 15
```

Box 55: Two sample t-test for the distance to maize fields for WC2 versus WC3 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                                N  Mean  StDev  SE Mean
Distance to Maize fields F     22  37.1   42.7      9.1
Distance to Maize fields M     24  21.4   18.1      3.7

Difference = mu (Dis from village Maize (min)_F) - mu (Dis from village Maize
(min)_M)
Estimate for difference:  15.6515
95% lower bound for difference:  -1.0984
T-Test of difference = 0 (vs >): T-Value = 1.59 P-Value = 0.062 DF = 27
```

Box 56: Two sample t-test for the distance to maize fields for males versus females for respondents who indicated upland rice within their top 4 livelihood strategies

46 respondents answered the question 14 did not. 7 respondents did not answer because they did not cultivate maize, 5 because it was not in their top 4 livelihood strategies and 2 respondents who had maize in their in top 4 livelihood strategies did not know how far time wise it took to get to their maize fields.

Sesame

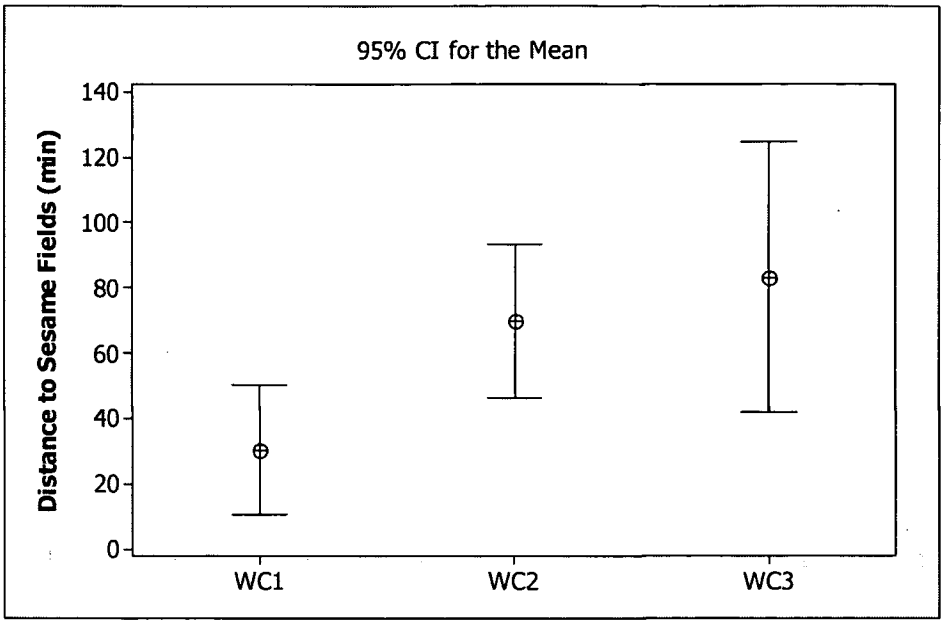


Figure 37: Interval plot for distance of sesame fields from village versus wealth ranking

Sesame fields are closer for the residents within WC1 than they are for residents in WC2 and WC3. The mean distance is 30.3 minutes for WC1, 69.6 minutes for WC2 and 83.2 minutes for WC3 (Figure 37). This difference between WC1 and the other two categories is statistically significant (Box 57 & Box 58). There is no statistical difference between WC2 and WC3 with respect to distance to sesame fields (Box 59). Women also describe their fields as being further away than the men with the average being 75.8 minutes for women and 49.4 minutes for men. Although the p value is not <0.05 it is still very close and with the other responses one could conclude that there is significant difference (Box 60).

```
                                N  Mean  StDev  SE Mean
Distance to Sesame fields WC1  14  30.3   34.1      9.1
Distance to Sesame fields WC2  18  69.6   47.3       11

Difference = mu (Dis Sesame (min) w upland one_1) - mu (Dis Sesame (min) w
     upland one_2)
Estimate for difference:  -39.3254
95% upper bound for difference:  -14.8553
T-Test of difference = 0 (vs <): T-Value = -2.73 P-Value = 0.005 DF = 29
```

Box 57: Two sample t-test for the distance to sesame fields for WC1 versus WC2 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                                N  Mean  StDev  SE Mean
Distance to Sesame fields WC1  14  30.3   34.1      9.1
Distance to Sesame fields WC3  19  83.2   85.5       20

Difference = mu (Dis Sesame (min) w upland one_1) - mu (Dis Sesame (min) w
     upland one_3)
Estimate for difference:  -52.8985
95% upper bound for difference:  -15.8855
T-Test of difference = 0 (vs <): T-Value = -2.45 P-Value = 0.011 DF = 24
```

Box 58: Two sample t-test for the distance to sesame fields for WC1 versus WC3 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                                N  Mean  StDev    SE Mean
Distance to Sesame fields WC2  18  69.6   47.3    11
Distance to Sesame fields WC3  19  83.2   85.5    20

Difference = mu (Dis Sesame (min) w upland one_2) - mu (Dis Sesame (min) w
     upland one_3)
Estimate for difference:  -13.5731
95% upper bound for difference:  24.8145
T-Test of difference = 0 (vs <): T-Value = -0.60 P-Value = 0.276 DF = 28
```

Box 59: Two sample t-test for the distance to sesame fields for WC2 versus WC3 for respondents who indicated upland rice within their top 4 livelihood strategies

```
                                N  Mean  StDev  SE Mean
Distance to Sesame fields F    28  75.8   76.4       14
Distance to Sesame fields M    23  49.4   43.5      9.1

Difference = mu (Dis Sesame (min) w upland one_F) - mu (Dis Sesame (min) w
     upland one_M)
Estimate for difference:  26.4161
95% lower bound for difference:  -2.2504
T-Test of difference = 0 (vs >): T-Value = 1.55 P-Value = 0.064 DF = 44
```

Box 60: Two sample t-test for the distance to sesame fields for males versus females for respondents who indicated upland rice within their top 4 livelihood strategies

For sesame 51 people answered the question regarding distance to the field. Three respondents did not answer because they did not grow sesame, another three respondents did not answer because sesame was not in their top four livelihood strategies and another three respondents were not sure how far their fields were.

Posa

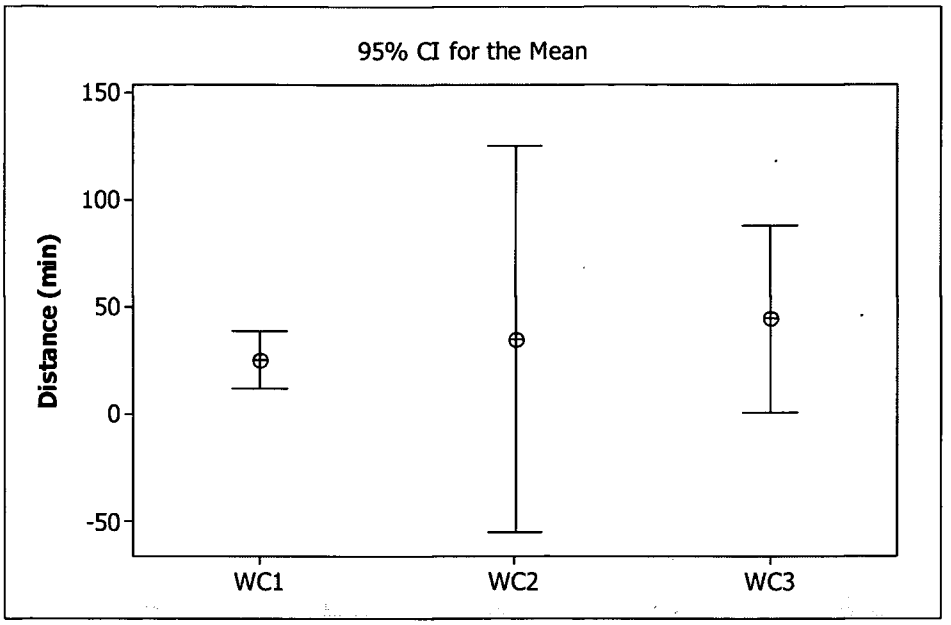


Figure 38: Interval plot for distance of Posa plots from village versus wealth ranking

There were only 19 respondents who gave a value for how far their posa plots were. Therefore it is difficult to say if there is a difference between wealth categories due to the high standard deviation and low sample number. However it does appear that a similar trend to the other agriculture strategies is forming based on the means. This is not conclusive though.

```
                          N  Mean  StDev  SE Mean
Distance to Posa plots WC1  6  25.0   12.6      5.2
Distance to Posa plots WC2  4  34.8   56.9       28

Difference = mu (Posa dis to plot_1) - mu (Posa dis to plot_2)
Estimate for difference:  -9.75000
95% upper bound for difference:  58.29012
T-Test of difference = 0 (vs <): T-Value = -0.34   P-Value = 0.379  DF = 3
```

Box 61: Two sample t-test for the distance to posa plots for WC1 versus WC2

```
                          N  Mean  StDev  SE Mean
Distance to posa plots WC1  6  25.0   12.6      5.2
Distance to posa plots WC3  9  44.4   56.8       19

Difference = mu (Posa dis to plot_1) - mu (Posa dis to plot_3)
Estimate for difference:  -19.4444
95% upper bound for difference:  16.5058
T-Test of difference = 0 (vs <): T-Value = -0.99 P-Value = 0.174  DF = 9
```

Box 62: Two sample t-test for the distance to posa plots for WC1 versus WC3

```
                         N  Mean  StDev    SE Mean
Distance to posa plots F 9  46.0   56.1    19
Distance to posa plots M 10 27.5   34.7     11

Difference = mu (Posa dis to plot_F) - mu (Posa dis to plot_M)
Estimate for difference:  18.5000
95% lower bound for difference:  -19.9054
T-Test of difference = 0 (vs >): T-Value = 0.85 P-Value = 0.205 DF = 13
```

Box 63: Two sample t-test for the distance to Posa plots for females versus males

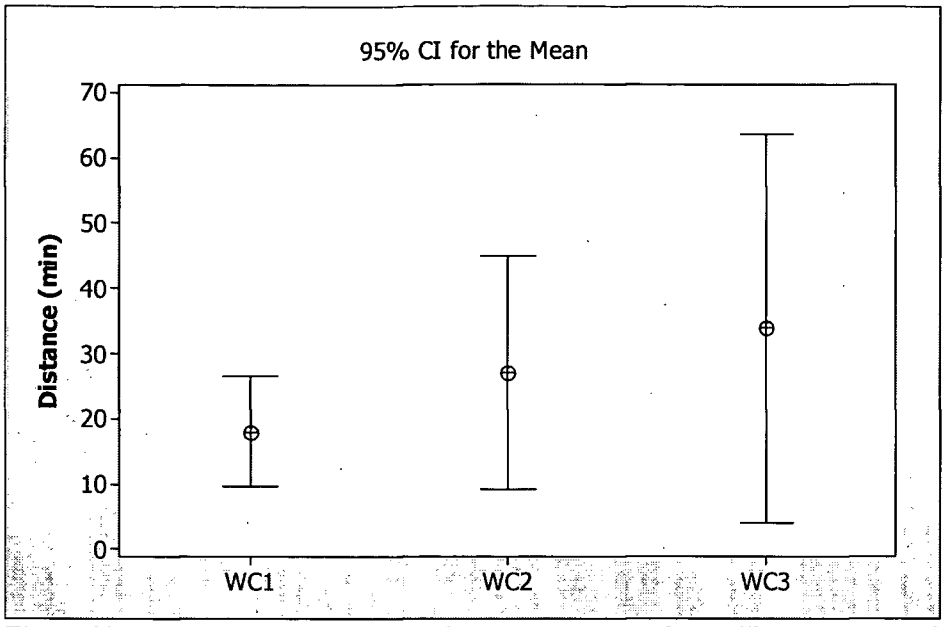


Figure 39: Interval plot for distance of Puak Muak plots from village versus wealth ranking

Similar to Posa the standard deviations are too high to determine if there is a trend between WC and distance to field with Puak Muak but if you look at the means then it appears that there might be.

```
                                N  Mean  StDev  SE Mean
Distance to Puak Muak plot WC1 11  18.0   12.5      3.8
Distance to Puak Muak plot WC2 16  27.1   33.6      8.4

Difference = mu (PM dis to plot_1) - mu (PM dis to plot_2)
Estimate for difference:  -9.06250
95% upper bound for difference:  6.84189
T-Test of difference = 0 (vs <): T-Value = -0.98 P-Value = 0.169 DF = 20
```

Box 64: Two sample t-test for the distance to Puak Muak plots for WC1 versus WC2

```
                                N  Mean  StDev  SE Mean
Distance to Puak Muak plot WC1 11  18.0   12.5      3.8
Distance to Puak Muak plot WC3 9   33.8   38.9       13

Difference = mu (PM dis to plot_1) - mu (PM dis to plot_3)
Estimate for difference:  -15.7778
95% upper bound for difference:  8.9723
T-Test of difference = 0 (vs <): T-Value = -1.17 P-Value = 0.136 DF = 9
```

Box 65: Two sample t-test for the distance to Puak Muak plots for WC1 versus WC3

```
                                N  Mean  StDev  SE Mean
Distance to Puak Muak plot F   20  28.6   30.0      6.7
Distance to Puak Muak plot M   16  22.7   31.1      7.8

Difference = mu (PM dis to plot_F) - mu (PM dis to plot_M)
Estimate for difference:  5.91250
95% lower bound for difference:  -11.49991
T-Test of difference = 0 (vs >): T-Value = 0.58 P-Value = 0.284 DF = 31
```

Box 66: Two sample t-test for the distance to Puak Muak plots for females versus males

Appendix N: Amount of Land

Lowland Field

```
                    N   Mean  StDev  SE Mean
Amount of LL lan   16  0.894  0.649     0.16
Amount of LL lan   17  0.241  0.348    0.084

Difference = mu (Amount of LL land (ha)_1) - mu (Amount of LL land(ha)_2)
Estimate for difference:  0.652574
95% lower bound for difference:  0.338633
T-Test of difference = 0 (vs >): T-Value = 3.57  P-Value = 0.001  DF = 22
```

Box 67: Two sample t-test for the amount of lowland rice of WC1 versus WC2

```
                    N   Mean  StDev  SE Mean
Amount of LL lan   16  0.894  0.649     0.16
Amount of LL lan   13  0.192  0.384     0.11

Difference = mu (Amount of LL land (ha)_1) - mu (Amount of LL land (ha)_3)
Estimate for difference:  0.701442
95% lower bound for difference:  0.369556
T-Test of difference = 0 (vs >): T-Value = 3.62  P-Value = 0.001  DF = 24
```

Box 68: Two-sample t-test for the amount of lowland rice of WC1 versus WC3

```
                    N   Mean  StDev  SE Mean
Amount of LL lan   17  0.241  0.348    0.084
Amount of LL lan   13  0.192  0.384     0.11

Difference = mu (Amount of LL land (ha)_2) - mu (Amount of LL land (ha)_3)
Estimate for difference:  0.048869
95% lower bound for difference:  -0.183697
T-Test of difference = 0 (vs >): T-Value = 0.36  P-Value = 0.361  DF = 24
```

Box 69: Two-sample t-test for the amount of lowland rice of WC2 versus WC3

```
                   N   Mean  StDev  SE Mean
Amount of LL lan  26  0.542  0.626     0.12
Amount of LL lan  20  0.340  0.488     0.11

Difference = mu (Amount of LL land (ha)_F) - mu (Amount of LL land (ha)_M)
Estimate for difference:  0.202308
95% CI for difference:  (-0.128868, 0.533483)
T-Test of difference = 0 (vs not =): T-Value = 1.23 P-Value = 0.225 DF= 43
```

Box 70: Two-sample t-test for the amount of lowland rice of females vs. males

Upland Rice

```
                       N   Mean  StDev  SE Mean
Amount of upland WC1  12   0.96   1.20     0.35
Amount of upland WC2  10  1.070  0.670     0.21

Difference = mu (Amount of land 1) - mu (Amount of land 2)
Estimate for difference:  -0.111667
95% upper bound for difference:  0.592950
T-Test of difference = 0 (vs <): T-Value = -0.28 P-Value = 0.393 DF = 17
```

Box 71: Two-sample t-test for the amount of Upland WC1 versus WC2

```
                    N   Mean  StDev  SE Mean
Amount of upland   12   0.96   1.20     0.35
Amount of upland    8  1.188  0.594     0.21

Difference = mu (Amount of land 1) - mu (Amount of land 3)
Estimate for difference:  -0.229167
95% upper bound for difference:  0.476233
T-Test of difference = 0 (vs <): T-Value = -0.57 P-Value = 0.289 DF = 16
```

Box 72: Two-sample t-test for the amount of Upland WC1 vs. WC2

```
                     N   Mean  StDev  SE Mean
Amount of upland F  13   1.12   1.00     0.28
Amount of upland M  17  1.012  0.804     0.19

Difference = mu (Amount of land F) - mu (Amount of land M)
Estimate for difference:  0.103620
95% CI for difference:  (-0.600955, 0.808194)
T-Test of difference = 0 (vs not =): T-Value = 0.30 P-Value = 0.763 DF= 22
```

Box 73: Two-sample t-test for the amount of Upland females versus males

Maize

```
                           N   Mean  StDev  SE Mean
Amount of Maize land WC1  14  1.518  0.823     0.22
Amount of Maize land WC2  13  0.669  0.789     0.22

Difference = mu (Maize Amount of land 1) - mu (Maize Amount of land 2)
Estimate for difference:  0.848626
95% lower bound for difference:  0.317796
T-Test of difference = 0 (vs >): T-Value = 2.74 P-Value = 0.006 DF = 24
```

Box 74: Two-sample t-test for the amount of maize land WC1 versus WC2

```
                           N   Mean  StDev  SE Mean
Amount of Maize land WC1   14  1.518  0.823     0.22
Amount of Maize land WC3   12  0.971  0.896     0.26

Difference = mu (Maize Amount of land 1) - mu (Maize Amount of land 3)
Estimate for difference:  0.547024
95% lower bound for difference:  -0.035874
T-Test of difference = 0 (vs >): T-Value = 1.61 P-Value = 0.061 DF = 22
```

Box 75: Two-sample t-test for the amount of maize land WC1 versus WC3

```
                    N   Mean  StDev  SE Mean
Maize Amount of    13  0.669  0.789     0.22
Maize Amount of    12  0.971  0.896     0.26

Difference = mu (Maize Amount of land 2) - mu (Maize Amount of land 3)
Estimate for difference:  -0.301603
95% upper bound for difference:  0.279963
T-Test of difference = 0 (vs <): T-Value = -0.89 P-Value = 0.191 DF = 22
```

Box 76: Two-sample t-test for the amount of maize land WC2 versus WC3

```
                    N   Mean  StDev  SE Mean
Maize Amount of    14  1.289  0.849     0.23
Maize Amount of    20  1.228  0.817     0.18

Difference = mu (Maize Amount of land F) - mu (Maize Amount of land M)
Estimate for difference:  0.061786
95% lower bound for difference:  -0.434680
T-Test of difference = 0 (vs >): T-Value = 0.21  P-Value = 0.417  DF = 27
```

Box 77: Two-sample t-test for the amount of maize land females versus males

Sesame

```
                    N   Mean  StDev  SE Mean
Sesame Amount of   10  0.650  0.626     0.20
Sesame Amount of   12  1.017  0.683     0.20

Difference = mu (Sesame Amount of land_1) - mu (Sesame Amount of land_2)
Estimate for difference:  -0.366667
95% upper bound for difference:  0.116504
T-Test of difference = 0 (vs <): T-Value = -1.31  P-Value = 0.103  DF = 19
```

Box 78: Two-sample t-test for the amount of sesame land WC1 versus WC2

```
                    N   Mean  StDev  SE Mean
Sesame Amount of   10  0.650  0.626     0.20
Sesame Amount of   10  0.980  0.244    0.077

Difference = mu (Sesame Amount of land_1) - mu (Sesame Amount of land_3)
Estimate for difference:  -0.330000
95% upper bound for difference:  0.051482
T-Test of difference = 0 (vs <): T-Value = -1.55  P-Value = 0.074  DF = 11
```

Box 79: Two sample t-test for the amount of sesame land WC1 versus WC3

```
                    N   Mean  StDev  SE Mean
Sesame Amount of   13  1.077  0.672     0.19
Sesame Amount of   19  0.763  0.463     0.11

Difference = mu (Sesame Amount of land_F) - mu (Sesame Amount of land(ha)_M)
Estimate for difference:  0.313765
95% CI for difference:  (-0.135442, 0.762972)
T-Test of difference = 0 (vs not =): T-Value = 1.46  P-Value = 0.160  DF = 19
```

Box 80: Two-sample t-test for the amount of sesame land females versus males

Appendix O: Statistical Analysis for amount of seed planted

Lowland rice seeds

```
                              N  Mean  StDev  SE Mean
lowland seeds planted WC1 20  36.0   21.2      4.7
lowland seeds planted WC2 20  17.3   19.7      4.4

Difference = mu (lowland No of seeds 1) - mu (lowland No of seeds 2)
Estimate for difference:  18.7000
95% lower bound for difference:  7.7972
T-Test of difference = 0 (vs >): T-Value = 2.89 P-Value = 0.003 DF = 37
```

Box 81: Two-sample t-test for the amount of lowland seeds planted WC1 versus WC2

```
                              N  Mean  StDev  SE Mean
lowland seeds planted WC2  20  17.3   19.7      4.4
lowland seeds planted WC3  19   9.5   11.3      2.6

Difference = mu (lowland No of seeds 2) - mu (lowland No of seeds 3)
Estimate for difference:  7.82632
95% lower bound for difference:  -0.83239
T-Test of difference = 0 (vs >): T-Value = 1.53 P-Value = 0.068 DF = 30
```

Box 82: Two-sample t-test for the amount of lowland seeds planted WC2 versus WC3

```
                              N  Mean  StDev  SE Mean
lowland seeds planted WC1 20  36.0   21.2      4.7
lowland seeds planted WC3 19   9.5   11.3      2.6

Difference = mu (lowland No of seeds 1) - mu (lowland No of seeds 3)
Estimate for difference:  26.5263
95% lower bound for difference:  17.3515
T-Test of difference = 0 (vs >): T-Value = 4.91 P-Value = 0.000 DF = 29
```

Box 83: Two-sample t-test for the amount of lowland seeds planted WC1 versus WC3

```
                    N  Mean  StDev  SE Mean
lowland No of se  30  21.0   21.6      3.9
lowland No of se  29  21.2   20.6      3.8

Difference = mu (lowland No of seeds_F) - mu (lowland No of seeds_M)
Estimate for difference:  -0.173563
95% CI for difference:  (-11.190668, 10.843542)
T-Test of difference = 0 (vs not =): T-Value = -0.03 P-Value = 0.975 DF = 56
```

Box 84: Two-sample t-test for the amount of lowland seeds planted female versus male

```
                              N  Mean  StDev  SE Mean
Lowland seeds planted WC1  17  42.4   15.7      3.8
lowland seeds planted WC2  10  34.6   12.3      3.9

Difference = mu (lowland No of seeds 5) - mu (lowland No of seeds 6)
Estimate for difference:  7.75294
95% lower bound for difference:  -1.58816
T-Test of difference = 0 (vs >): T-Value = 1.43 P-Value = 0.084 DF = 22
```

Box 85: Two-sample t-test for the amount of lowland seeds planted WC1 versus WC2

```
                              N   Mean  StDev  SE Mean
lowland seeds planted WC1    17  42.4   15.7      3.8
lowland seeds planted WC3     9  20.00   7.07     2.4

Difference = mu (lowland No of seeds 5) - mu (lowland No of seeds 7)
Estimate for difference:  22.3529
95% lower bound for difference:  14.6693
T-Test of difference = 0 (vs >): T-Value = 4.99 P-Value = 0.000 DF = 23
```

Box 86: Two-sample t-test for the amount of lowland seeds planted WC1 versus WC3

```
                              N   Mean  StDev  SE Mean
lowland seeds planted WC1    10  34.6   12.3      3.9
lowland seeds planted WC3     9  20.00   7.07     2.4

Difference = mu (lowland No of seeds 6) - mu (lowland No of seeds 7)
Estimate for difference:  14.6000
95% lower bound for difference:  6.6050
T-Test of difference = 0 (vs >): T-Value = 3.22 P-Value = 0.003 DF = 14
```

Box 87: Two-sample t-test for the amount of lowland seeds planted WC2 versus WC3

Upland seeds

```
                    N  Mean  StDev  SE Mean
Number of seeds_   13  40.8   61.4       17
Number of seeds_   15  56.3   32.2      8.3

Difference = mu (Number of seeds WC1) - mu (Number of seeds_WC2)
Estimate for difference:  -15.5641
95% upper bound for difference:  17.4194
T-Test of difference = 0 (vs <): T-Value = -0.82  P-Value = 0.212  DF = 17
```

Box 88: Two-sample t-test for the amount of in upland seeds planted WC1 versus WC2

```
                     N  Mean  StDev   SE Mean
Number of seeds_    13  40.8   61.4     17
Number of seeds_    14  74.6   47.7     13

Difference = mu (Number of seeds_WC1) - mu (Number of seeds_WC3)
Estimate for difference:  -33.8736
95% upper bound for difference:  2.6667
T-Test of difference = 0 (vs <): T-Value = -1.59  P-Value = 0.063  DF = 22
```

Box 89: Two-sample t-test for the amount of upland seeds planted WC1 versus WC3

```
                     N  Mean  StDev  SE Mean
Number of seeds_    15  56.3   32.2      8.3
Number of seeds_    14  74.6   47.7       13

Difference = mu (Number of seeds_WC2) - mu (Number of seeds_WC3)
Estimate for difference:  -18.3095
95% upper bound for difference:  7.8254
T-Test of difference = 0 (vs <): T-Value = -1.20  P-Value = 0.121  DF = 22
```

Box 90: Two-sample t-test for the amount of upland seeds planted WC2 versus WC3

```
                    N  Mean  StDev  SE Mean
Number of seeds_   23  67.2   47.5      9.9
Number of seeds_   19  46.1   48.8       11

Difference = mu (Number of seeds_F) - mu (Number of seeds_M)
Estimate for difference:  21.1213
95% CI for difference:  (-9.1453, 51.3878)
T-Test of difference = 0 (vs not =): T-Value = 1.41  P-Value = 0.166  DF = 38
```

Box 91: Two-sample t-test for the amount of upland seeds planted F versus M

Maize seeds

```
                          N  Mean  StDev  SE Mean
Maize seeds planted WC1  17  19.5   12.5      3.0
Maize seeds planted WC2  18  6.36   6.29      1.5

Difference = mu (Maize seed planted (kg)_1) - mu (Maize seed planted (kg)_2)
Estimate for difference:  13.1095
95% lower bound for difference:  7.3203
T-Test of difference = 0 (vs >): T-Value = 3.88 P-Value = 0.000 DF = 23
```

Box 92: Two-sample t-test for the amount of maize seeds planted WC1 versus WC2

```
                          N  Mean  StDev  SE Mean
Maize seeds planted WC1 17  19.5   12.5      3.0
Maize seeds planted WC3 17  6.97   6.53      1.6

Difference = mu (Maize seed planted (kg)_1) - mu (Maize seed planted_3)
Estimate for difference:  12.5000
95% lower bound for difference:  6.6414
T-Test of difference = 0 (vs >): T-Value = 3.65 P-Value = 0.001 DF = 2
```

Box 93: Two-sample t-test for the amount of maize seeds planted WC1 versus WC3

```
                  N  Mean  StDev  SE Mean
Maize seed plant  26   8.7   10.6      2.1
Maize seed plant  26  13.0   10.4      2.0

Difference = mu (Maize seed planted (kg)_F) - mu (Maize seed planted_M)
Estimate for difference:  -4.23077
95% CI for difference:  (-10.08199, 1.62045)
T-Test of difference = 0 (vs not =): T-Value = -1.45  P-Value = 0.153  DF= 49
```

Box 94: Two-sample t-test for the amount of maize seeds planted female versus male

Sesame Seeds

```
                          N  Mean  StDev  SE Mean
Sesame seeds planted WC1  14  2.50   1.40     0.37
Sesame seeds planted WC2  19  2.16   1.83     0.42

Difference = mu (Sesame seed planted 1) - mu (Sesame seed planted 2)
Estimate for difference:  0.342105
95% lower bound for difference:  -0.611425
T-Test of difference = 0 (vs >): T-Value = 0.61 P-Value = 0.274 DF = 30
```

Box 95: Two-sample t-test for the amount of sesame seeds planted WC1 versus WC2

```
                          N  Mean  StDev  SE Mean
Sesame seeds planted WC1  14  2.50   1.40     0.37
Sesame seeds planted WC3  16  2.25   1.77     0.44

Difference = mu (Sesame seed planted 1) - mu (Sesame seed planted 3)
Estimate for difference:  0.250000
95% lower bound for difference:  -0.737236
T-Test of difference = 0 (vs >): T-Value = 0.43 P-Value = 0.335 DF = 27
```

Box 96: Two-sample t-test for the amount of sesame seeds planted WC1 versus WC3

The values between the number of sesame seeds planted between males and females were very close 2.33 versus 2.24 therefore were not analyzed.