Swidden-based Smallholder Livelihoods under Marketization in Northern Laos

(ラオス北部における市場化の下での焼畑を基盤とした小農生業)

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SUMMARY

In Laos, swidden farming seems to have diminished compared to the past. However, it still plays an important role as a livelihood in the northern part of the country, regardless of the strong pressures by the government. This study aims to explore the role of swidden farming of upland smallholder's livelihood under the land constraint and marketization in northern Laos. The study area is Poung Pao village, Phonxay district, Luang Prabang province, where residents have engaged in livelihood that integrates traditional swidden farming with livestock herding. In order to clarify the role of swidden farming in the smallholder's livelihood and to explore the swidden combined livelihood diversification of upland farmers, surveys on crop-livestock systems and labor allocation under the livelihood diversification were conducted.

A mixed research methodology including quantitative and qualitative methods is applied as a study method. A series of field surveys were conducted in February and May 2016 and August 2017. Information on the socio-economic development of the village, the composition of the family, migration history, sources of income, land use, and farming systems through an interview with 92 sample households were obtained in 2016. Then, an in-depth survey with 53 households to obtain economic activities, landholding and monthly time spent on each livelihood activity of 133 individuals was conducted in 2017. In addition to this, 231 cattle have measured the girth.

Under the pressures of land constraint and the changing in the market economy, cattle raisers in the village have diversified their cattle raising systems. The free range system combined with swidden farming has diversified into three different systems namely grazing in fenced fallow vegetation in the wet season plus free ranging in swidden fallow fields in dry season (system B), rotation grazing in pastures in the wet season plus free ranging in swidden fallow fields in dry season (system C), and rotation grazing in pastures in both dry and wet

seasons (system D). These grazing systems are likely to intensify both labor and land use due to the limitation of open area for free grazing as fallow fields have decreased. The study found that none of the systems improved cattle body weight better than others. However, the system that integrated rotation grazing in pastures in the wet season plus free ranging in swidden fallow fields in dry season successfully increased the holding capacity of the land. This suggested that under the limitation of the grazing area the newly modified system could help cattle holders successfully cope with land constraint and balance crop-livestock systems in upland environment.

The labor allocation analysis found that land holding, skills, and financial capital that originated from the livelihood history of both ethnic groups are key drivers of livelihood diversification. The labor allocation to livelihood diversification has a greater during the peak cropping season from May to August particularly individuals who engage in multiple livelihood categories into their livelihood portfolio. However, labor allocated for swidden farming compare to other activities is moderate and acceptable to villagers.

Although swidden farming is believed to decline, the study indicates that swidden farming persistence and plays an important role where farmers combined with several other economic activities. This is because swidden farming supplies not only families' daily food such as staple-diet rice, but provides their main source of income. Therefore, this study can neither deny nor support the predictions from development studies that swidden farming will be replaced with other intensive farming or non-farm jobs. From the results of this study, it is certain that swidden farming is an important livelihood activity that can be flexibly combined with other activities for livelihood diversifications.

Given the importance of swidden farming in smallholders' livelihoods, appropriate development approaches for upland regions should be created that work with swidden farming instead of against it, whereby swidden farming is combined with other livelihood activities.

However, such combinations must provide economic, social, cultural and environmental suitability for upland regions.

LIST OF ACRONYMS AND ABBREVIATIONS

ACIAR	Australia Centre for International Agricultural Research
AEC	ASEAN Economic Community
AFAS	ASEAN Framework Agreement on Services
AFTA	ASEAN Free Trade Area
APTA	Asia-Pacific Trade Agreement
ASEAN	Association of Southeast Asian Nations
CPI	Consumer Price Index
DAFO	District Agriculture and Forestry Office
EU	European Union
IPSARD	Institute for Policy and Strategy Agriculture and Rural Development
LFAP	Land and Forest Allocation Program
LSUAFRP	Lao-Swedish Upland Agriculture and Forestry Research Program
LUP/LA	Land Use Planning and Land Allocation
MAF	Ministry of Agriculture and Forestry
MPI	Ministry of Planning and Investment
NAFRI	National Agriculture and Forestry Research Institute
NEM	New Economic Mechanism
NGPES	National Growth and Poverty Eradication Strategy
NTFP	Non-Timber Forest Product
PLUP	Participatory Land Use Planning
SIDA	Swedish International Development Agency
PRA:	Participatory Rural Appraisal
SPS:	Sanitary and Phytosanitary

TLUC	Temporary Land Use Certificate
UNDP	United Nation for Development Program
WTO	World Trade Organization

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1. INTRODUCTION

1.1. Worldwide swidden farming trends

Swidden farming is a highly diverse and one of the oldest land use systems; it has been evolving since 10,000 BC across a wide range of socioeconomic and ecological conditions, from mountains to lowland ecosystems, from tropical forests to grasslands (Thrupp et al. 1997). During the classic Mayan period (250–900 AD), the formation of a food crisis due to overpopulation caused people to construct boundaries to defend their land use for swidden farming, which they practice to this day, just like their descendants from Central America, with maize and beans as the primary crops. They cleared plots of land by cutting and burning, grew crops until the soil was exhausted, and then moved on, returning later when the soil had recovered (Russell 1988). Swidden farming employs a natural or improved fallow phase that is longer than the cultivation period of annual crops, yet sufficiently long enough to be dominated by woody vegetation and cleared using fire (Mertz et al. 2009). The production system of this method varies worldwide, but most types depend on regenerated trees to control weeds and recover soil nutrients (Roder 2000). In other words, swidden farming is a slash-and-burn kind of agriculture or shifting cultivation (Rasul and Thapa 2003; Rerkasem et al. 2009). Swidden is in the sense of burned cleaning or burn plot of woody vegetation, then cropped for short period than the follow up fallow. Swiddening is a way of life associated with cultural. In Southeast Asia, the swidden farming normally practiced by the local ethnic minority (Li et al. 2014). In this study I will use the term "swidden farming."

Swidden farming is an important farming practice for smallholders' livelihoods (Fox et al. 2009); it largely consists of subsisting on crops grown on swidden farms and refraining

from selling them (even when there is a surplus) due to the risk adaptive strategy of storing food products, which are needed to meet frequent, unpredictable harvest shortfalls. In addition to swidden farming, swidden cultivators engage in cash crops cultivation and integrated into the world economy (Dove 1983). The most ubiquitous crop in Mexico is maize, while cassava and yam are the most common types of produce in the tropical forests of South America. Millet, sorghum, and yam are most prevalent in West Africa, while in South and Southeast Asia, dry rice is the staple, although it can also be maize in some parts. Cassava, bananas and other annual or perennial crops are secondary ones; some cash crops such as ginger, cardamom, and others are also cultivated (Colfer et al. 2015). Swidden farming is believed to be disappearing from upland livelihoods because of policies that limit it, in addition to improved infrastructures associated with accessing markets and employment opportunities. However, it appears to be relatively persistent in some areas, with alternative economic opportunities comprised of subsistence and commercial farming (Hansen and Mertz 2006). In upland Southeast Asia, farmers often combine swidden farming with other forms of livelihood ventures such as cash crops, plantations, livestock, non-timber forest products (NTFPs), and off-farm jobs (Cramb et al. 2009; Li, 2002). People in upland Myanmar continuously rely on swidden farming in combination with forest resources, engage in wage employment, living from remittances, practice non-forest tree husbandry, and undertake self-employed business activities (Kmoch et al. 2018).

Swidden farming consists of diverse cultural practices and cropping systems, and can thus be seen as a mixture of land and resource use adapted to local ecologies, cultures and regional economies. In Malaysia, rice production using swidden fields is linked to local views, beliefs, and social organization. Various types of ceremonies and religious events are integrated into all aspects of swidden farming. Rice is not merely a staple but also has a spirit, soul, and proper rituals that must be followed in order to win the respect and favor of the "paddy spirits,"

who provide a plentiful supply of grains (Majid 1983, cited in Browder et al. 1995). Throughout Laos, swidden farming is part of local ethnic groups' day-to-day lives; it is especially significant in the attitudes of concerned tribal societies and in social relationships, cultural values, and mythical beliefs, which are directly tied to it. Traditionally, swidden farming has taken place in a social structure where farmers work in fields that are close to each other, which fosters intimate relationships in communities and villages (Sodarak 1999). Upland communities often exchange their labor particularly for the urgent activities that need to complete in a short period, in the rural area of upland farmers, 30% of labor input for one hectare of dry rice was from exchanged labor (Asai et al. 2017). Different kinds of food crops are integrated with rice and serve as food sources for upland farmers; at the end of the workday, farmers normally collect these crops to prepare meals for their families (Roder et al. 1996).

Although swidden farming can still be seen in certain places, it is no longer dominant worldwide and has decreased considerably; for example, the estimated size of the global area in which swidden farming takes place has declined over the past four decades. Despite this, the practice remains widespread. In 1980, it was predicted that swidden farming was occurring across 409,550,000 hectares, of which tropical zones comprised 42% in the Americas, 41% in Africa, and 18% in Asia-Oceania (Lanly 1985). In 2015, swidden farming covers around 280 million hectares worldwide (Heinimann et al. 2017). Van Vliet et al. (2012) reviewed 111 publications – including 157 case studies (92 from Asia and the Pacific, 20 from Africa and Madagascar, and 45 from Latin America and Central America) – and concluded that 103 cases focused on the changes of swidden farming between 1995 and 2010. For 55% of 103 cases, swidden farming declined; for 32%, it rose, and for 13%, it remained stable.

However, changes in area differ by region. Africa and Madagascar saw an increase in swidden farming, while it remained stable in the Solomon Islands and fell in Southeast Asia (Van Vliet et al. 2012). Southeast Asia seems to have witnessed a swifter transformation than

other areas. In Indonesia and the Philippines, swidden farming has been replaced by numerous permanent agricultural and non-agricultural kinds of land use (Huijun et al. 2002; Schreinemachers et al. 2013). In West Kalimantan, Indonesia, the average area of swidden farming diminished from 4 ha in the 1980s to 1.84 ha in the 1990s as farmers began to grow wet rice using irrigation, rubber gardens, and fruit tree gardens (Padoch et al. 2007). In Sarawak, Malaysia, the area under swidden farming became smaller; upland populations, particularly younger ethnic minorities, started moving to urban hubs (Schreinemachers et al. 2013). In northern Thailand, swidden farming was replaced by alternative livelihoods (e.g., cash crops, plantations, handicrafts, tourism, and food processing) through the introduction of high-value crops, capacity building, and upgrading farmers' skills. This allowed locals to harness the full potential of economic and social integration (Ellis et al. 2012). The development approaches described above encouraged upland farmers to move away from swidden farming toward better livelihood activities.

1.2. External factors associated with reduced swidden farming

Several scholars have widely observed the drop in swidden farming, which is due to various external factors. Three key external elements linked to the shrinking area of this practice include population growth, economic and market development, and policies (particularly those related to environmental conservation) (Van Vliet et al. 2012). Demographic trends encompass both population growth and decline associated with in- and out-migration; hence, swidden farmers change their practices in response to demographic shifts, either through intensification or out-migration. In Mexico, due to out-migration, a smaller workforce caused farmers to move toward less labor-intensive agricultural activities, such as grazing pastures and annual cash crops (e.g., chili) (Schmook and Radel 2008). In the Philippines, in-migrants brought new methods (e.g., paddy rice cultivation techniques). Swidden land was claimed

through seizures or purchases, then converted to paddy fields through improved harvests with a high yield of seeds, which led to successful rice production (Cramb et al. 2009). In the central highlands of Vietnam, a government sponsored in-migration program transformed sites where swidden farming had previously occurred into places for generating high-value crops (e.g., coffee). However, this also created a difference between wealthier and poorer groups, the latter of which continued to engage in swidden farming as a safety net (Cramb et al. 2009). Regarding out-migration, Hansen and Mertz (2006) claimed that swidden farming is normally combined with other livelihood options, but may gradually be wiped due to the increasing, permanent migration of younger generations. In the Cordillera of Luzon, the Philippines, the abandonment of swidden farming after 1945 resulted from men migrating for work (Preston 1998).

Simultaneously, economic interventions have transformed uplands in the sense that forest zones have shrunk, road networks have extended into the mountains, and shifts in land use have occurred. Furthermore, swidden agriculture has intensified whereby farmers are now observing shorter fallow periods and turning to permanent crops (Padoch et al. 2007). The subsequent expansion of agricultural commercialization has influenced changes in swidden farming, yet some farmers have continued the practice to fulfill their subsistence needs by adding small portions of land and labor to produce crops ready for the market. Furthermore, farmers have allocated most of their land and labor for this purpose, and rely on purchasing materials to meet their needs based on the revenue they earn from selling commercial crops (Cramb et al. 2009).

The marketization of agriculture production, along with integration into large regional markets, has pulled farmers away from swidden farming toward other activities. In Zambia, in response to market demand for maize during the 1990s, farmers slowly shifted to a different type of cultivation (Kakeya et al. 2006). In Uganda, forests and woodlands were converted into sugarcane plantations, resulting in less land available for swidden farming (Mwavu and

Witkowski 2008). In southern Cameroon, market integration caused farmers to start growing coffee, cocoa, plantain, and non-plantain crops for the national and regional markets (Mertens et al. 2000; Van Vliet 2010). Examples that represent the transformation from swidden farming to cash crops include rubber plantations, palm oil, and pepper in Malaysia and Indonesia, where smallholders saw their incomes rise in comparison to what they had earned from swidden farming (Cramb 1993; Fox et al. 2009; Hansen and Mertz 2006). In Xishuangbanna, China, fallow swidden fields were completely replaced by rubber plantations (Zeng et al. 2001, cited in Padoch et al. 2007).

Another important aspect is conservation policies, which accelerate changes in swidden farming by restricting forest clearing and encouraging commercial agriculture. In some cases, the implementation of these policies has deprived farmers of using land in the traditional way and curbed their access to forest resources. Furthermore, swidden farming is a serious land use problem in upland areas (Erni 2015); governments across regions have criticized it heavily for causing fields to be cultivated non-permanently and leading settled populations to relocate after land is cleared (Friederichsen and Neef 2010). Regarding climate change, swidden farming is blamed as a reason for carbon emissions, and thus for contributing to global warming. It is listed as the first of four main causes of deforestation and forest degradation (Erni 2015). Thus, in the name of forest conservation and rural development (Erni 2015), governments have implemented a number of policies to eliminate swidden farming and move toward more sustainable, permanent occupations in upland regions. Some countries help farmers find alternative jobs. For example, in the Brazilian Amazon, policies have been put in place for permanent agricultural land use (including exemptions for agricultural income tax), rules that determine land tenure security, and credit schemes that subsidize corporate livestock farms (Binswanger and Deininger 1997). Madagascar has also launched a series of agricultural

and social plans to end swidden farming, because it is believed that doing so will promote biodiversity conservation and improve crop yields to meet population demand (Hume 2006).

Similarly, in South and Southeast Asia, policies have been created for land law, planning, and allocation; forest allocation; and swidden farming stabilization (Padoch et al. 2007; Fox et al. 2009; Ziegler et al. 2009). Examples include forest classifications in some Southeast Asian countries (e.g., land use planning and allocation in Laos during the 1990s, land law in Vietnam, etc.) (Ducourtieux et al. 2005). In Bangladesh, land use laws in the administrative orders of local authorities affect people's livelihoods by limiting swidden farming, which is prohibited within 15 km of border areas and within 2 km of reserve forests. To practice it, permission must be obtained from security forces and local authorities, and cannot be carried out in any area that is demarcated by the swidden farming control division. In addition, the fallow cycle of swidden farming was reduced to 2–3 years due to the loss of agricultural land (which resulted from a dam that generates hydroelectricity); forest reserves were expanded; unclassed state-owned land was leased to grow rubber and tea; industrial plantations opened up; infrastructure was developed; and resettlement programs were created (Khisa and Mohiuddin 2015). In Vietnam, permanent cultivation and settlement programs, promulgated in 1968, targeted upland ethnic groups and their alleged role in deforestation, explicitly aiming to combine sedentary programs with collectivization. This simultaneously resolved the problems of nomadic farming and forest destruction. The abovementioned programs had three clear goals: (1) to help people gain stable livelihoods; (2) to promote a balanced sense of mental well-being; and (3) to foster ethnic unity (Friederichsen and Neef 2010). In Thailand, particularly in the north, the government has tried to outlaw swidden farming and to encourage farmers to adopt permanent agricultural land use practices (Padoch et al. 2007). Policies like those described above have restricted and controlled swidden farming, causing it to decline throughout the world.

1.3. Swidden farming in northern Laos and the key question of the study

In Laos, swidden farming seems to have diminished compared to the past, but it is still vital and widespread in the northern part of the country (Heinimann et al. 2013). In 2016, the total area of swidden farming for dry rice reached 105,148 ha of which 76% was in the north, 19% in the center, and 5% in the south. At this time, the area for swidden farming had shrunk by approximately 50% compared to 2011 (DoP 2017). An earlier assessment from 2003–2009 found that the total swidden farming area in northern Laos was 197,750 ha with 552,000 inhabitants (Heinimann et al. 2013). The decline in the practice was due to upland farmers shifting toward forms of intensive commercial agriculture, such as contract farming of maize and the replacement of rubber cultivation, which local governments promoted for a more sustainable alternative (Vongvisouk et al. 2014). Today, upland farmers continue to practice swidden farming (especially for rice as the stable food crop), either by choice or to meet the needs of the household (Heinimann et al. 2013; Vongvisouk et al. 2016).

Changes in Laos' swidden farming have been influenced by population pressure, economic growth, and marketization, as well as national policies. The practice can be economically sensible and ecologically sustainable when there is low population density, along with integrated cultivation to maintain forest regeneration during long fallow periods (Fujisaka 1991). Roder (1997) found that where there is low population density, in addition to low incomes and reduced access to inputs, swidden farming is the best land use option for rural inhabitants in the country's hilly regions. Yet nowadays, increasing population pressure and interdependence between lowland and upland farmers have forced swidden farmers to take new approaches toward a more intensive practice, with a fallow period in the north. Population density has increased due to villages relocating and spontaneous migration, thereby diminishing available land and placing pressure on land use (Douangsavanh et al. 2006). In contrast, out-migration (particularly among the younger generations) has resulted in a labor

force shortage for swidden farming in upland societies (Rigg et al. 2004). The major shift in younger Laotians moving from the rural uplands to the lowlands, where the capital Vientiane is located, has substantially reduced labor inputs for swidden farming in the upland regions (Phouxay et al. 2010).

Market integration and the expansion of market demand (which have augmented agricultural commercialization) seem to have simultaneously pushed swidden farming to evolve into different kinds of commodity production (e.g., smallholder production, contract farming, and land concessions). Market integration has caused land investments to rapid expand, which has transformed rural agriculture, particularly in regards to land use.

In Laos, foreign direct investments (FDIs) in land concessions for commercial crops have risen swiftly in recent decades, as well as FDIs in land and forest resources. In 2016, 1,521 land deals took place, involving nearly a million hectares. The share of land under concession consists of four main sectors: (1) agriculture (45%), (2) mining (41%), (3) tree planting (14%), and (4) hydropower (1%). In 2017, the owners of such land comprised of domestic investors (29%), foreigners (60%), and joint venturers (11%) (Ingalls et al. 2018). Land concessions/leases have caused many farmers to lose control over their property, which represents one of the biggest changes in the country's northern rural area and has led to acute shifts in their traditional livelihoods (Thongmanivong and Fujita 2006).

In Luang Namtha Province in northern Laos, smallholders have faced problems with land grabbing when turning to commercial agriculture; at the start of engaging in such farming, rubber plantations belong to smallholders. In terms of writing up a contract, to guarantee the existence of a market for – and pricing of – latex, smallholders and foreign investors take part in a "2+3" arrangement ("2" refers to the land and labor contributed by the farmer, while and "3" refers to the capital, technology, and marketing provided by the investor) and a "1+4"

arrangement ("1" refers to the land contributed by the farmer, while "4" refers to the labor, capital, technology, and marketing provided by the investor).

Some smallholders sell their rubber plots to investors, which makes them landless households (Cramb et al. 2017). Similarly, Manivong and Cramb (2008) claimed that in Luang Namtha, certain cash crops (such as rubber trees, maize, and bananas) for the Chinese market have been replaced and expanded to land that previously contained fallow forests for swidden farming and paddy rice. The shrinking of fallow land and forests (where livestock was once free-range) has put pressure on livestock herding, revealing the conflict between rubber plantations and livestock production. As a result, livestock holders have sold off their stock to avoid strife (Takai and Sibounheuang 2010). In addition, Takai and Sibounheuang (2010) asserted that it is difficult for smallholders in Laos to extend their property because of land constraints.

Since the late 1980s, the government has tried to preserve upland biodiversity and increase forest cover; one of its goals is to achieve a forest cover reach of 70% by 2020 (GOL 2005). The government views swidden farming as an obstacle to realizing this objective and has implemented a number of initiatives to combat it, such as the Land and Forest Allocation Program (LFAP) and the Village Relocation Program (Kenney-Lazar 2013). The LFAP has reduced the amount of agricultural land available for farmers, which in turn has diminished the length of shifting cultivation cycles, and hence the length of time allowed for vegetation growth during fallow periods was shorter. Meanwhile, village relocation has increased local populations, which has resulted in land scarcity in relocated villages (Douangsavanh et al. 2006). The LFAP hindered swidden farming by differentiating forest from agriculture land. With such classifications, the long fallow period came to be seen as forest, which makes it unviable for the next cycle of swidden farming.

Later on, the Land Use Planning and Land Allocation (LUP/LA) Program was implemented to re-allocate more agricultural land to farmers by issuing temporary land use certificates (TLUCs) to upland households (Moizo 2004). TLUCs usually include three plots for a household for swidden farming (Rock 2004). At the same time, upland inhabitants are encouraged to produce cash crops (e.g., rubber, banana, maize, and sugarcane), since the government would like to increase households' income as swidden farming is gradually replaced (Manivong and Cramb 2008; Phanxay 2015; Phouyyavong and Talje 2006; Southavilay et al. 2012b; Thongmanivong and Fujita 2006). These policies and development interventions have curbed swidden farming.

Regardless of the strong pressures on swidden farming in other parts of the world, why does it persist in Laos? Perhaps because upland smallholders are less able to choose how they earn a living. Many development studies maintain that smallholder farmers do not have a choice (even though they are willing to earn a cash income) due to the difficulty of accessing the market and other services, which in turn results from the country's topography (Hazell et al. 2010; Morton 2007; Okello et al. 2011; Poulton et al. 2010). However, I assume that smallholders in northern Laos are proactively involved in swidden farming, rather than reluctant. In order to verify my hypothesis, I focus on cattle productivity and labor allocation in relation to swidden farming.

1.4. Cattle raising based on swidden farming

Crop-livestock systems in Laos are unique. A swidden-based cattle raising system predominates. Fallow swidden areas produce natural vegetation for free-range grazing, and livestock holders often combine swidden farming with other livelihood activities (Millar and Photakoun 2008; Nakatsuji 2010; Phonvisay et al. 2016; Pravongviengkham 1998; Shirai and Yokoyama 2014; Takai and Sibounheuang 2010).

In northern Laos, large livestock graze widely in fallow fields, communal grazing areas, grasslands, and forests, especially in sloping land areas. There is little management input for large livestock, which are usually left to forage for much of the year. Different ethnic groups and villages have distinct management approaches for handling their animals (Millar and Photakoun 2008). In general, there are two kinds of large ruminant production systems in the upland areas, where smallholders engage in both extensive and low input breeding, as well as in more intensive fattening or finishing using their own (or purchased) stock (Millar and Photakoun 2008; Nampanya et al. 2014; Phonvisay et al. 2016; Pravongviengkham 1998).

Cattle and swidden farming are interconnected through fodder production in fallow fields. Natural grass and rice straw are good sources of animal feed, cattle manual is good for soil fertility, and cattle can be used for transport. Swidden farming and cattle raising seem to be labor extensive and require a lower input system. Cattle raising is normally supplementary to swidden farming, and few families specialize in livestock production (Hansen 1998). The most upland land farmers depend heavily on ruminant livestock for livelihood security (Phengsavanh et al. 2000). Traditionally, livestock have been integrated with swidden farming in the sense of being permitted to freely graze in fallow fields; this practice can be sustained with minimum inputs. The crop-livestock system allows crops and livestock to complement each other. Byproducts from crops (primarily rice straw) can be fed to livestock, and animal manure is good for soil fertility; these are interchangeable within the system, which diminishes environmental pollution by reducing the use of chemical fertilizers (Hansen 1998).

One of the most important livelihood activities in upland society is swidden farming for dry rice production, which is the dominant type of land use in upland Laos. Normally, this practice starts by slashing fallow or shrub vegetation in January and February, and burning the dry biomass in April. Planting occurs in late May or early June when the rains arrive. The rice varieties used are all traditional kinds. Early, medium and late varieties are used to arrange the

date of the harvest (labor requirements, early consumption) and to mitigate the risks of weather and pest damage. Weed control is the single most vital labor requirement, accounting for more than 50% of the labor input, because weeding is necessary at least three times during the season of upland rice cultivation, when labor productivity is comparatively low (Roder et al. 2001). Apart from rice, several upland intercrops are grown in the same plot together with rice, but their portions are very small. They include corn, cucumbers, pumpkins, taro, cassava, chili, sesame, smooth loofah, sweet potatoes, long beans, peanuts, eggplants, Job's tears (adlay millet), ginger, sorghum, yam beans, pigeon peas, and sunn hemp. The purpose of integrating these intercrops with upland rice is mainly for household consumption. When rice is harvested, the fallow land is used for grazing cattle and buffalo, with the best grazing value in the initial years of the fallow period (Sodarak 1999; Roder 2000).

Swidden farming and livestock raising (particularly cattle) are critical for upland livelihoods; the former is significant for the subsistence needs of upland households (Vongvisouk et al. 2014). Among the upland population in Phongsaly Province, swidden farming supplies over 75% of food resources (Ducourtieux et al. 2005). A survey conducted by the Food and Agriculture Organization (FAO) on smallholders' income composition in upland villages in the provinces of Luang Prabang, Xiengkhuang and Hoaphanh found that 12% of people's income derives from cattle; this is the second-largest proportion of all income sources. Within agricultural activities, the share of earnings from cattle is the largest (Phonvisay et al. 2016). This suggests that cattle play a vital role in households' cash income and saving property, while swidden farming provides a source of food for consumption.

Recently, swidden farming and cattle raising have been facing limitations, especially to accessible land. Policies on land and forest allocation, village relocation, and the promotion of plantations have resulted in agricultural land constraints for swidden farming and livestock raising among upland farmers. Furthermore, swidden farming and grassland have been

replaced by other crops. This curbs the availability of feed for cattle, which is due to the decline in available grazing areas, leading to further discord between livestock and crop production (Takai and Sibounheuang 2010).

One solution is the introduction of forage crops and the advancement of cattle raising by the government and international organizations, and the plausible impact on the crop-livestock system (Nampanya et al. 2014). Under such external pressures and development interventions in relation to livestock production, farmers can replace crop-livestock systems to employ intensified cattle raising systems for cash income.

1.5. Labor allocation for swidden farming in livelihood diversification

Swidden farmers' livelihoods in northern Laos comprise various activities, such as swidden farming integrated with upland crops (e.g., maize, Job's tears), small rainfed paddies, home gardens, forest resources, small and large livestock, NTFPs, hunting, non-farms, and off-farms (Leek 2007; Pravongviengkham 1998; Yokoyama 2010). Wet rice is found near rivers and valleys among the hills, but paddy fields are quite limited. Paddy rice fields are cultivated during the rainy season (Linquist et al. 2007). In some areas, agroforestry has been initiated for environmental conservation and permanent agricultural production. Growing cardamom, in combination with tree planting in forest zones and fallow fields, is an alternative to permanent crop cultivation, thereby converting fallow land into agroforestry zones (Ducourtieux et al. 2006). Agroforestry includes perennial tree crops in swidden farming areas (such as paper mulberry trees) incorporated into forest land; for example, cardamom and coffee are integrated into the forest (Ducourtieux et al. 2006; Openshaw and Trethewie 2006). Large and small livestock are vital for upland farmers in terms of food security and cash income, primarily large livestock, which are permitted to graze freely and widely. Livestock grazing is conducted in grasslands and fallow rice fields (Vongvisouk et al. 2014).

Forest resources are crucial for earning a living in uplands, which are rich in agrobiodiversity. Upland people rely on NTFPs from the forest and longer fallow periods for their food and income. NTFPs include wild vegetables, bamboo shoots, and rattan shoots. Others kinds of NTFPs are used for household food and sold for cash (Hirota et al. 2014). A case study on some villages in Ngoy District in Luang Prabang Province revealed that seven kinds of NTFPs produce cash income: (1) cardamom, (2) benzoin, (3) *puack muack*, (4) paper mulberry, (5) rattan fruit, (6) galangal fruit, and (7) tiger grass (Yokoyama 2004). In the village of Namphaeng in Namor district, in Oudomxay Province, important NTFPs include bitter bamboo shoot (*Indosasa sinica*) – a significant source of household income – followed by cardamom (*Ammonium sp.),* rattan (*Calamus sp.*), sapan (*Debregeasia hypoleuca*), baylai (*Sanseviera zeylania*), and bone home (*Colocasia esculentum*) (Soydara and Ketphanh 2000). Another case study on five villages in the Nakai plateau in Khammouan Province found 22 types of NTFPs, of which 56% serve as food sources and 44% are sources of income. When focusing on household income composition, the share from NTFPs accounted for 76%, followed by livestock (16%) and other (8%) (Foppes et al. 1997).

The government aims to increase household income by replacing swidden farming with permanent farming (including wet rice and cash crops), enhancing infrastructure, and expanding the market economy to eliminate the rural one. Improved road conditions – which strengthen connections among neighboring countries in terms of business – have amplified opportunities for smallholders to find valuable cash crops, as well as on-farm and off-farm jobs (Bouahom et al. 2004). These circumstances have made it difficult for farmers to continue swidden farming, which they are forced to replace with other livelihood activities. Now given several choices as to how to earn a living, smallholder farmers might diversify by cultivating cash crops. If development studies' findings are correct, non- and off-farm activities, as well as the allocation of resources for swidden farming, may be diminishing.

1.6. The purpose of the study

This study aims to explore the role of swidden farming in upland smallholders' livelihoods under the conditions of land constraints and marketization in northern Laos. The purpose is multifold: to demonstrate diversification in crop-livestock systems, to evaluate cattle productivity in combination with swidden farming, and to examine labor allocation for swidden farming based on livelihood diversification.

After describing the target village's socio-economic history and general features in Chapter 2, I discuss the diversification of crop-livestock systems in Chapter 3 and labor allocation in Chapter 4. Finally, in Chapter 5, I answer the main question and discuss how livelihoods could become sustainable in combination with swidden farming (based on Chapters 3 and 4); this applies not only to Laos, but also to other parts of the world.

CHAPTER 2. STUDY AREA AND METHODOLOGIES OF THE RESEARCH

Chapter 2 describes the implications of policies related to the forest, environmental conservation, and rural development (including land and forest allocation, village relocation, and market integration). Afterward, I discuss the study area where I conducted the research. I explain why I chose the village, in addition to describing its location, its climate, its land and forest allocation, its demography, its ethnic composition, its history, the introduction of forage crops, as well as the villages merging and relocation of Hmong and Khmu households that migrated there. Finally, I briefly address the methodology used in this dissertation. I delve into the specific technique applied to each research question in Chapters 3 and 4.

2.1. Upland characteristics in Laos

Upland farmers tend to practice swidden farming in remote areas, where there are very few alternative occupations that would be more suitable for the socioeconomic and biophysical features of upland regions. Other activities such as paddy farming are limited; building terraces for paddy fields requires greater capital and is more labor-intensive. Perennial tree crops require large amounts of input and investments. Furthermore, access to credit for initial agricultural production, as well as the market for products, is quite limited. These are significant challenges (Kenney-Lazar 2013). The majority of rural Laos has inadequate roads. This is a big problem for rural inhabitants because it hampers the connections between the upland and lowland economies, and restricts access to markets where people can sell their crops, purchase consumer goods, and find healthcare (Warr 2010). Upland inhabitants have a hard time finding food outside of where they live; the same issue does not surface as much in lowland areas, where there is more land for paddy rice and other crop production. Furthermore,

upland inhabitants have fewer opportunities to increase their incomes by growing cash crops, which are in demand in the lowlands due to the high cost of transport.

However, upland farmers along the roadside still engage in swidden farming because of facing poor treatment during village relocation. Relocated farmers often take part in traditional swidden farming by shortening fallow periods along the roadside, which increases land degradation (Kallabinski and Lundgreen 2006)

2.2. Village relocation

Village relocation was implemented based on the government's goals to reduce poverty, build up rural areas, and increase nationwide construction (Baird and Shoemaker 2007). The government recognized regional inequality in light of various aspects of human development. Focal area development is one of the policies adopted in the government's National Growth and Poverty Eradication Strategy (NGPES), which was initiated in 1994 to lower rural poverty, particularly in upland regions. In 1997, 62 focal development areas were established (Bird 2009). Next, village relocation took place to help people access public infrastructure and services, to pursue consolidation and nationwide construction, to mitigate or properly manage swidden farming, and to eliminate opium cultivation (Baird and Shoemaker 2007). Apart from the Village Relocation Program, village resettlement has taken place due to development projects. According to the agricultural census of 2011, approximately 10% of all villages had been resettled countrywide, mostly in upland regions (19% of total villages in upland had been resettled) (Ingalls et al. 2018). Resettled villagers were able to access to public services (e.g., healthcare, sanitation, education), roads, irrigation, electricity, and markets. Villagers found permanent occupations (e.g., in intensified agricultural production for food and cash income) (Baird and Shoemaker 2007).

Village relocation and merging caused local populations to increase, but some inhabitants have faced land use problems. In many cases, migration put pressure on agricultural land and on the populations in newly relocated villages (Douangsavanh et al. 2006). Hence, land and forest allocation have been implemented along with village relocation to identify forest and agricultural land, as well as to allocate agricultural land for individual households.

2.3. Land and forest allocation

Land and forest allocation have been carried out according to the land law, which aims to preserve forests and the environment. The enforcement of the land law in 1997 provided a legal guideline for the LFAP, which intends to boost sustainable management and use of natural resources, reduce and gradually eliminate shifting cultivation, and enhance commercial production. The LFAP consists of a number of steps: (1) identifying village boundaries (including forest, agricultural, and other land frontiers); (2) providing recommendations on land accessibility, use and management; (3) decentralizing resource management responsibilities to village committees; and (4) allocating agricultural land to households in the form of TLUCs (Fujita and Phanvilay 2008; Castella et al. 2014).

Many of the initial LFAP schemes proved unfeasible, while later land-use planning efforts made a more explicit effort to involve local communities. With follow-up programs such as Participatory Land Use Planning (PLUP), participatory elements were brought into the process. This new approach was evaluated in August 2003, and a variety of recommendations were made to improve it for the future (Dwyer 2017; Kallabinski and Lundgreen 2006).

Several ministerial directives have been released on forest and land allocation. The Forestry Strategy for 2020, launched in 2005 and headed by the Ministry of Agriculture and Forestry (MAF), and a series of instructions on procedures for implementing land use and land allocation, such as No.822/1996 (Manivong and Sophathilath 2007). According to the

execution of PLUP, each village should have a village boundary, types of forest zoning, agricultural land, and households should have TLUCs.

The LUP/LA Program, mentioned earlier, recognizes farmers' right to use and manage natural resources, particularly agricultural land. It was put into effect in different provinces on different dates with support from various development partners. The LUP/LA Program aims to ensure land ownership for farmers, to promote decentralized and community-based management of land and natural resources, to advance forest and environmental protection, to bring about stabilization, to limit shifting cultivation, to consolidate villages in relation to land use, and to eradicate opium (Ducourtieux et al. 2005; Kallabinski and Lundgreen 2006). The LUP/LA Program issues land titles to individual households. The permanent agriculture land title is based on lowland notions and uses of space. Paddy cultivation, gardens, orchards, and plantations are acknowledged as the only kinds of land use that deserve titles, while swidden farming, foraging, hunting and gathering, and cattle grazing have not yet been considered for permanent land titles. Based on these conditions, the LUP/LA Program grants TLUCs to upland households (Moizo 2004) in order to allocate additional land to them (Rock, 2004).

Upland inhabitants are encouraged to produce cash crops, since the government would like to increase household income in the hope of replacing swidden farming. Nowadays, the Chinese market demands cash crops such as maize, bananas, rubber, sugarcane, and vegetables (Phouyyavong and Talje 2006; Thongmanivong and Fujita 2006; Manivong and Cramb 2008; Southavilay et al. 2012; Ingxay 2015).

2.4. Market integration

The New Economic Mechanism (NEM) was initiated in the 1980s to boost the country's economic growth by opening it up to the rest of the world. The economy transformed

from one based on subsistence to a commercialized one. During this time, small trading establishments were consolidated, and the government no longer interfered in trading operations. Domestic and foreign trade were also made easier, and a number of state-owned enterprises were privatized (Vilavong 2018b).

Since then, Laos has integrated into the regional economy. Laos joined the Association of Southeast Asian Nations (ASEAN) in July 1997 and the ASEAN Economic Community (AEC) in 2015. The creation of the AEC is a major milestone in ASEAN's regional economic integration agenda, offering opportunities in the form of a huge market. Within the AEC, goods, services, investments and capital flow freely (MPI and UNDP 2017; Vilavong 2018a). Laos is part of ASEAN's Free Trade Area (AFTA). Moreover, the ASEAN Framework Agreement on Services (AFAS) sets specific targets for lifting nearly all restrictions on trade in relation to services.

Laos is a partner of regional trade negotiations with ASEAN members and non-ASEAN countries (Australia, China, Japan, India, New Zealand, and South Korea), and is a party to the Asia-Pacific Trade Agreement (APTA). Members of APTA include Bangladesh, China, India, South Korea, Laos, and Sri Lanka. The ASEAN-China cooperation on pre-harvest trading and production, the Early Harvest Program (EHP), was launched in 2003. Between Laos and China, the EHP tariff reduction began in 2006; all import tariffs were eliminated in 2010 (Vilavong 2018b).

Laos became the 158th member of the World Trade Organization (WTO) in 2013, and enacted or revised around 90 laws and regulations governing economic activities in the years leading up to its WTO membership, the goal being to build a national consensus and align its domestic policies with international practices (Pholsena and Vilavong 2015 cited in Vilavong 2018a). As a member of the WTO, Laos must comply with trade regulations, including sanitary and phytosanitary (SPS) ones; this is the responsibility of MAF, in addition to overseeing

agricultural and livestock products. Laos' main purpose in being a member of the WTO is to reach new and wider markets – since Laos is an underdeveloped state, Laos received duty-free export policies to developed and developing countries (e.g., Australia, Canada, the European Union [EU], Japan, China, Russia, and India) – in addition to establishing rules-based trade systems that ensure non-discrimination and predictability, as well as internal reforms (Vilavong 2018b).

The tangible benefits of integrating into the regional economy include reinforcing trade and foreign investment with regional and neighboring countries. The close relationship with ASEAN and its partners should provide more opportunities for Laos, especially a stronger comparative advantage that includes agro-processing, particularly from crops and livestock (tea, coffee, bananas, cattle); it is rich in biodiversity regarding natural products (MPI and UNDP 2017). Moreover, road network linkage offers opportunities for local production in regional markets, and encourages farmers to shift toward commercial agriculture in the north, where, in response to increased Chinese demand for maize for animal feed, smallholders have switched to maize production in Oudomxay (Phouyyavong and Talje 2006) and Bokeo provinces (Southavilay et al. 2012a). Luang Namtha and Oudomxay provinces have gradually stopped growing local crops and moved toward commercial agriculture through land concessions and leases, as well as contract farming (e.g., bananas, watermelons, chili, pumpkins, sugarcane and rubber; the seedlings are imported from China, which engages in mono-cropping) (Khontaphane et al. 2006; NAFRI and IPSARD 2016).

2.5. Study area

I conducted the study in the village of Poung Pao in Phonxay District of Luang Prabang Province, about 80 km from the provincial capital. Although Poung Pao is not particularly remote, it contains other characteristics that are typical of upland villages in

northern Laos. It is mostly inhabited by Hmong and Khmu. The systems of farming include swidden farming and raising cattle. Migration and land constraints are issues. These are common problems; hence, the conditions of this village can be seen as representative of upland villages in this part of the country (Figure. 1). The village is about 400 m above sea level and surrounded by mountains ranging from 1000 to 1400 m in elevation. Distinct wet and dry seasons occur from May to September and October to April, respectively. Temperatures are higher in the wet season (the high in May 2014 was 41°C) and lower in the dry season (the low in January 2014 was 7°C 2014) (Figure 2).

2.5.1. The village's history and demography

Poung Pao is a mixed ethnic community; its inhabitants migrated from small villages according based on the district's Village Relocation Program. As of 2016, the population was 826, with 132 households (Table 1). Most villagers belong to the Hmong and Khmu ethnic groups, which predominate in northern upland Laos (Epprecht et al. 2018). The villagers described a clear difference in the migration patterns between the Hmong and Khmu. The Hmong immigrated as a village unit, whereas the Khmu did so in household units from multiple villages. Consequently, the Hmong can be divided into three subgroups based on their village of origin, from which the migration took place following the government's village merging program to move people closer to roads and other infrastructure facilities (LSUAFRP 2003).

2.5.2. Characteristics of Hmong and Khmu in the village

The Hmong and Khmu groups differ in their historical and current agricultural production methods, including in the amount and type of land and livestock (Table 1). In their traditional villages before migration, generations of Hmong households grew high-value opium and owned cattle as their primary livestock. Cattle are preferred because of their resistance to cold and general tolerance of conditions at higher elevations. Moreover, the Hmong live in

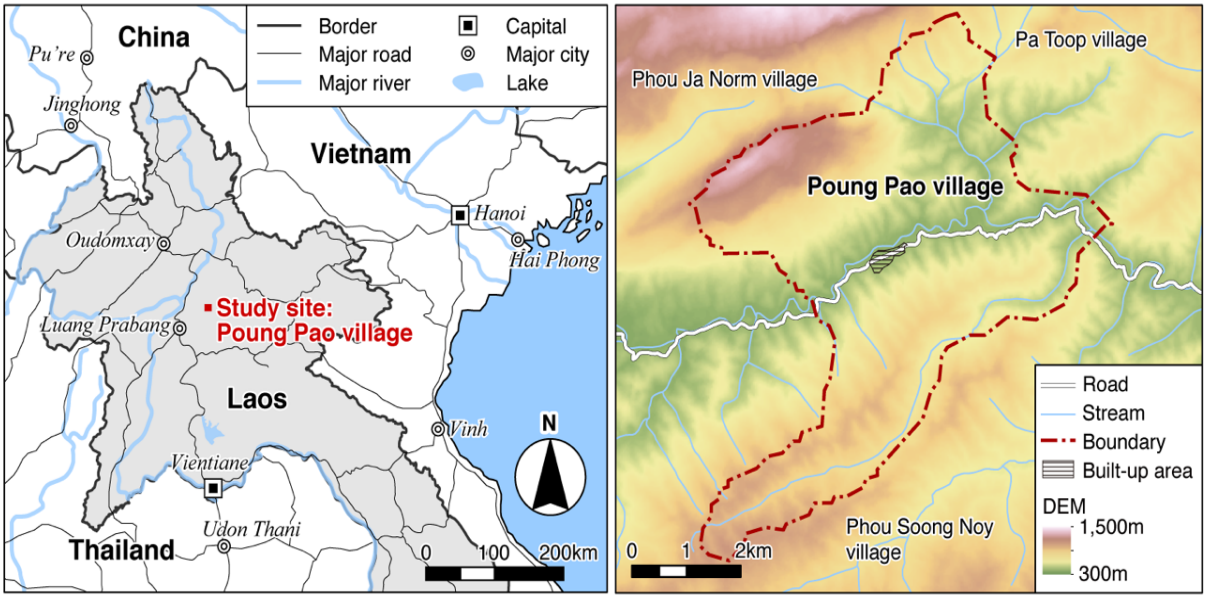

Figure 1 Study site location and surrounding villages.

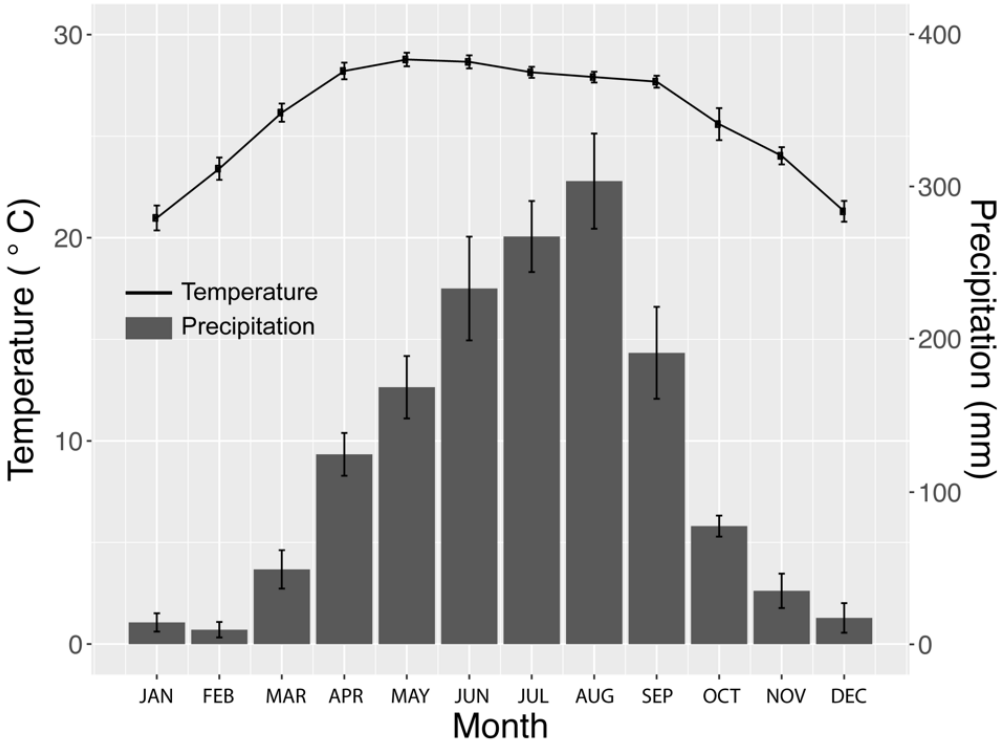

Figure 2 Mean monthly temperature and precipitation from 2004–2015 in Luang Prabang Province.

Table 1 Population, number of total households, and number of sampled households in Poung Pao, grouped by ethnicity

Description	Hmong	Khmu	Lao	Total
Population	518	286	22	826
Total households	79	47	6	132

regions with large grazing areas suitable for cattle. They tend to wish to continue cattle raising on lands in their old village area, and/or areas zoned for cattle production within Poung Pao. Apart from agricultural work, they also wish to provide better education for their children (as they have more opportunities compared to the old village site) so that their children can find better jobs. They acknowledged the importance of holding land for cattle grazing to ensure livelihood security and engaging in other commercial production activities (e.g., rubber and other cash crops) (LSUAFRP 2003).

Khmu people depend on forest products such as wild vegetables, mushrooms, and bamboo shoots. They tend to cultivate (glutinous) rice for subsistence. Some villages produce baskets and knives, while others grow different kinds of sweet potatoes, taro, and vegetables (Vixathep 2011). Khmu households usually raise small livestock (e.g., poultry) because their lower-elevation villages contain less available grazing land (Schlemmer 2002).

These historic settlement preferences make them unique. Hmong households have greater assets and are often more able to buy agricultural land and other necessities when settling in a new village. The Khmu wish to maintain a secure livelihood in the village based on swidden farming combined with off-farm work, some commercial tree crops (e.g., teak), NTFPs, and raising small animals. They have a future interest in large animals (e.g., cows and buffalo) but have few animals at present due to low investment capacity (LSUAFRP 2003).

2.5.3. Village relocation and village merging in the village

According to the government's policy on rural development and poverty reduction through the focal development areas, relocation and village merging aim to provide public services and infrastructure for rural inhabitants. Small villages were merged with Poung Pao, and populations in small villages have been encouraged to live near roads and basic infrastructure. This has drastically changed the ethnic composition in Poung Pao.

In 2005, the Governor's Office planned to relocate several smaller, more isolated villages in Phonxay District in Luang Prabang Province to sites assigned for development (LSUAFRP 2003). These were Pha Toup, Phou Soong Noy and Phou Cha Norm in the high hills surrounding Poung Pao, inhabited by Hmong; they began to migrate to Poung Pao in 2000 according to the district relocation plan (Table 2). Simultaneously, the Opium Elimination Strategy prohibited Hmong households from growing opium in the mountains, causing them to move down to Poung Pao. Meanwhile, Khmu households also immigrated to Poung Pao, drawn by the promise of arable land, electricity, water, and other services. Unsurprisingly, this increased the population concentration, leading to disputes over land use (Jones et al. 2004). According to the relocation plan, some of the inhabitants migrated out. From 1997–1998, the number of Khmu households was 28, of which 16 left before 2003 (LSUAFRP 2003). This movement was confirmed by interviewing villagers, who stated that most Khmu households originally residing in the village had moved to central Laos. Of the 40 Khmu households surveyed in the study, all except five immigrated to Poung Pao after 2000 (Table 2). Most current Hmong households moved from 2000–2004 from villages at relatively high elevations in the surrounding mountains (e.g., Pha Toop, Phou Soong Noy, and Phou Cha Norm) (Figure. 1, Table 2).

2.5.4. Land and forest allocation in the village

The LUPLA Program was established in the early 1990s. Since then, LUPLA has become one of the key elements of Laos' land-use planning system. In its early form – often referred to as Land and Forest Allocation (LFA) – the program involved identifying village boundaries and demarcating land to be conserved or regenerated as forest. The process gradually became more elaborate, involving the individual allocation of agricultural plots to village households, and the zoning and mapping of village land. The individual allocation of

agricultural plots to village households meant that a household gained the land-use right of their agricultural land, particularly for swidden farming (Lestrelin et al. 2012).

The implementation of village relocation/merging and land use planning/allocation restricted the amount of arable land villagers could use, limiting their ability to subsist off of mixed-farming livelihoods. Then, in 2000, each household received TLUCs held at District Agriculture and Forestry Office (DAFO) ranging from 4 to 5 plots per household; 28 Khmu households in Poung Pao were allocated 150 ha of land, which was divided into 133 plots, and the village authority received 437 ha. This is the size that can be allocated to communal grazing zones for crop cultivation and swidden farming for any new households that claim agricultural land (LSUAFRP 2003). These changes led to an emigration of Khmu households, who sold their allocated land to other villagers. One notable consequence of these conflicts was increased cattle mortality, causing the Hmong households to move their cattle back to their original villages (LSUAFRP 2003). At the beginning of village relocation, some Hmong households did not receive any parcels of land (i.e., they have not been able to claim land in their new location). The new residents of Hmong families have acquired land from Khmu households that migrated out. Khmu households in the village claimed that they have fewer plots of agricultural land to use compared to the past. They normally hold more plots. Rotational swidden farming has been reduced because fewer plots were allocated. Some households have problems with the soil quality of agricultural land, so they often claim fertile land in addition to already allocated plots.

2.5.5. The introduction of forage crops in the villages

To address issues related to cattle production, LSUAFRP, a joint rural development effort of the government and the Swedish International Development Agency (SIDA), introduced forage crops and cattle fattening techniques to Poung Pao from 2005–2006. The project freely distributed the seeds of several forage types (Ruzi grass, Napier grass, Stylo

Table 2 History of sample household migration by ethnic group

Year of immigration	Hmong	Khmu	Total
Born in Poung Pao	0	5	5
Before 2000	2	2	4
2000–2004	40	12	52
2005–2009	6	6	12
2010–2015	4	15	19
Total	52	40	92

legume, Guinea grass and Mulato grass), educated villagers on cattle production, and designated a fenced communal field to grow fodder. Cattle were permitted to graze in this field for several months after forage species were established. The villagers were encouraged to fatten their cattle using the cut-and-carry system, whereby cattle are tethered in stalls within the settlement area and supplied with forage. Immediately after these methods were introduced, eight Hmong households started the cut-and-carry system; this number increased to 23 by 2010, whereas other Hmong households employed free-grazing.

2.5.6. Methodology

I used both qualitative and quantitative techniques. I employed the qualitative, flexible, and descriptive approach known as the Participatory Rural Appraisal (PRA), which saves both money and time. It works well in collecting information through a times series (past, present and future situations) to grasp rural conditions, allowing for a comprehensive idea regarding problems, potential, resources and solutions (Chambers 1994). I used a qualitative and quantitative techniques to understand people's livelihoods and livelihood diversifications, as well as changes in livelihood activities. I conducted household surveys and carried out face-to-face interviews with heads of households (or their representatives), who possess a good understanding of their families' composition, migration history, income structure, agricultural practices, land use, livestock raising practices, cash crops, off-farm work, labor allocation, and time spent on livelihood activities. I executed key informant interviews at the village and district levels to realize policies at these levels. I also reviewed the literature on related policy implications, which I expected to influence changes in swidden farming in the upland area, such as those linked to land and forests, village relocation, market integration, and agriculture commercialization. In responding to each research question, I clearly explain the specific methodology and data analysis in each case study in Chapters 3 and 4, respectively.

CHAPTER 3. IMPACT OF FORAGE INTRODUCTION ON CATTLE RAISING AND CROP-LIVESTOCK SYSTEMS

Chapter 3 introduces the case study on crop-livestock systems which demonstrates how land constraints have altered swidden combined cattle grazing systems, while accounting for seasonality; and evaluate the effect of forage crops on grazing systems and cattle productivity. Based on the findings, a plausible future for crop–livestock systems for upland villages in northern Laos was discussed.

3.1. Introduction

Smallholders in Southeast Asia have long relied on the crop–livestock systems that integrate large ruminants, such as water buffalo and cattle, into subsistence-oriented crop farming (Devendra and Thomas 2002; Stür et al. 2002). Upland and lowland rice cultivation results in fallow natural vegetation that is used for extensive free-range feeding. Ruminants provide food protein and labor as draught animals, thus serving as a valuable asset that can act as a safety net for households (Vien et al. 2006). However, smallholders experience livestock feed and water deficiency during the dry season, and restrictions of free grazing in the wet season to avoid crop damage (Devendra and Thomas 2002; Phonvisay et al. 2016).

Regional socioeconomic changes (increasing population pressure on land use, shorter rotations, village resettlement, intensification of cropping, and livestock production) have necessitated fundamental changes to the historical crop–livestock systems (Roder 2001; Bouahom et al. 2004). Population increases in Southeast Asia have led to shorter rotations for swidden agriculture and lower crop yields (Cramb et al. 2009). In an effort to enhance rural economic development and conserve natural resources, each household is now designated a set

amount of arable land, thus limiting the cultivation area (Thongmanivong and Fujita 2006) and raising the population pressure (Jones et al. 2004). Economic development has also focussed on the introduction of cash crops (e.g. rubber-producing plants) to replace the traditional swidden farming. This shift shrinks the fallow vegetation area, and so decreases the amount of land suitable for cattle grazing (Takai and Sibounheuang 2010). Simultaneously, the region has seen an increase in demand for beef and a concurrent rise in cattle prices. As a result, cattle farming has become an increasingly important income source for smallholders (Huyen et al. 2010).

The inevitable land-use conflicts between large ruminant farming and cash crop cultivation are causing multiple issues in northern Laos. For example, the number of water buffalo has decreased (Takai and Sibounheuang 2010), and some buffalo owners have been forced to sell their livestock in order to avoid conflict with rubber plantation owners. This problem has exacerbated as the Lao government implemented land-use zoning to stabilise swidden farming, diminishing the fallow forests where water buffalo were allowed to graze freely. Indeed, smallholders in Laos had difficulties expanding their holdings because of these land constraints (Harding et al. 2007). It is difficult for the traditional Lao crop–livestock systems to co-exist with the shifting land uses occurring under modernisation.

One potential solution is to change cattle grazing systems through the introduction of forage crops that can be used for intensive grazing by livestock and reduce the amount of labor required to collect wild vegetation (Millar and Photakoun 2008). Changes in feed directly affect cattle health and bodyweight (Peters et al. 2001). On-farm fattening experiments conducted in northern Laos demonstrated that the farm-fattened cattle had growth rates eight times higher than the free-range cattle (Nampanya et al. 2014). Studies from Vietnam, where farmers are increasingly using forage crops, indicate that stall feeding and fattening techniques (cutting

and carrying forage to penned livestock) have decreased the need for labor and have improved cattle productivity (Huyen et al. 2010; Stür et al. 2013).

Lao farmers employ a variety of pasture management practices, cattle raising methods, and seasonal combinations to ensure sufficient feed sources (Phonvisay 2013). However, few studies have examined variation in grazing systems across wet and dry seasons in relation to cattle productivity (Pravongviengkham 1998; Horne and Stür 1999; Nakatsuji 2010; Takai and Sibounheuang 2010; Shirai and Yokoyama 2014; Phonvisay et al. 2016).

This chapter aims to investigate the relationships between multiple grazing systems and cattle performance. First, I demonstrate how land constraints have altered cattle grazing systems, while accounting for seasonality; second, I evaluate the effect of forage crops on grazing systems and cattle productivity; and finally, based on our findings, I discuss a plausible future for crop–livestock systems for upland villages in northern Laos.

3.2. Methods

I applied a mixed research methodology (including quantitative and qualitative methods). A focus group discussion with the village committee and cattle raiser group was conducted in May 2016 to obtain the viewpoints of the villagers with regard to their livelihoods. Semi-structured household interviews were then conducted in August 2016 with 92 out of the 132 households in the village were randomly selected households who are available in the villages at the time of survey and willingly to interview (Table 3).

Households were interviewed regarding the composition of the family, migration history, sources of income, agricultural practices (swidden farming, plantation of rubber, teak, cash crops), and land use. The income sources were grouped into four categories: cattle, other livestock, cash crops, and off-farm work. All cattle were of the indigenous yellow breed widely domesticated throughout East and Southeast Asia (Namikawa et al. 2000; Wilson 2007) and

Table 3 Population, number of total households, and number of the sampled households in Poung Pao, grouped by ethnicity

Description	Hmong	Khmu	Lao	Total
Population	518	286	22	826
Total households	79	47	6	132
Sampled households	52	40	0	92
Households with cattle	51	8	0	59
Households without cattle	1	32	0	33

genetically closest to the Vietnamese local cattle (Nomura et al. 2000). Other livestock included buffalos, pigs, poultry, and goats. The cash crops consisted of Job's tears, sesame, maize, and rubber. The off-farm income involved hired labour for agricultural work, collecting non-timber forest products, construction, trading, and salaries or pensions from previous work. The swidden farming practices, forage cultivation, and land acquisition methods such as inheritance, purchasing, rent, and allocation were also recorded.

In August 2017, data on the heart girths, age, sex and owner identity of 231 cattle were collected. The measurements were made for all cows in a household, if there were five or fewer cows in the household. If there were more than five cows in a household, I randomly selected only five and measured.

Household incomes in 2016 were compared with household incomes in 2003. The income data for 2003 included data for 17 households (five Hmong and 12 Khmu) (LSUAFRP 2003). The data collection in 2003 and 2016 were done by the author using the same method.

In addition, I classified the cattle grazing systems prevalent in the village using three major components based on the previous studies conducted in Lao PDR (Table 4). Free-range cattle are free-grazing and this was the most popular feeding type (Table 4). Previously, land-sharing has been relatively common between groups of villagers within a village, and between villages in a region (Pravongviengkham 1998; Takai and Sibounheuang 2010). More recently, some land-owning households have taken action to exclude other households from using their land, e.g. by fencing pasture land to exclude free-ranging cattle (Phonvisay et al. 2016) Additionally, villagers have enclosed land in order to: grow forage (Phonvisay et al. 2016); prevent cattle from feeding on cash crops (Takai and Sibounheuang 2010); and prevent thefts and wild-animal attacks on livestock (Pravongviengkham 1998; Nakatsuji 2010). Overall, I

Table 4 Summary of published data on the cattle-grazing systems in Lao PDR

Classifi-cation	Feeding method	Land-use population unit	Land type	References
LA01	Free-ranging	Region, village, or within-village group	Fallow and natural vegetation	Pravongviengkham (1998); Phonvisay et al.(2016); Takai and Sibounheuang (2010); Shirai and Yokoyama (2014)
LA02	Free-ranging	Region, village, or within-village group	Fenced-fallow and natural vegetation	Pravongviengkham (1998); Phonvisay et al.(2016); Nakatsuji (2010)
LA03	Free-ranging	Region, village, or within-village group	Fenced pasture	No published data available (N/A)
LA04	Free-ranging	Household	Fallow and natural vegetation	N/A
LA05	Free-ranging	Household	Fenced-fallow and natural vegetation	Pravongviengkham (1998); Phonvisay et al.(2016)
LA06	Free-ranging	Household	Fenced pasture	N/A
LA07	Cut-and-carry	Region, village, or within-village group	Fallow and natural vegetation	Pravongviengkham (1998)
LA08	Cut-and-carry	Region, village, or within-village group	Fenced-fallow and natural vegetation	Pravongviengkham (1998)
LA09	Cut-and-carry	Region, village, or within-village group	Fenced-pasture	Phonvisay et al. (2016)
LA10	Cut-and-carry	Household	Fallow and natural vegetation	N/A
LA11	Cut-and-carry	Household	Fenced-fallow and natural vegetation	Pravongviengkham (1998)
LA12	Cut-and-carry	Household	Fenced pasture	Phonvisay et al. (2016); Millar and Photakoun (2008)
LA13	Herding	Region, village, or within-village group	Fallow and natural vegetation	Phonvisay et al. (2016); Pravongviengkham (1998); Takai and Sibounheuang (2010)
LA14	Herding	Region, village, or within-village group	Fenced-fallow and natural vegetation	N/A
LA15	Herding	Region, village, or within-village group	Fenced-pasture	N/A
LA16	Herding	Household	Fallow and natural vegetation	N/A
LA17	Herding	Household	Fenced-fallow and natural vegetation	N/A
LA18	Herding	Household	Fenced pasture	N/A

classified 18 different systems in Laos based on the feeding methods, land-use population unit, and land type, nine of which were novel (Table 4). These systems were then considered in the context of seasonality between the wet and dry seasons.

To test the influence of grazing systems on cattle productivity, I used analysis of variance (ANOVA) and a generalised linear model with t-tests. Heart girth is a predictor of liveweight and was, therefore, used as an index of cattle bodyweight (MacDonald et al. 2008; Lukuyu et al. 2016). All data were analysed in R 3.4.0

3.3. Results

3.3.1. Changes to household income structure

Compared with 2003, the total income of villagers was over two times greater in 2015 (Figure 3), showing that the villagers are increasingly taking part in the market economy. This rise marks a shift from their engagement in diverse activities for livelihood to a greater reliance on cash-earning, specifically on cattle production and off-farm jobs.

An income disparity grew between the Hmong and Khmu groups during this period. By 2015, Hmong households earned on average 1.8 times more than Khmu households, largely because Hmong households increased cattle production. The Khmu men worked more often as agricultural laborers and construction site workers in urban areas. Most Khmu households did not keep cattle. The income from cash crops did not change much during this period.

3.3.2. Differences in land use and number of cattle

The overall landholding size was significantly larger and land use more diversified in the Hmong households than in the Khmu households (Table 5). The average size of the land owned by the Hmong households (6.8 ha) was 2.8 times larger than that owned by the Khmu

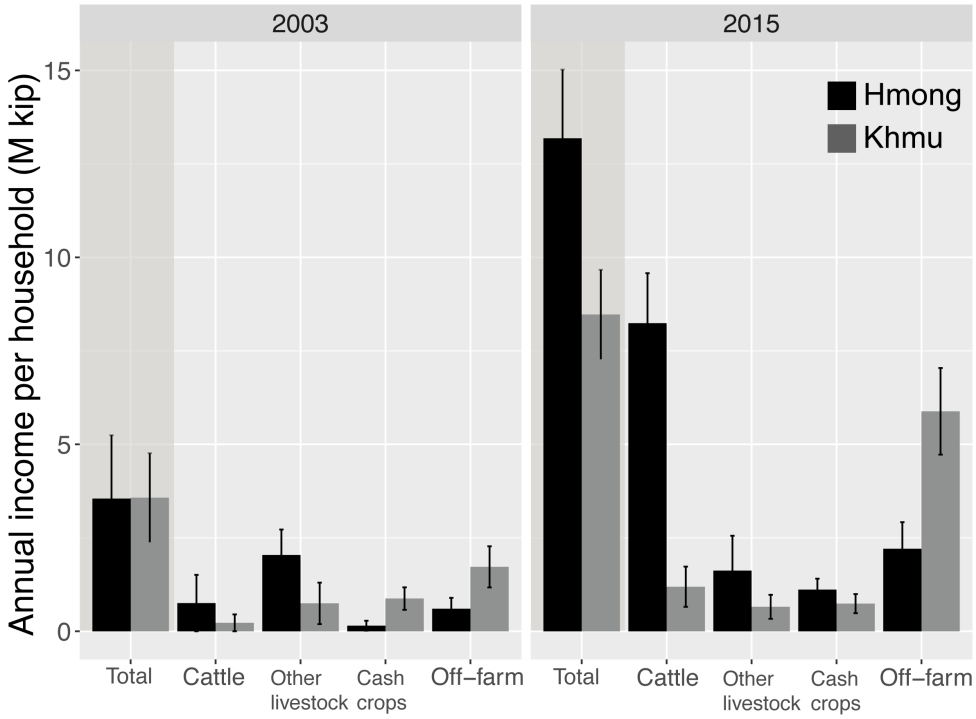

Figure 3 Changes in the income structures of the Hmong and Khmu households between 2003 (LSUAFRP, 2003) and 2015.

The income was adjusted by the World Bank's consumer price index (CPI, 2010 = 100) (http://data.worldbank.org/indicator/FP.CPI.TOTL?end=2015andlocations=LAandstart=1988andview=chart).
(M Kip = million kip; kip is the Lao currency)

households (2.4 ha). Hmong households also held more land plots (on average 3.9 plots) than the Khmu households (on average 1.6 plots) (Table 5) The land area used for pasture, rubber, and teak plantations was significantly greater for Hmong households, but area used for swidden farming was not significantly different between Hmong and Khmu households (Table 6). The Hmong households invested in a wider range of crops, whereas Khmu focussed almost entirely on swidden farming (86% vs 42% for Hmong). In addition, over half of the Hmong households grew forage in at least one field, using 37% of their land on average, whereas most Khmu households did not grow forage at all (Table 6).

Most Hmong households (79%) raised cattle significantly more than the 20% of Khmu households that raised cattle (Table 5). Among the households that raised cattle, the herd size difference was not significant. Both ethnic groups primarily acquired land through the village authority and purchases from other households at or before migration (Table 6). In addition, the Hmong households made post-migration land purchases for forage cultivation.

3.3.3. Cropping schedules of upland rice and forage crops

Upland rice was grown through swidden farming with a two-year fallow period, and with households normally owning three plots of upland rice fields and farmers rotating rice cultivation among the three plots (Figure 4). Both Hmong and Khmu households conducted land preparation and seeding before the wet season and harvested after the wet season. Additionally, both groups fenced fields to protect upland rice from cattle grazing and destructive wildlife such as boars. Overall, the two ethnicities did not differ in their cropping schedules. During the fallow period, farmers did not weed the fields or apply fertilizer; cattle were allowed to graze freely in the fallow fields.

As of 2016, only Napier grass (*Pennisetum purpureum*), Ruzi grass (*Brachiaria ruziziensis*) and Guinea grass (*Panicum maximum*) were being grown as forage crops in the

Table 5 Mean (± standard error) number of the Hmong and Khmu households engaging in various land uses and cattle production

	Hmong	Khmu
Land use		
Number of households	52	40
Landholding size (ha)		
Total	6.8 ± 0.6[a]	2.4 ± 0.4[b]
Swidden	2.4 ± 0.3	2.0 ± 0.4
Pasture	3.1 ± 0.4[a]	0.2 ± 0.1[b]
Rubber	1.0 ± 0.2[a]	0.1 ± 0.0[b]
Teak	0.2 ± 0.1[a]	0.1 ± 0.0[b]
Other	0.0 ± 0.0	0.1 ± 0.0
Cattle raising		
Number of households	50	8
Herd size	8.1 ± 0.1	5.8 ± 2.0

Within columns, means followed by different letters indicate differences (95% confidence level)

Table 6 Amount of arable land and its ratio to the number of households and the total amount of land, separated by ethnic group

	Hmong							Khmu						
	Total amount of land (plots)	% land/ household (N = 52)	% land/ total land	% swidden/ total land	% forage/ total land	% rubber/ total land	% teak/ total land	Total amount of land (plots)	% land/ household (N = 40)	% land/ total land	% swidden/ total land	% forage/ total land	% rubber/ total land	% teak/ total land
Inheritance	9	0.2	4.4	2.9	1.0	0.5	0.0	1	0.0	1.6	0.0	1.6	0.0	0.0
Allocation	88	1.7	43.1	13.2	21.6	8.3	0.0	36	0.9	56.3	48.4	1.6	1.6	4.7
Purchased at or before migration	76	1.5	37.3	25.0	0.0	10.8	1.5	24	0.6	37.5	34.4	0.0	3.1	0.0
Purchased after migration	30	0.6	14.7	0.0	14.7	0.0	0.0	1	0.0	1.6	0.0	1.6	0.0	0.0
Rent	1	0.0	0.5	0.5	0.0	0.0	0.0	2	0.1	3.1	3.1	0.0	0.0	0.0
Total	204	3.9	100.0	41.7	37.3	19.6	1.5	64	1.6	100.0	85.9	4.7	4.7	4.7

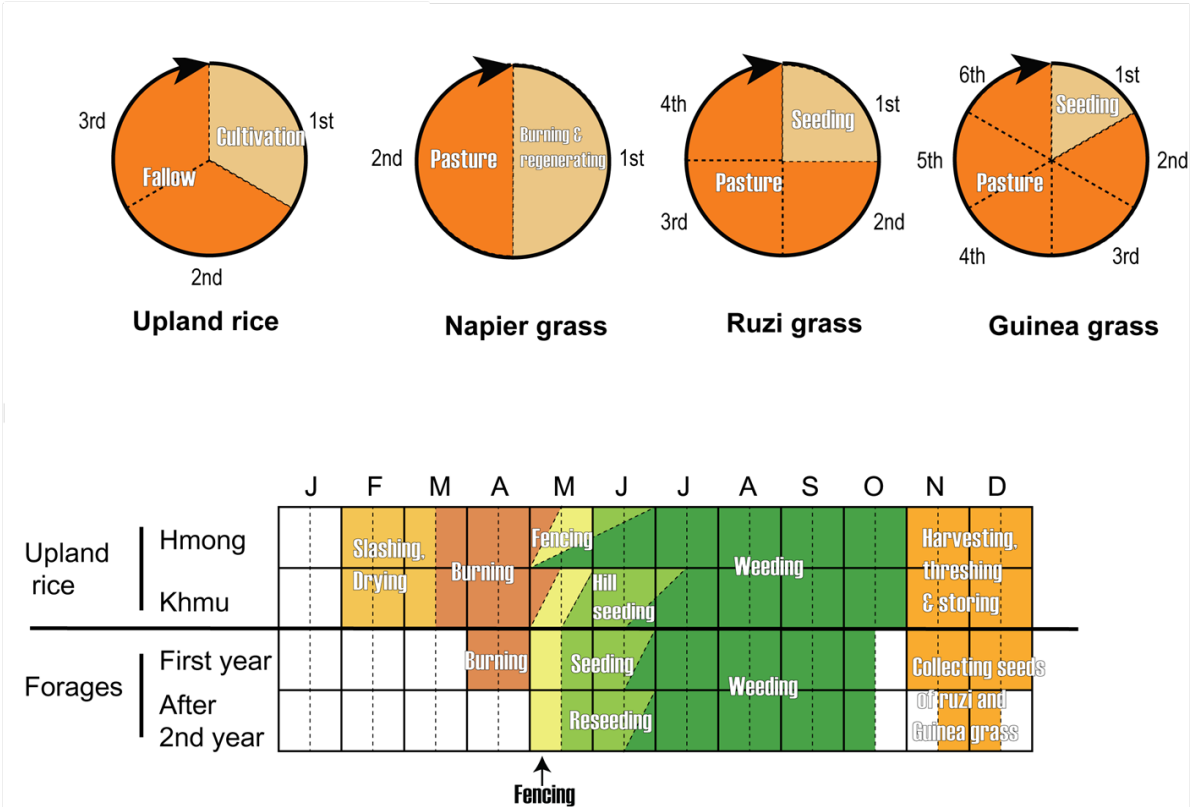

Figure 4 Yearly cropping schedules (top) and cropping calendars (bottom) of upland rice and forage crops.

village. The Hmong households indicated that they had grown only Napier grass as a forage crop in their natal villages and were introduced to the other two forage crops through LSUAFRP.

Forage crops differed significantly in the years of pasture use, but not in the cropping calendars (Figure 4). During the first year, all three forage crops were seeded after the commencement of the wet season, weeded for a few weeks, and grown to grazing-suitable pasture by November. The Ruzi and Guinea grasses can be used as pastures for three to five years (if properly managed with fence repair, reseeding, and weeding) after which farmers have to clean and regrow them. Because the Napier grass pastures must be burned for regeneration every two years, farmers need to replant Napier grass in areas where the Napier grass has died out. Although the Napier grass appeared to require more labor, villagers were accustomed to grow the Napier grass and found its management easy. The labor competition between upland rice and forage cultivation was higher during the wet season than during the dry season.

3.3.4. Types of cattle grazing systems

Five cattle grazing systems (Table 3) were identified during the last decade: system A, free-ranging in fallow and natural vegetation (LA01) in both seasons; system B, wet-season free-ranging in fenced-fallow (LA02) + dry-season LA01; system C, wet-season rotational grazing in fenced pasture + dry-season LA01; system D, rotational grazing in fenced pasture in both seasons; and system E, cut-and-carry (LA12) in both seasons (Figure 5). System E was the stall-feeding method introduced by LSUAFRP. As of 2016, systems B, C, and D were still active. Of the feeding types reported in previous studies (Table 3), only free-range grazing was still in use. In addition, system C (rotational grazing) was becoming predominant. Some villagers still use the LSUAFRP-introduced communal land for cattle grazing.

The national road to Luang Prabang separates Poung Pao into the north and south

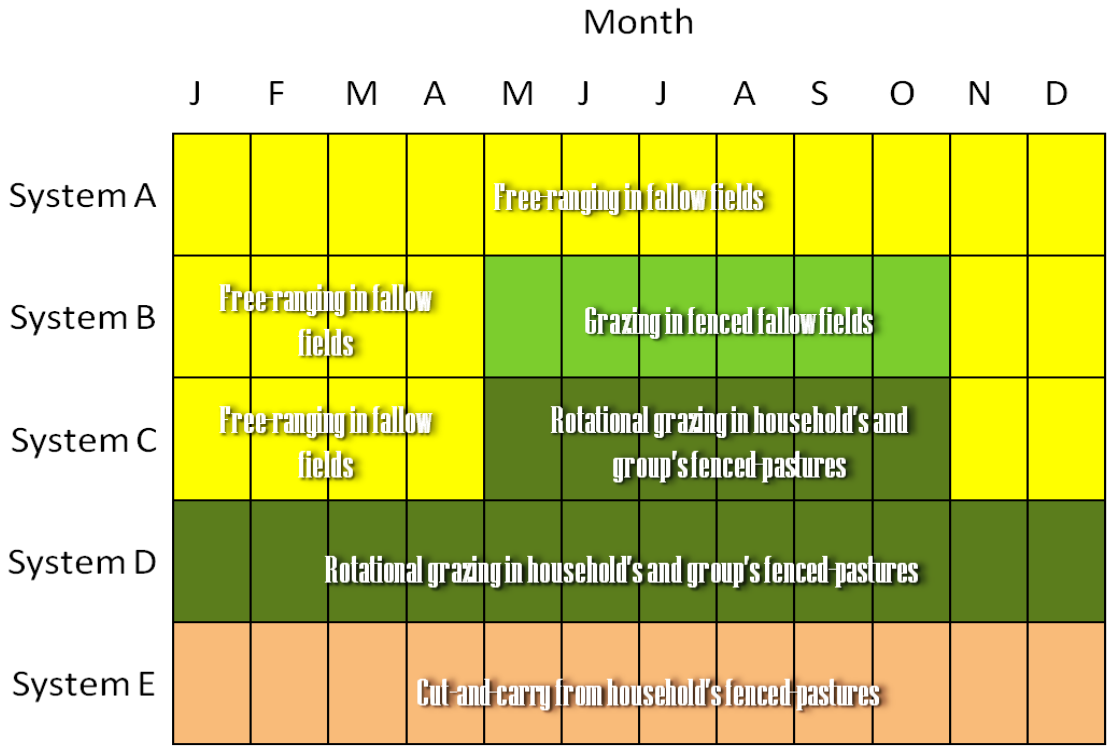

Figure 5 Types of cattle-grazing systems in use at Poung Pao.

portions. The Hmong group uses the land to the north of the road, whereas the Khmu group uses the land to the south of the road. The group-managed fenced pastures were present in the Hmong natal villages (e.g. Pha Toop, Phou Soong Noy and Phou Cha Norm), located within a radius of ~4 km from Poung Pao. Only the households that originated from these villages were allowed to use the fenced pastures. Although I did not observe a clear relationship between household landholdings and forage crops, the Napier grass was more likely to be grown in the group-managed fenced pastures.

Previous studies in Laos did not mention rotational grazing. In the present study, I found that the Hmong group rotated their cattle among the household-managed and group-managed pastures during the wet season (system C) or across both the wet and dry seasons (system D). Villagers reported moving cattle to another pasture when the forage in one pasture had been completely grazed; the pasture fields are then fenced, and the forage regrown (Figure 6).

Although cattle were vaccinated in all grazing systems, villagers employing system B vaccinated only the cattle that showed signs of infection. More attention was paid to cattle health in systems C and D. According to the respondents, system D was the most labor-intensive (based on forage crop cultivation and yearly cattle grazing schedule), followed by systems C and B. The cattle numbers in each of the grazing systems B, C and D were 48, 224, and 181 respectively.

Most Hmong households employed systems C and D (Table 7). Only 15% of the total sampled households raised cattle using system B, and the majority of these were Khmu. The cattle density differed significantly between systems C and D ($P < 0.05$), but not between systems B and D. The significant difference was attributable to the increased amount of cattle raised under system C, despite a greater ratio of pasture size to the total landholding size in system D. However, the pasture size and number did not significantly differ between systems

(a) Pasture field of Napier grass

(b) Cattle in fenced pastures field

Figure 6 Pastures field at Poung Pao.

Source: Taken by author in 2016.

C and D. Furthermore, three systems (B, C and D) had similar herd size and cattle per laborer (Table 7). I also observed that the group-managed fenced pastures in natal villages of Hmong were able to considerably improve the rotational grazing capability. In systems C and D, even households with no pastures or only a single pasture could rotate their cattle among these group-managed pastures.

3.3.5. Changes in cattle grazing systems

The Hmong and Khmu groups differed significantly in the changes made to their cattle grazing systems. In 2000, most households either raised cattle using system A or had no cattle, regardless of their ethnicities (Figure 7). Since 2004, the Hmong households increasingly began to use systems B, C, D and E; there was also a decrease in the use of system A and in the number of households not raising cattle. By 2016, systems A, B and E were used considerably less than systems C and D. Many households stopped using system E because it was easier to graze in a fenced area than use the cut-and-carry (system E). Another reason why respondents felt that the extra effort involved in cut-and-carry was not justified, was the difference in price when the cattle were sold. In contrast to the Hmong households, the proportion of no-cattle households among the Khmu households remained consistent during 2000–2016. However, the use of system A declined among the Khmu households from 2006 until it was completely replaced with system B or C by 2016. The reason for the decline in use of system A was because the land area became more limited as the area occupied by rubber and other cash crops increased in the village. Therefore, villagers assigned and fenced-fallow and fenced pastured for cattle grazing. Of the studied households, two households stopped cattle production entirely because all cattle had died or were sold.

In summary, the Hmong households drastically changed their production strategy over

Table 7 Variation in the land-use characteristics of the Hmong and Khmu households across the cattle-grazing systems

System	Number of households		Herd size	Number of laborers	Total land size (ha)	Swidden (ha)	Number of pastures	Pasture size (ha)	Cattle per laborer	Cattle density (herd size/pasture size)	Pasture size/total land size
	Hmong	Khmu									
B	3	7	4.8 ± 1.6	2.8 ± 0.3	1.9 ± 0.4[a]	1.7 ± 0.4	0[a]	0[a]	1.7 ± 0.5	2.5*	-
C	27	0	8.3 ± 1.2	3.5 ± 0.3	6.9 ± 0.8[b]	2.4 ± 0.4	1.5 ± 0.2[b]	3.0 ± 0.6[b]	2.6 ± 0.4	3.8 ± 0.4[a]	0.4 ± 0.0[a]
D	20	1	8.6 ± 1.5	3.6 ± 0.8	7.5 ± 1.1[b]	2.4 ± 0.4	1.7 ± 0.2[b]	4.2 ± 0.6[b]	2.6 ± 0.4	2.5 ± 0.4[b]	0.6 ± 0.1[b]

* estimate based on size of fenced fallow fields in the wet season (10 ha)

B: Free-ranging at fenced-fallow (LA02) in wet-season + free-ranging at fallow and natural vegetation (LA01) in dry-season
C: Rotational grazing at fenced pasture in wet-season + LA01 in dry-season
D: Rotational grazing at fenced pasture in both seasons
Within rows, mean ± standard error with different superscripted lowercase letters indicates significant difference (95% confidence)

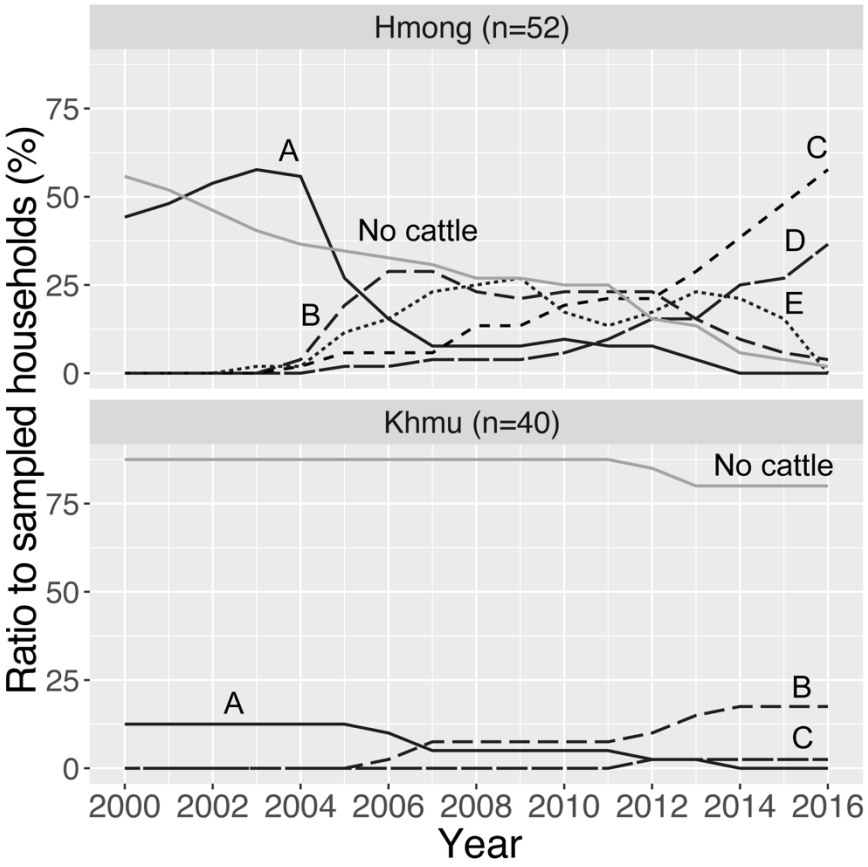

Figure 7 Changes in the use ratio of cattle-grazing systems (described in Figure 5) among the Hmong and Khmu groups.

the 17-year analysis period, experimenting with several systems before selecting C or D. Furthermore, some households with no cattle also participated in these two systems because they used to have cattle before 2016. In contrast, the Khmu households showed an overall simpler trend of shifting from system A to system B (Figure 7) because Khmu households engaged in swidden farming and have no forage fields.

3.3.6. Differences in cattle growth among grazing systems

As expected, there was a difference in the growth rate of male and female cattle, with males growing faster than females by age four (Figure 8). Beginning at age three, female heart girth remained consistent at ~1.4 m as they reached maturity. Sex differences among older cattle could not be compared because the village had no males older than five years; the bulls were typically sold when they were approximately four years old, whereas the cows were kept until they were 12 years old.

Heart girth among cattle aged one to four was significantly related to their age, sex, and the ethnicity of the households that owned the cattle, but not to the grazing system or socioeconomic variables, implying the rejection of our hypothesis, which proposed that different grazing systems may lead to differences in cattle productivity (Table 8). The Khmu households tended to have cattle with heart girths larger than those owned by the Hmong households. Although the pasture size had no significant effect on cattle growth, the positive effect of number of pasture plots trended towards significance (P = 0.0801); this may be because Khmu cattle were fewer in number and they were free grazing in the fallow-fenced area, where natural grass was grown, whereas Hmong households have more cattle and grazed in assigned and fenced areas.

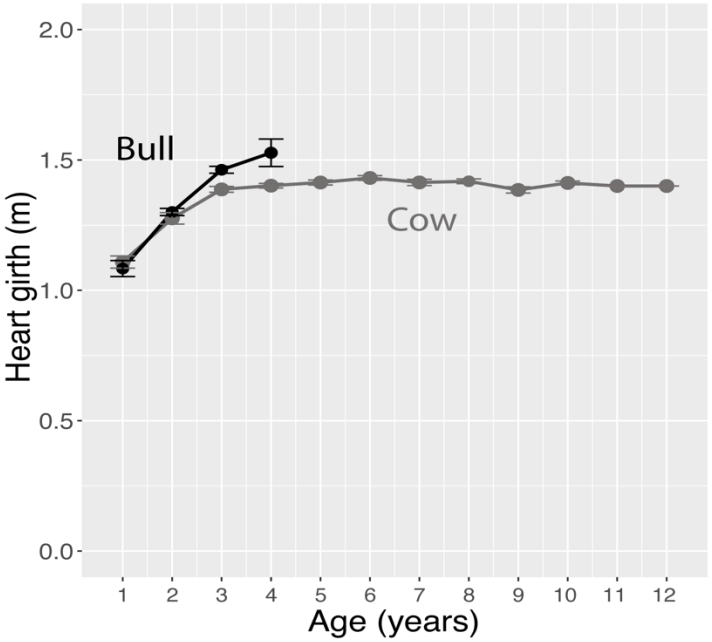

Figure 8 Growth of male and female cattle as indicated by their heart girths.

Table 8 Results of generalized linear model examining variables affecting cattle heart girth as a proxy for growth (n = 138).

	Estimate	Standard error	*t* value	Pr (>|t|)
(Intercept)	86.28404	6.11553	14.109	$< 2.0 \times 10^{16}$
Variables related to cattle heart girth				
Cattle age	1.05747	0.06746	15.676	$< 2.0 \times 10^{16}$
Female	*--Reference category for the male--*			
Male	4.9929	1.9346	2.581	0.0110
Grazing system variables				
System B	*--Reference category for the system C and D--*			
System C	-0.45421	3.99089	-0.114	0.9096
System D	3.06883	3.68457	0.833	0.4065
Cattle density	0.70163	0.57553	1.219	0.2251
Socioeconomic variables				
Hmong	*--Reference category for the Khmu--*			
Khmu	10.77809	4.57176	2.358	0.0199
Labor force	0.91198	0.66253	1.377	0.1711
Number of pastures	1.57136	0.89052	1.765	0.0801
Pasture size	0.18158	0.63376	0.287	0.7750

3.4. Discussion

It is clear that the livelihoods strategies of Hmong and Khmu have been changed as a result of the change of land availability and market intervention and cash crops replacement to swidden farming. The household are diversified and engage in livelihoods activities as their availability of asset endowment which streamline from their livelihood history. With regards to the changes, I indicate the modification of livelihood activities focusing in cattle raising systems those upland households adapted in order to response to the changes and constraints they confronted and the impact of those modification of cattle raising systems. These responsive strategies coping with constraints are seen as important massages that could be an applicable strategy for future upland development agenda at where the similar condition is in place.

3.4.1. Responses to land constraints under rising beef prices

The Hmong and Khmu groups differed noticeably in their responses to rising beef prices, which increased from 34 139 Lao kip/kg in January 2010 to 66 256 Lao kip/kg in January 2015 (Lao Statistics Bureau 2011, 2016). The Hmong households diversified their livelihood portfolios, building on their cattle production and other forms of commercial farming (e.g. rubber plantations) to supplement swidden farming of upland rice. In contrast, the Khmu households focussed on subsistence-oriented swidden farming and off-farm work, without increasing cattle production. In the villages of origin, the Khmu households generally had fewer assets and earned less than Hmong households.

In conjunction with their diversified portfolio, the Hmong households were more likely to purchase extra land for forage cultivation. The households of both ethnicities received identical-sized plots upon arrival in the village, but the Hmong group purchased land from the

Khmu group after immigration. As a result, the landholding area was significantly larger among the Hmong households than the Khmu.

However, neither ethnic group possess enough land for maintaining their livelihood, as the village authority limits the total area that can be officially allocated to them. Villagers stated in their interviews that the field rotation for upland rice cultivation occurs in a three-year cycle (two-year fallow period followed by rice cultivation). However, neither the Hmong nor the Khmu households had sufficient land (the Hmong had an average of 6.8 ha of land in an average of 3.9 plots; the Khmu had an average of 2.4 ha of land in an average of 1.6 plots) for swidden farming, unless the communal or unallocated land is also used for cattle grazing. In addition, the village does not contain enough pastures for effective rotational cattle grazing; for instance, many Hmong households own less than two plots for forage cultivation in Poung Pao and must supplement with communal lands in their natal villages where they cultivated forage. A clear negative consequence of this situation is the expansion to unauthorised land, such as conservation forests, widely observed in upland villages in northern Laos (Pravongviengkham 2004).

The distinctly different responses of the Hmong and Khmu groups were more attributable to their livelihood history than to ethnicity. The Khmu households did not have communal lands for rotational grazing or saved capital from lucrative agricultural businesses (e.g. opium cultivation and cattle herding reported in LSUAFRP 2003), as the Hmong households did in their natal villages. Thus, the Khmu have few options besides selling their land and focusing on off-farm work to earn their livelihoods.

3.4.2. Changes to cattle grazing systems

The principal driving forces of changes in crop–livestock systems are natural resources, population pressure, urbanisation, and market opportunities. These driving forces

have also been reported in studies in West Africa (Fernández-Rivera et al. 2004). For example, in the Harar Highlands of Ethiopia, as more land is used to grow cash crops, farmers lease out or sell animals instead of overstocking animals on the smaller areas of land available for grazing (Kassa et al. 2002). In Laos, the diminishing available land and raising opportunity to export beef to Vietnam and China are likely a major impetus for the observed changes in cattle grazing systems. As the population of Poung Pao rose sharply during 2000–2004, a corresponding limitation of the natural grazing area negatively affected rice production as free-ranging livestock use the upland fields as grazing area (Takai and Sibounheuang 2010). As confining the cattle was the easiest way of preventing crop damage, the Hmong households drastically decreased their use of free-range grazing beginning in 2004 and switching to the fenced-in fallow fields during the wet season. Further, to mitigate over-grazing under confinement, the Hmong farmers also included forage crops and rotational grazing. The latter method reducing the grazing pressure and necessary pasture size compared with continuous grazing (Hart et al. 1993). However, the pastures included in rotational grazing were located in the Hmong natal villages, and the long travel distance and extra effort could outweigh any positive effects on weight gain for the cattle (Hart et al. 1993).

The swidden farming system (in which the land is ‘slashed and burned’ and then primarily planted with rice followed by upland rice fallow) provides a significant grazing area during dry season, which allows the villagers to feed cattle throughout the year. During the dry season, the free-range grazing resulted in a higher number of cattle, whereas the rotational grazing increased the ratio of the pasture size to the total landholding size. The two systems did not differ in pasture size or number. These results suggest that fallow fields hold larger numbers of cattle. Contrary to expectation (e.g. Horne 1998), growing forage in the dry season did not increase the herd size unless farmers made hay or silage. Indeed, compared with fallow vegetation, the forage crops improved fodder quality as well as quantity in the wet season, but

did not improve fodder uptake during the dry season. This finding was a part of the reason why the cut-and-carry system had fallen out of favour by 2016, and had largely been replaced with rotational grazing. Another factor that contributed to this change was labor intensity. Villagers found that the cut-and-carry system required more labor than free grazing. This contradicts previous suggestions that the cut-and-carry system was relatively less labor-intensive for livestock (such as pigs, cattle and goats) that needed supplementary fodder in the dry season especially in lowland villages (Millar and Photakoun 2008; Stür et al. 2013).

3.4.3. Effects of forage crops and rotational grazing on cattle productivity

Differences in grazing systems (e.g. pasture size and number) did not affect the cattle body size, with only age and sex being significant factors. This result implies that the pastures and fallow vegetation are equally effective in maintaining cattle; however, there is potential to increase the cattle performance if the cattle are properly fed, e.g. by intensive fattening. Therefore, forage crops should contribute to maintaining, and possibly increasing, cattle body size, even if the fallow grazing area decreases. In addition, the lack of a relationship between pasture plot number and body size could be ascribed to the intervening effects from the increased travel distance to pastures and water (Hart et al. 1993). Monitoring cattle grazing behaviour via GPS might, therefore, contribute to improving grazing systems (Turner et al. 2000; Shirai and Yokoyama 2014).

Cattle, particularly bulls, in the study village have the potential for weight increase. The domestic yellow bulls and cows in Laos can weigh up to 600 and 400 kg respectively (Wilson 2007). Further, the liveweight of a bull at age four is ~200 kg, whereas a mature cow weighs only 180 kg (MacDonald et al. 2008). The use of the cut-and-carry fattening methods also warrant more consideration in terms of increasing cattle productivity (Nampanya et al. 2014); in northern Vietnam, the same breed of cattle supplemented with cut-and-carry forage

grew to 220–230 kg at the age of four years (Huyen et al. 2011). However, market push, government support and a cost–benefit analysis that considers villager descriptions of increased labor must be performed before expending more effort on encouraging the cut-and-carry system or maintaining free-grazing (Phonvisay 2013).

Overall, the swidden farming-based grazing resulted in the highest cattle holding, an outcome that seems linked to the increased labor intensity of maintaining rotational grazing all year long compared with grazing on fallow fields with larger areas. Thus, even if the rising beef prices appear to offset productivity decreases, increased labor requirements and decreased soil fertility were observed under rotational grazing because this system in the fenced pasture plots puts more pressure on soil as there is a shorter duration for soil nutrient recovery (Roder et al. 1995). However, if rotational grazing is allowed in assigned areas, the soil would receive nutrients in the form of manure. This might diminish the actual economic return from cattle raising efforts because the poor soil leads to relatively less forage biomass, which in turn affects cattle performance. Moreover, the labor shortages per household do not seem to be an issue in Poung Pao, in contrast with other studies concerning cattle production in northern Vietnam (Huyen et al. 2010). However, more research on the exact time allocation of household labor on cattle production would provide further insight into the division of labor and existence of potential shortages.

3.4.4. Changing crop–livestock systems

The different forms of crop–livestock systems are decreasing or increasing in popularity in the study village as land quotas, an increasing population, and changing economics force households to alter their land-allocation strategies and use unallocated lands. In particular, the introduction of cash crops has reduced the land available for subsistence-based swidden farming of rice and cattle grazing. Of the five systems developed to use the

remaining land, the systems that incorporate forage crops (i.e. system C) have become more popular because rotational grazing is employed in forage pastures only during the wet season, with the supplementation of free-range grazing on fallow vegetation in the post-harvest dry season. This method successfully maintains both upland rice and cattle production, while increasing the cattle holding capacity of the village. In contrast, the systems dependent on grazing in fenced fields (systems B and D) are becoming less popular. This is probably due to increasing tensions between rice and cattle production during the wet season. Specifically, the emphasis of system B on grazing in fallow fields limits cattle production, as the land is already being used for rice cultivation. Likewise, the focus of system D on the year-long pasture grazing prevents that land from being converted to rice fields. As seen in the Khmu households, the land constraints and rising cattle prices can limit cattle production among smallholders, whereas the upland rice production excludes the land from being used for cattle grazing and vice versa. In systems where the cattle graze only on fallow vegetation, a shortened fallow period that degrades the fallow fields also limits cattle productivity, increasing the difficulty of maintaining such systems.

Crop–livestock systems have long provided food security and have a continued potential to mitigate the adverse effects of the changing market conditions in northern Laos (Nie et al. 2016). Declines in such systems to simply favour intensifying cattle production could increase smallholder vulnerability to a fluctuating market. Furthermore, animal wastes from intensive industrial livestock degrade environment quality (Naylor et al. 2005). Thus, future studies should expand their focus from profitability to include the investigations of food security and household safety nets. In addition, the efficiency of resource use (e.g. circulation of raw materials) across various crop–livestock systems should be compared for a better evaluation of livelihood sustainability.

3.5. Chapter summaries

The traditional free-range, swidden-based grazing system in Poung Pao village of northern Laos has evolved under increasing pressure from land constraints and changing market economy. The three systems that have emerged include: (1) grazing fenced fallow vegetation during the wet season; (2) rotational grazing in pastures during the wet season; and (3) rotational grazing in pastures during both dry and wet seasons. None of the systems increased cattle body size but the system that integrated pastures and swidden farming successfully increased the grazing capacity, and balancing crop and cattle production in the context of land constraints. Therefore, the rising financial costs of cattle production prevented households that did not have savings from raising cattle, leading to a wide disparity in annual income and landholding size.

CHAPTER 4. SMALLHODER'S LABOR ALLOCATION FOR LIVELIHOOD DIVERSIFICATION

Chapter 4 introduces the case study on labor allocation in swidden-combined livelihood diversification through an analysis of the livelihood portfolio, annual working hours, and seasonal changes in working hours for individuals in a village in northern Laos. This chapter also examined the labor allocation and copping mechanism of smallholders under the labor constraints in livelihood diversification during the peak cropping season of farming activities, and exploring how swidden farming can combine with others livelihood activities in term of labor demand for multiple livelihood activities.

4.1. Introduction

The livelihood diversification of smallholder farmers is observable and well-characterized worldwide (Ellis 1998; Ellis 2000). Smallholders are often pluriactive, as they combine on-farm and off-farm activities to form a livelihood portfolio, which includes the components of their household activities (Eder 1993; Netting 1993). Ellis (1998) defines livelihood diversification as the process by which rural families construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standards of living. This form of livelihood is also known for its contrasting purposes to achieve survival and capital accumulation (Ellis 2000). Either way, strategies of risk aversion are necessary to combat erratic natural conditions and socio-economic changes.

Non-farm income, or non-agricultural activities to earn wages, and off-farm income, which is typically wages or exchanges on other farms, is a major part of the smallholder's livelihood; these activities typically complement agricultural production to sustain the farm household economy in a market economy. Therefore, livelihood diversification studies focus

on income diversification and are seeking to grasp what is needed to achieve income diversification. However, income diversification is not only the option for risk aversion. Independent from a market economy in the livelihood portfolio, another livelihood strategy could be used to sustain well-being under unpredictable market situations (Ripoll-Bosch et al. 2014). Especially in Southeast Asia, it is one of the broadly observable forms of livelihood that includes subsistence farming.

Although swidden farming in Southeast Asia has been transformed in several ways in response to socio-economic changes, it aids in securing livelihood at the household level in some cases (Cramb et al. 2009). In Sarawak in Malaysia, where people have been involved in the cash economy since the late 19th century (Cramb 1989), Cramb (1993) found a mutual buffer effect between price fluctuations in cash crops, such as black pepper and rubber, and swidden farming. Wadley and Mertz (2005) claimed that cash crop cultivation and swidden farming remain safer targets of investment for the Iban and other local communities in Malaysia and Indonesia, despite the availability of job opportunities and other alternative income sources. A study by Sulistyawati et al. (2005) in Kalimantan found that swidden farming is a safer strategy to moderate the impact of commodity price fluctuations. In southern Laos, subsistence wet rice farming remains an important cornerstone of the rural economy for livelihood diversification to non-farm activities (Martin and Lorenzen 2016).

The pursuit of labor allocation would provide a clearer image than the analysis on income diversification for such livelihood diversification that incorporates subsistence-oriented farming into the livelihood portfolio. Smallholders often rely on their own supply of labor (Netting 1993); thus, a means of labor allocation for diversification at the household and individual levels is critical for securing livelihood.

While household asset endowments shape livelihood diversification (Ellis 2000), labor is critical for livelihood diversification in rural areas of economically developing regions.

In the Amazon, the capability of adding new livelihood reflects labor endowment in a household, as households with greater adult laborers have more diversified production systems (Perz 2005). In addition, the author pointed out that, given the importance of labor availability, the capacity for households to diversify their livelihood portfolio changes over the course of the household's demographic life cycle, which includes changes to age structures. This life cycle effect on livelihood is supported by research on land use changes in the same region, as the proportions in livelihood portfolios transition to activities with lower labor requirements, such as annual crops transitioning to perennials and pasture, while the household is aging (Perz 2001; Perz et al. 2006).

Simultaneously, livelihood diversification requires greater labor investment from single individuals. There is often seasonality in labor demand in farming, but labor is scarce during peak season because laborers are often confined to family labor; additionally, the value of hired labor is greater than the standard wage, which is unaffordable for the smallholders (White et al. 2005). One way to accommodate other livelihoods while avoiding such a bottleneck is through labor smoothing (Ellis 2000). In a case from the Nigerian Savanna, where cultivated crops are highly diversified with a four-month rainy season, farmers reduce seasonal fluctuations in their working time by adopting varieties with early-maturity and weak sensitivity to day length. In addition, they extend the agricultural year by harvesting, processing, clearing fields, and some planting during the dry season (Stone et al. 1990). Another example is in southern Laos, where villagers who engage in wet rice production are employed as non-farm workers during the agricultural slack period (Martin and Lorenzen 2016). In addition, Cramb (1993) introduces a case of labor smoothing through swidden farming in Malaysia; relatively even distribution of monthly working hours because the peak seasons for dry rice and perennial crops, such as black pepper and rubber trees, do not largely overlap.

Given the importance of labor allocation, the types of livelihood chosen to fit with swidden farming and the extent to which such limited labor is allocated is the key to successfully diversifying livelihood into commercialization, while keeping subsistence-oriented farming in the portfolio year-round. To discuss this issue, I examine a case in northern Laos where swidden farming is persistence while increasing opportunities for non-farm jobs and commercial farming.

The purpose of this chapter is to examine labor allocation in swidden-combined livelihood diversification through an analysis of the livelihood portfolio, annual working hours, and seasonal changes in working hours for individuals in a village in northern Laos. The current research is a case study on subsistence farming-based livelihood diversification that will be useful in livelihood diversification studies, and will contribute to labor allocation studies in farm-based societies. The research may also expand swidden farming studies by suggesting that this type of farming is the cornerstone, while subsistence and commercial farming are mutually supplemental.

4.2. Materials and methods

4.2.1. Methods

Semi-structured household interviews were conducted in August 2017 with 53 out of the 132 households in the village. The participating households included those who were available at the time of the survey and were willing to be interviewed. Household heads were interviewed regarding family composition, the sex and age of each family member, economic activities, and monthly time use for each family member per economic activity in 2016. In addition, the number of plots and total area of arable land that the household owns were viewed as asset variables.

The monthly working hours for family members were estimated by the household heads if the family members were not available, as some had left the village for schooling, as temporary migrant workers, or to work in the fields. The cropping calendar for farming activities is very similar among households, and I cross checked the information with other households. Thus, I can secure the accuracy of time spent for farming activities. However, for non-farm jobs performed by other members of the household who temporarily stay in Luang Prabang or another urban area nearby, the household head could not indicate accurate working hours. Instead, the number of working days were indicated. Thus, I used 8 hours per day (official number of working hours per day in Laos) to calculate the time spent working non-farm jobs. Although it may not be an accurate working time for the non-farm job, 8 hours per day is common in daily labor in Laos and it should not cause any errors in the analysis. In addition, the economically non-active population in the village, which included those who were physically and mentally disabled, house makers, or permanently working in other regions, were excluded from the sample. As a result, 168 individual samples were obtained (Table 9). After excluding those aged less than 20 years old, 133 individual samples were ultimately analyzed. The annual working hours of those less than 20 years old was negligible, less than 1 hour/day on average for the year, as it consisted mostly of students who were studying in an urban area during the week.

4.2.2. Livelihood portfolio

There were 17 livelihood activities included as a result of the interviews (Table 10). In order to simplify analysis, these activities were divided into eight classifications based on their characteristics. Cattle were separated from livestock as an independent classification since cattle raising was the predominant economic activity, as well as a cash income source, in this village (Phouyyavong et al. 2019). There was only one woman who claimed to grow vegetables. Since the vegetable farming was an exceptional case in this village, it was excluded

from the analysis. Swidden farming was mainly for self-sufficiency, while other activities were related to cash earning activities in the local market with the exception of livestock. Livestock was used for both earning cash and self-sufficiency. Forage cultivation was used for feeding cattle through a rotational grazing system (Phouyyavong et al. 2019).

Since villagers usually engaged in pluriactivity, the total number of individuals in the livelihood classification and engaging in economic activities was larger than the sampled population. Although annual income from swidden farming was less than that of other activities, this was the second most popular activity for the villagers following livestock raising; this implied that swidden farming was one of the main or complementary livelihoods in the individual's livelihood portfolio.

4.2.3. Analysis

1) Livelihood portfolio

To visualize the similarity of each individual's livelihood structure, a non-metric multi-dimensional scaling (NMDS) was performed. NMDS is one type of multivariate data analysis that is widely applied in ecological studies and is increasingly being used in the social sciences (Woods et al. 2017; Hout et al. 2013). Since it does not require assumptions on the distribution of the underlying data, NMDS is a widely applicable ordination technique in multivariate data analysis (Jiang et al., 2010; Gu et al. 2018). The sum of the individual's monthly working hours for each livelihood category was used to determine annual working hours for each individual and livelihood category. Then, the data were ordinated using the metaMDS function with Bray-Curtis dissimilarity in the vegan package in R version 3.6.1 (permutation = 100). The relative location of each individual's livelihood structure was plotted in the ordination space, then over-layered with the location of the livelihood categories. The location of a livelihood structure closer to a livelihood category can be interpreted as an individual uses more time for that category than other livelihoods.

Table 9 The number of sampled individuals by age cohorts, ethnic groups and sex

Age cohort	Total population	Hmong		Khmu	
		Female	Male	Female	Male
< 20	35	10	9	8	8
20-29	40	17	9	6	8
30-39	38	11	15	9	3
40-49	20	4	7	5	4
50-59	28	5	5	8	10
>=60	7	1	3	2	1
Total	168	48	48	38	34
Total without the < 20 cohort	133	38	39	30	26

Table 10 The number of individuals by livelihood, ethnic groups and sex, and household cash income in 2016

Livelihood	Total	Hmong			Khmu			Household cash income (LAK*)	
		Female	Male	Total	Female	Male	Total	Mean	se
Swidden farming	**97**	**25**	**26**	**51**	**24**	**22**	**46**	**276,604**	**142,911**
dry rice	97	25	26	51	24	22	46	276,604	142,911
Forage cultivation	**75**	**31**	**35**	**66**	**4**	**5**	**9**	**0**	**0**
Cash crops	**35**	**16**	**17**	**33**	**1**	**1**	**2**	**240,440**	**118,485**
job's tears	13	6	7	13	0	0	0	410,000	213,576
maize	21	9	10	19	1	1	2	28,302	28,302
sesame	1	1	0	1	0	0	0	283,019	283,019
Plantations	**62**	**24**	**27**	**51**	**5**	**6**	**11**	**1,133,042**	**327,602**
rubber	47	21	23	24	2	1	3	1,490,612	524,508
teak	15	3	4	7	3	5	8	775,472	391,657
Cattle raising	**52**	**16**	**32**	**48**	**2**	**2**	**4**	**3,209,434**	**1,033,535**
Livestock	**103**	**41**	**21**	**62**	**26**	**15**	**41**	**475,401**	**118,059**
buffalo	6	2	1	3	0	3	3	471,698	330,593
pig	40	12	7	19	14	7	21	728,302	262,239
poultry	57	27	13	40	12	5	17	701,604	203,967
NTFPs	**43**	**12**	**10**	**22**	**13**	**8**	**21**	**609,038**	**173,837**
Wage laborer	**49**	**4**	**11**	**15**	**20**	**14**	**34**	**1,933,906**	**525,703**
off-farm laborer	25	4	6	10	10	5	15	1,801,699	682,847
employee	6	0	2	2	0	4	4	1,929,283	851,054
trading (self-employment)	8	0	1	1	6	1	7	3,495,283	1,775,964
other non-farm laborer	10	0	2	2	4	4	8	509,359	233,920
Other	**1**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**
vegetables	1	0	0	0	1	0	1	0	0
Total	**517**	**169**	**179**	**348**	**96**	**73**	**169**		

*LAK: Lao Kip, Laos' National Currency (1US$=8,806 kip) according to Banque Pour Le Commerce Exterieur Lao Public, dated 15th October 201

To examine the similarity of each livelihood structure, a permutation-based analysis of variance (PERMANOVA) was implemented in the vegan function adonis (permutation = 999). The distance matrix was calculated using Bray-Curtis dissimilarity, then the influence of variables such as ethnic group (the Hmong or the Khmu), age, sex (male or female), landholding size (ha), household size, and household (household's categorical ID) were tested. The ethnic group variable is used as an index of mixed assets that include natural capital (land), human capital (skills and knowledge), and financial capital. These ethnic groups have contrasting capitals stemming from livelihood history (Phouyyavong et al. 2019): the Hmong have communal lands in the natal village while the Khmu do not; the Hmong possess the knowledge to grow forage crops and raise cattle to a larger extent than the Khmu; the Hmong have more financial capital from lucrative agriculture (e.g. opium cultivation) than the Khmu. The household was used as a categorical variable that indicates if all individuals that belong to the same household have a similar livelihood structure; the variable also represents the household's assets that villagers were reluctant to report. Households are likely to use more land than stated, as they often cultivate unauthorized land (Phouyyavong et al. 2019).

2) Annual working hours

ANOVA type III was performed in the car package in R to test if mean annual working hours vary based on demographic variables (sex, age cohort [20 to 29 years old, 30 to 39 years old, 40 to 49 years old, 50 to 59 years old, and older than 60 years old], and household size), as well as socio-economic variables such as ethnic groups, number of plots, landholding size (ha), annual income (Lao kip (LAK)), and number of livelihood activities. In addition, the omega squared was computed to estimate the effect size of each variable using the sjstats package in R. The omega squared is less biased, and is therefore recommended for estimating the effect size in n-way ANOVA (Ialongo 2016). Then, Tukey's HSD test was implemented for the variables with a larger effect size.

3) Monthly working hours

The peak months for monthly working hours based on ethnic group and sex were identified by visualizing the monthly changes in working hours over the course of the year. The ratio of the number of individuals who engaged in each livelihood category was calculated for sex, ethnic group, and month; then, I extracted the livelihood categories that were a particularly large portion of its ratio. Finally, ANOVA type III was performed to examine which variables (sex, ethnic group, age cohort, and livelihood categories) are significantly related to monthly working hours during the peak period. Next, the effect size of each variable was estimated by calculating omega squared. Tukey's HSD test was implemented on the variable that was likely to explain its working hours to demonstrate the differences in hours between the categories.

4.3. Results

4.3.1. Livelihood portfolio of individuals

The result of the NMDS was interpretable for analysis since the stress value was less than 0.2 (Clarke 1993). The livelihood portfolios of individuals belonging to the same ethnic group were closer in distance, although some individuals overlapped or were close to one another regardless of ethnic group (Figure 9). The results can be grouped into three types. The first type diversified their livelihood portfolio into commercial farming with a plantation, forage crop cultivation, cattle raising, or cash crops; they are mostly Hmong. The second type included those

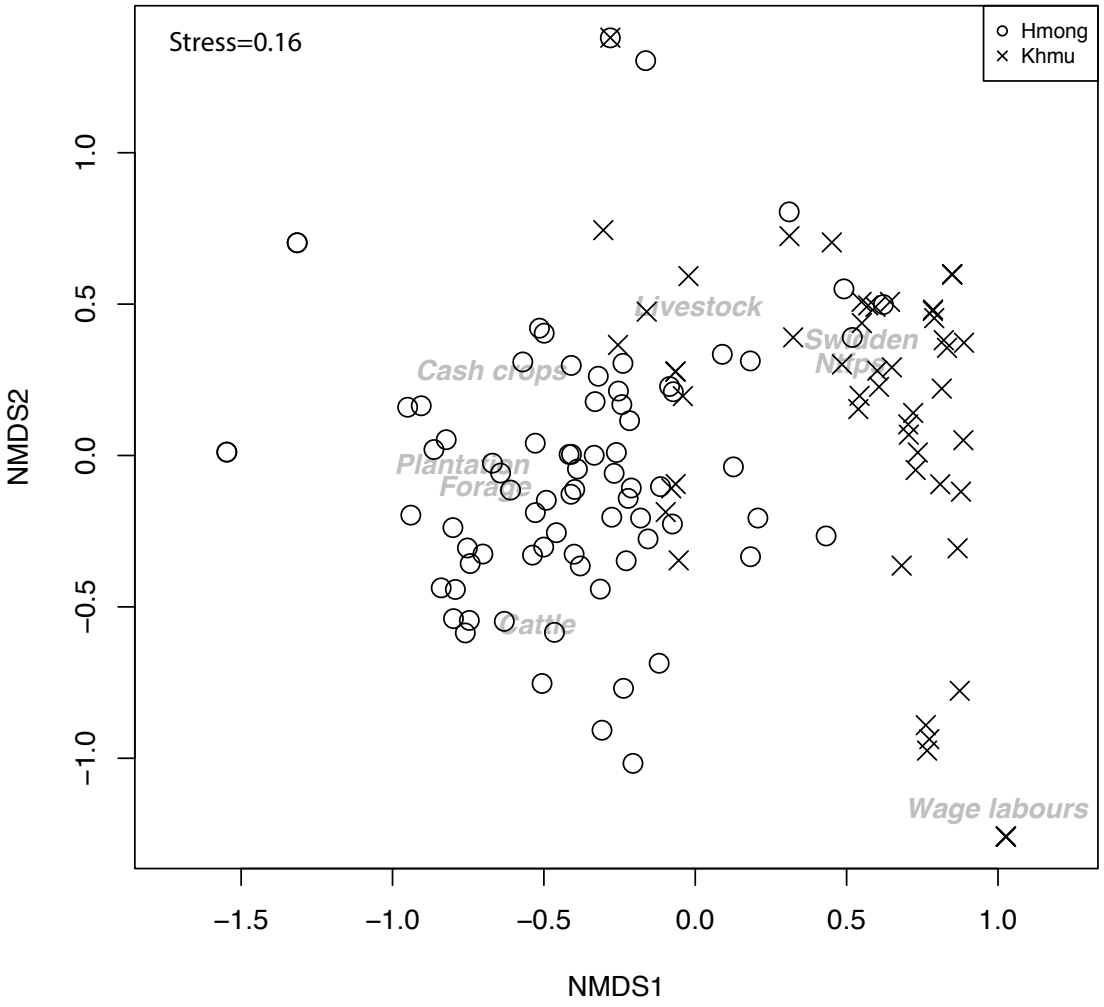

Figure 9 Nonmetric Multidimensional Scaling (NMDS) of livelihood portfolios of individuals.

Livelihood portfolios consist of annual working hours for each category.

that were persistence to subsistence-oriented with swidden farming and NTFPs (Figure 10). The third type, that were leaving farming to become wage laborers, were mostly Khmu. Of the 45 individuals who included wage laborer as part of their livelihood portfolio, 15 individuals (33%) spent more than 50% of their working hours as wage laborers, and 5 individuals (10%) devoted all of their working hours as wage laborers.

All of the demographic and socioeconomic variables were significantly related to the individual's livelihood portfolio at a 1% significant level (Table 11). R-squared values, which were the sums of the squares column divided by its total, among these variables were higher in household and ethnic group, and lower in age, sex, household size, and landholding size. The R-squared values of household and ethnic group were 0.50487 and 0.14728, respectively, whereas this value ranged from 0.01263 to 0.02455 for other variables. This could be interpreted as household and ethnic group variables can explain 50% and 15% of the distance between samples, respectively, whereas other variables explained less than 3% of the distance. The higher R-squared value of household and ethnic group indicated that household members and individuals belonging to the same ethnic group were likely to have similar livelihood portfolios.

4.3.2. Annual working hours

The differences in annual working hours among age cohorts and the number of livelihood activities were remarkable, although the effect sizes of other variables related to demography, assets, and annual income were small (Table 12). The effect sizes suggested that 14.5% and 17.0% of the variance in age and the number of livelihood activities was attributable to the differences in annual working hours, while other variables explained less than 1.0% of the difference between them.

(0) Rubber plantation

(b) Clearing land for swidden farming

Figure 10 Rubber plantation and swidden farming at Poung Pao.

Source: Taken by author in 2016.

Table 11 PERMANOVA analysis on livelihood portfolio

	df	Sums of squares	Mean squares	F.Model	R^2	Pr (>F)
Demographic variables						
Age (years)	1	0.698	0.6983	5.503	0.01953	0.001
Sex	1	0.878	0.8777	6.917	0.02455	0.001
Household size	1	0.510	0.5105	4.023	0.01428	0.002
Socioeconomic variables						
Landholding size	1	0.452	0.4517	3.560	0.01263	0.005
Household	49	18.049	0.3684	2.903	0.50487	0.001
Ethnic group	1	5.265	5.2652	41.493	0.14728	0.001
Residuals	78	9.898	0.1269		0.27686	
Total	132	35.75			1.00000	

Table 12 Results of ANOVA type III on annual working hours

	Sum of Squares	Df	F value	Effect size*	Pr(>F)
(Intercept)	92769	1	0.2954		0.58781
Demographic variables					
Sex	878186	1	2.7960	0.010	0.09708
Age cohort	5344914	4	4.2543	0.145	0.00295
Household size	366109	1	1.1656	-0.005	0.28245
Socio-economic variables					
Ethnic group	1038179	1	3.3054	0.000	0.07153
The number of plots	531496	1	1.6922	0.060	0.19578
Landholding size (ha)	687933	1	2.1903	-0.002	0.14149
Annual income (LAK)	1775983	1	5.6544	-0.003	0.01898
The number of livelihood	11674233	1	37.1686	0.170	<0.00001
Residuals	38004682	121			

* Estimated by omega squared. This ranges from -1 to 1. No effect=0.

The mean annual working hours of the individuals in their 30s (30 to 39 years old) and 40s (40 to 49 years old) was significantly larger than that of the other age cohorts (Figure 11). Those aged 30 to 49 years old spent 1170 to 1982 hours a year in 95% confidence intervals (95%CI) for work, whereas the range of mean annual working hours for other age cohorts were from 776 to 1231 hours. In the confidence interval, 7.4% of working hours of individuals aged 30 to 49 were compatible with 13.3% of that of other age cohorts. In addition, mean annual working hours for individuals increased with the number of livelihood categories (Figure 12). The annual working hours of the villagers with one or two livelihood categories ranged from 548 to 1031 hours in 95%CI, whereas those with 5 to 7 categories were from 1212 to 2342 hours. Converting mean annual working hours to daily working hours, the upper figure of daily working hours for individuals aged 30 to 49 years old was 5.4. In addition, the upper figure of mean annual working hours for individuals with the most diverse portfolio was 2342 hours, which can be converted to 6.4 hours per day.

Assets and annual income were not strong variables in explaining the difference in annual working hours. The 95% CI for Hmong and Khmu ranged from 1032 to 1626 hours and 848 to 1450 hours, respectively. For approximately 70% of those, the intervals were compatible. In addition, returns of work could be small since the effect size of annual income was -0.003; however, working hours and annual income were positively correlated.

4.3.3. Monthly working hours of individuals

There was seasonality over monthly working hours and three peaks in labor demand regardless of ethnic group and sex (Figure 13). The working hours, which combined ethnic group and sex in 95%CI, increased to 103 to 145 hours in March, then dropped to 76 to 94 hours in April when the rainy season began. After that, it increased to 148 to 209 hours in June, then gradually

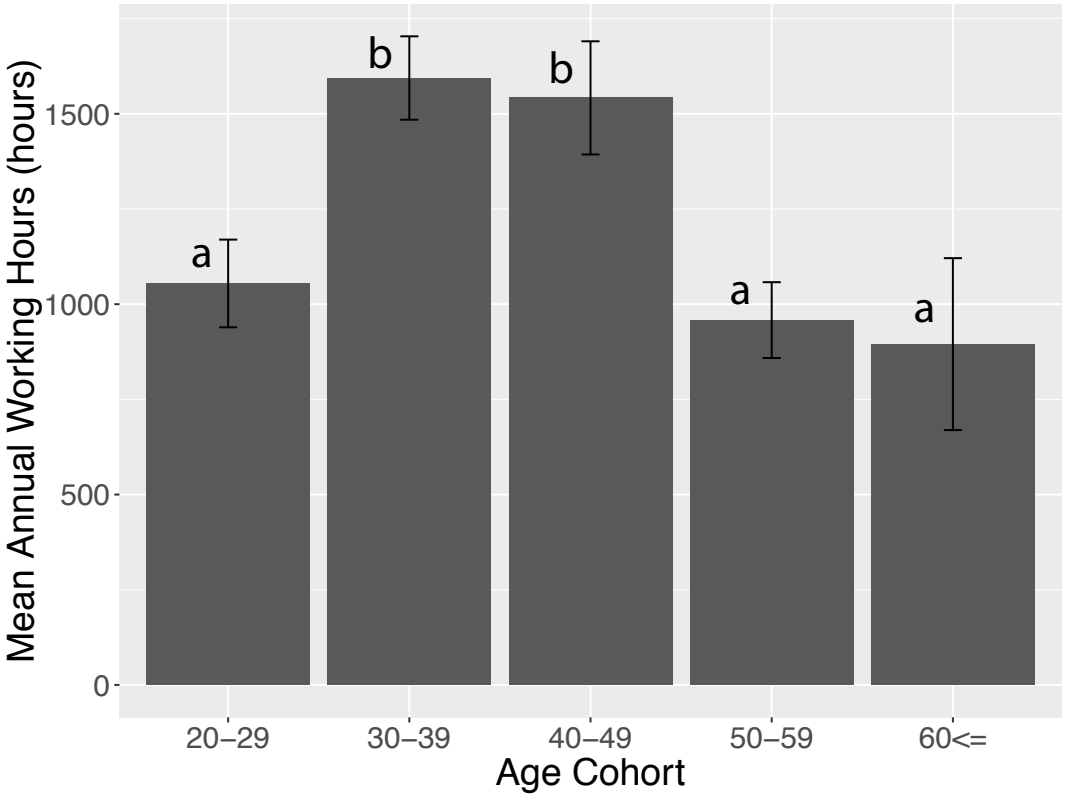

Figure 11 Mean annual working hours of age cohorts.

Data are expressed as mean ± standard error. Different letters above bar plots indicate significant difference by Tukey's HSD test (95% confidence level)

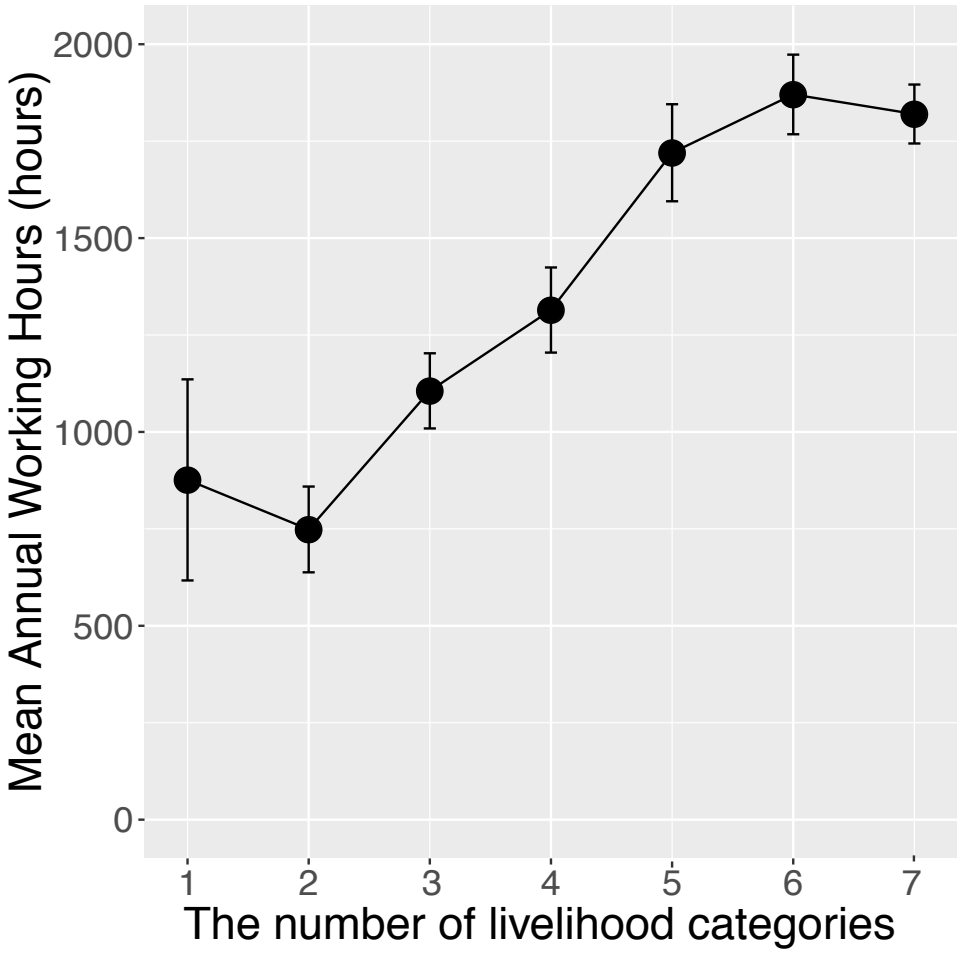

Figure 12 The relationship between annual working hours and the number of categories in livelihood portfolio of individuals.

The data are expressed as mean ± standard error

Figure 13 Monthly working hours by ethnic groups and sex.

The data are expressed as mean ± standard error

decreased to 51 to 71 hours in October. In November when the dry season began, the monthly working hours increased to 95 to 134 hours.

This seasonal pattern of monthly working hours was clearly consistent with the cropping calendars of swidden farming, forage cultivation, and plantation (Figure 14). A decent number for individuals from both ethnic groups worked in swidden farming. In addition, the Hmong were more likely to engage in forage cultivation and plantation than the Khmu. They conducted land preparation and seeding before the wet season, and harvested after the wet season from November to December. During the cropping season for dry rice, they continued to weed the fields. The pasture was burned to replant forage crops or facilitate re-germination before the rainy season arrived. Then, workers weeded throughout the rainy season. The teak plantations were also weeded during the rainy season, and the weeding and tapping of rubber trees occurred during this time as well. The villagers claimed that they never applied agrochemicals such as herbicides, pesticides, or fertilizers regardless of cultivated crops.

Other clear differences between the ethnic groups occurred in non-seasonal work such as cattle raising and wage laborers, as villagers allocated smaller amounts of labor towards them. The Hmong, especially the Hmong male, participated in cattle raising, whereas the Khmu worked non-farm and off-farm jobs throughout the year. The number of individuals who worked for livestock, particularly poultry and pigs, was larger for both ethnic groups throughout the year. Mean monthly working hours for cattle raising by the Hmong male ranged from 36.43 to 43.69 in 95%CI. The Khmu worked as wage laborers for 6.91 to 7.46 hours per month in 95%CI. Both ethnic groups spent only 1.67 to 1.75 hours a month in 95%CI with livestock.

4.3.4. Livelihood portfolio and working hours during the peak period

The livelihood portfolio of individuals during the peak period from May to August was

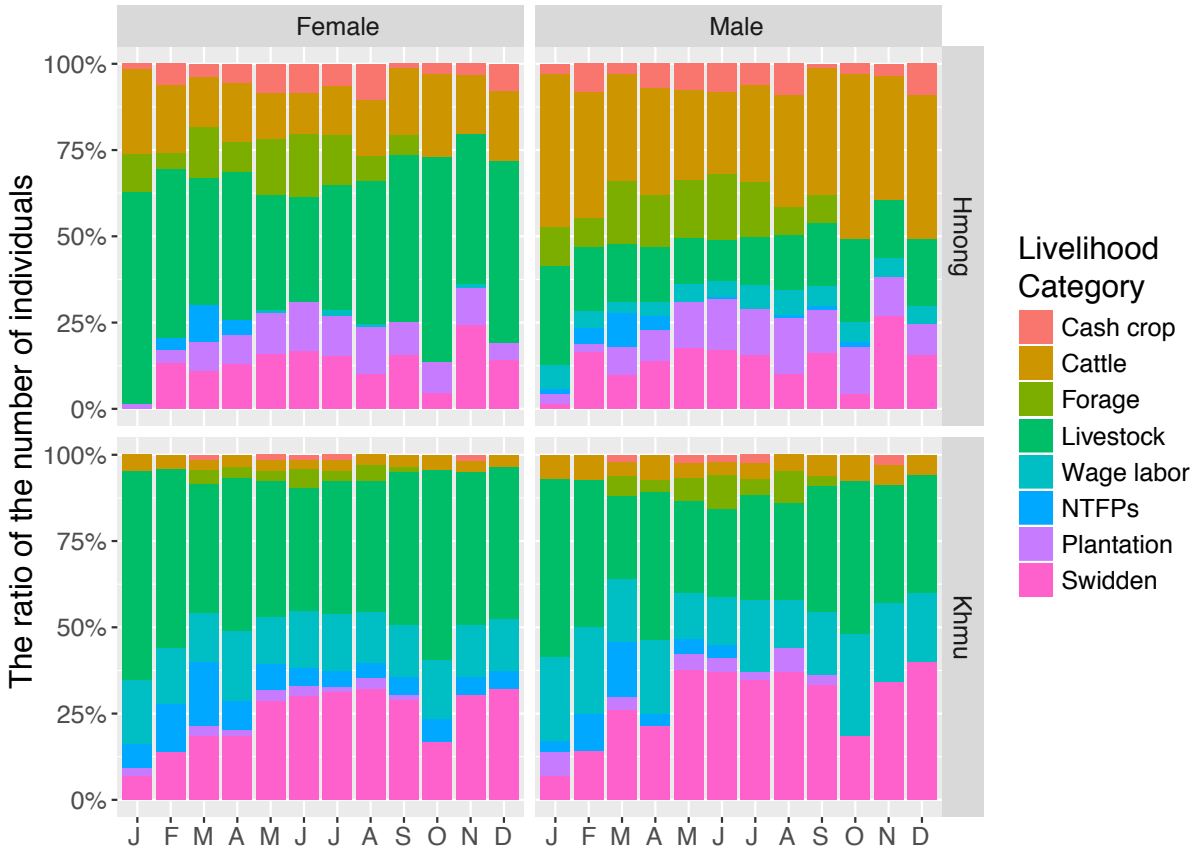

Figure 14 The ratio of the number of individuals by month, ethnic groups, and livelihood category.

classified based on swidden farming (S), forage cultivation (F), and plantations (P) (Table 13). The livelihood portfolio was more varied among Hmong individuals, while the Khmu were inclined to include swidden farming. In total, 79 % of Hmong and 72 % of Khmu individuals who worked during the period were engaged in swidden, forage, plantation, or some combination. Forty five % of the employed Hmong and 67 % of the employed Khmu embraced livelihood portfolios that included swidden farming (S, SF, SP, and SFP). In addition, 37 % of the Hmong worked for forage, plantations, or some combination (F, P, and FP).

The effect sizes of all factors were remarkably small except for livelihood combination (Table 14). The effect size of livelihood combination suggested that 31.8 % of the variance in livelihood combination was attributable to the differences in working hours in the peak period (Table 14). The effect sizes for individuals with more than 2 livelihood categories in their livelihood portfolio were significantly larger than those for individuals who devoted their working time to swidden, forage, or plantations (Figure 15). Monthly working hours for individuals with livelihood portfolios that included swidden, forage, or plantations was 111 to 142 hours in 95%CI, whereas the portfolios that included two of them was 169 to 243 hours, and 206 to 442 hours in portfolios that combined all of them. Approximately 50% of the double and 16% of the triple were compatible. Mean monthly hours can be converted to daily working hours as 3.7 to 4.7 hours in single, 5.6 to 8.1 hours in double, 6.9 to 14.7 hours in triple combinations of swidden, forage, and plantations.

The labor allocation for swidden, forage, and plantation widely varied among individuals when placing more than 2 into their livelihood portfolio. The ratios in monthly working time during the peak period from May to August between the livelihood categories were wide in the range of distribution (Figure 13). As an example, the range of the ratio for individuals with swidden and

Table 13 The number of individuals who worked during the peak season from May to August by livelihood combinations

	Total	Hmong	Khmu
Swidden (S): Swidden and other livelihoods without forage cultivation and plantations	173	48	125
Forage (F): Forage cultivation and other livelihoods without swidden farming and plantations	44	35	9
Plantations (P): Plantation and other livelihoods without swidden farming and forage cultivation	38	37	1
SF: Mixed of swidden, forage cultivation and other livelihoods without plantations	59	43	16
SP: Mixed of swidden, plantation and other livelihoods without forage cultivation	30	20	10
FP: Mixed of forage, plantations and other livelihoods without swidden farming	31	31	0
SFP: Mixed of swidden, forage, plantations and other livelihoods	29	29	0
Other: Cattle raising, cash crop cultivation, livestock raising, NTFPs collecting or wage laborer	128	65	63
Total	532	308	224

Table 14 A result of ANOVA type III on monthly working hours

	Sums of Squares	Df	F value	Effect size*	Pr(>F)
Intercept	280912	1	44.7041		<0.00001
Demographic variables					
Sex	37116	1	5.9066	0.016	0.01543
Age cohort	103275	4	4.1088	0.052	0.00276
Household size	33993	1	5.4096	-0.001	0.02042
Socio-economic variables					
Ethnic group	19161	1	3.0493	0.012	0.08139
The number of plots	683	1	0.1087	0.029	0.74182
Landholding size (ha)	3898	1	0.6203	-0.001	0.43129
Annual income (LAK)	79192	1	12.6025	0.001	0.00042
Livelihood combination	1828300	7	41.5648	0.318	<0.00001
Residuals	3104203	494			

*Estimated by omega squared. This ranges from -1 to 1. No effect=0.

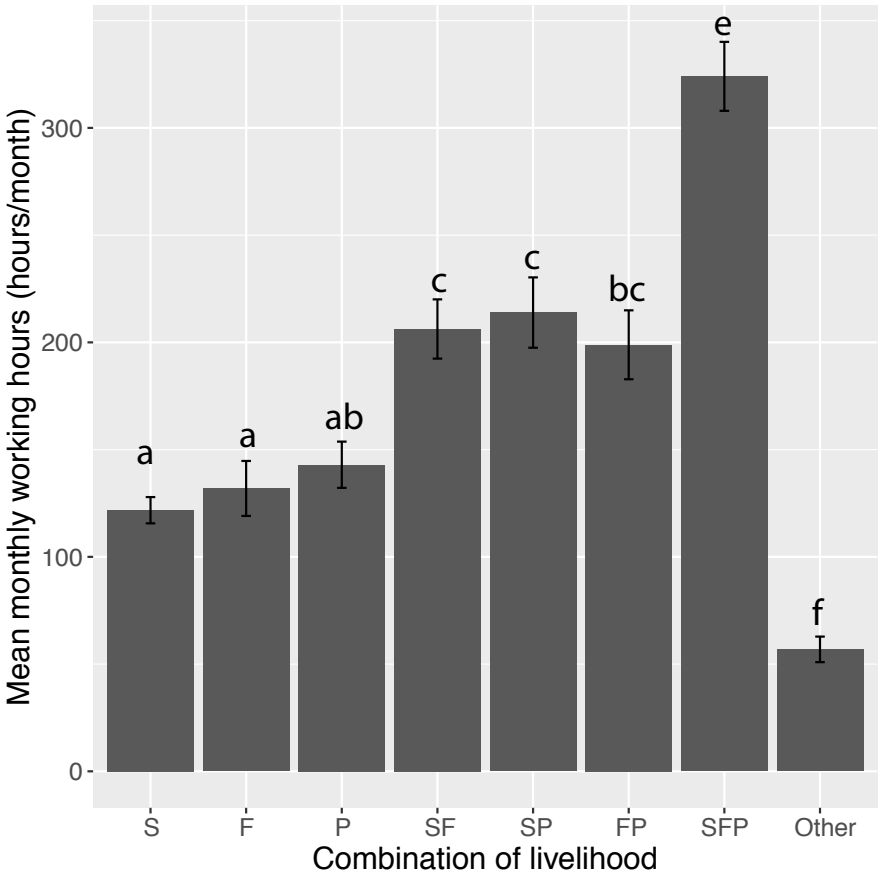

Figure 15 Mean monthly working hours by livelihood combination.

Data are expressed as mean ± standard error. Different letters above bar plots indicate significant difference by Tukey's HSD test (95% confidence level)

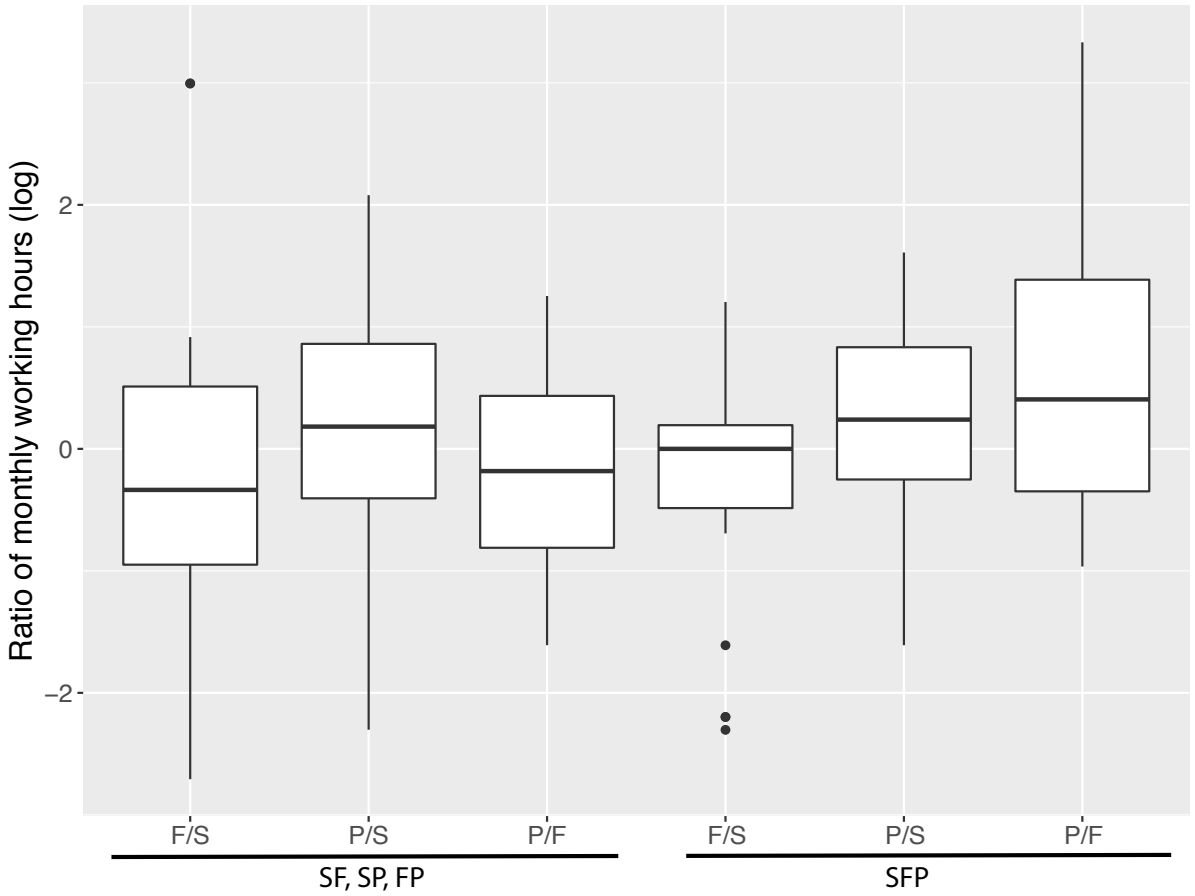

Figure 16 Box plots of the ratio of monthly working hours between livelihood combination during the peak period: F/S: forage cultivation/swidden farming, P/S: plantation/swidden farming, and P/F: plantation/forage cultivation.

forage (F/S) was -2.7 to 0.9; this indicated that while there was an individual who allocated 2.5 times more working hours to swidden than to forage, another individual used only 7% of the working hours of swidden for forage.

In the swidden-combined livelihood portfolio (SF, SP, SFP), the results were mixed (Figure 16). In the combination of forage and swidden, more than 50% of individuals allocated longer or similar hours to swidden, as revealed by the medians of F/S in SF and SFP which were -0.3 and 0.0, respectively. Conversely, more than 50% of individuals did not spend longer hours for swidden in the combination of plantations and swidden. The medians in both P/S in SP and SFP were 0.2. In the combination of forage and plantation, individuals spent more hours on forage in FP, whereas it was the opposite in SFP.

4.4. Discussion

4.4.1. Plausible determinants of individual's livelihood portfolio

Although swidden farming and forage cultivation were not critically important as household income sources, villagers devoted a significant amount of time to its cultivations. Reflecting this reality of rural economy, the individual livelihood portfolios can be roughly divided into three types, based on annual time allocation to each livelihood category: 1) having diversified its livelihood portfolio into commercial farming, 2) persistence to subsistence-oriented, and 3) leaving farming. The portfolio that reveals on-farm diversification is likely to allocate more working time towards income-generating activities such as cash crops, plantations, forage cultivation for feeding cattle, and cattle raising. The portfolio geared towards subsistence-oriented

farming devotes working time to swidden farming and NTFPs to a large extent. In addition, some villagers devoted their entire livelihood to wage labor. These results were consistent with our observations in the village (Phouyyavong et al. 2019), as well as, partly, the findings from

the previous research involving land-use analysis (Vongvisouk et al. 2014) and qualitative research (Bouahom et al. 2004) conducted in other parts of northern Laos.

The most influential factors that determined the individual's livelihood portfolio were the assets that each ethnic group and each household had; this was indicated in that assets variables, such as ethnic group and household, explained 65% of the distance between the livelihood portfolios. This suggests that assets, such as land, skills, and financial capital that stem from livelihood history, are likely to exert influence on an individuals' decisions regarding livelihood choice and time allocation. In addition, the range of variety in land type, as the Hmong have communal land while the Khmu do not, could have a positive effect on livelihood diversification to a larger extent than landholding size. Earlier studies also found that diversity in land type is more important for livelihood diversification than landholding size (Martin and Lorenzen 2016; Perz 2005).

Livelihood diversification takes place at the individual rather than at the household. In other words, the individual engages in multiple economic activities, rather than the household consists of members who engage in different single activity. Maintained a similar livelihood portfolio among household members allows individual to be pluriactive. This is also supported by the finding that effect sizes of age, sex, and labor availability in a household were smaller as explanatory variables for individuals' livelihood portfolio. This indicates that work is not divided into sex and age to a large extent; household members are likely to work together on their own fields, and share a wide variety of agricultural practices regardless of age and sex.

The results contrast with previous research in livelihood combined subsistence-oriented farming: labor capability to add new livelihood reflects the number of adults in a household (Perz 2005); the younger generation tends to engage in arduous work, while elderly are devoted to relatively light work that requires skill and knowledge (Perz 2001); and younger generations, especially women, are willing to participate in non-farm work (e.g. Bouahom et

al. 2004; Martin and Lorenzen 2016). This may be partly due to a biased population, as this study excluded the younger people who are permanently working or studying outside of the village, and did not include the elderly's small activities, such as handcrafts, into the analysis. Another reason may be the assignment of roles in farming. As an example, hill seeding in swidden farming often requires both sexes, as men dig a hole and women place several rice seeds into the hole. In this case, it may be difficult to conduct swidden farming if one sex engages in other activities.

4.4.2. Livelihood diversification along with an increase in annual working hours

In addition to assets being the most important variables determining an individual's livelihood portfolio, the annual working hours at the individual level is likely to be another variable that heavily influences livelihood diversification. Age and the number of livelihood impact annual working hours to a large extent. Individuals aged 30 to 49 years old work longer hours than other age cohorts, which is likely due to competition in labor allocation with childbearing and childrearing for younger generations, and physical working capacity for older generations. In other words, the elderly work less because of aging, whereas the livelihood portfolio is unlikely to be different than other generations. In addition, villagers are likely to accommodate a wide variety of livelihoods by working more. This type of livelihood diversification is also reported in the Nigerian Savanna (Stone et al. 1990).

Whereas the working hours increase with livelihood diversification, the amount does not seem to be higher than in other agricultural societies. This suggests that the extent of labor intensification is moderate. Working hours for an adult with wet rice and other cash crop cultivations totaled 5.4 hours among the Paori in Hainan, China (Jiang et al. 2006), 6.2 hours for an adult male among the Sundanese in West Java (Moji 1980), 6.7-7.1 hours among the Kabupaten in central Java (Hart, cited in Moji 1980), and 6.3 hours among Javanese in East Java (Edmundson, sited in Moji 1980). The annual working hours among the Kofyar in the

Nigerian Savanna with diverse and intensive farming was estimated as 1,599 annual hours, which is equivalent to 4.4 hours/day (Stone et al. 1990). Out of these cases, innovative technologies (e.g. high-yielding varieties) that improved labor productivity were only introduced in Hainan. Whereas a portion of the variation is attributable to methodological differences, working hours in the current village are equivalent or lower than most of the traditional farming systems, except for the case mentioned in Nigeria. The current village case is situated in the lower half of the range of the agricultural societies reviewed (Minge-klevana et al. 1980).

In terms of productivity, hard work in diversification is less likely to increase income. In addition, as seen in other cases (Perz 2005; Ripoll-Bosch et al. 2014), when livelihood includes subsistence-oriented farming and forage cultivation without directly increasing income, it is possible that the villagers are investing their time in order to secure future returns (Ellis 2000).

4.4.3. Seasonality and competition in labor demand

As opposed to cases in Malaysia, Nigeria, and southern Laos where farmers combine crops with varying peaks in labor demand (Cramb 1993), shift agricultural practices to avoid overlapping of the peak season (Stone et al. 1990), and participate in non-farm work during the agricultural slack period (Martin and Lorenzen 2016), Pung Pao village had a clear peak period. This is mainly due to overlap in the cropping season for swidden, forage, and plantations. It was found that the more livelihoods in their portfolio, the more work they needed during that period. In particular, individuals whose portfolios contained all of the above mentioned livelihoods worked longer than those who had only one or two. This indicates that livelihood diversification occurs by working harder during the peak period rather than by labor allocation during the slack period. In other words, competition in labor demand is absorbed by self-exploitation.

Whereas the monthly working hours increased with livelihood diversification, its amount does not seem to be extraordinarily higher than other agricultural societies. The daily working hours for an adult during the peak season was 9.5 hours in Hainan (Jiang et al. 2006), and 7.4 hours in the Nigerian Savanna (Stone et al. 1990). The upper figure in the triple combinations for someone who implemented two or three activities on the same day was very difficult to recall; thus, it could be overestimated as those working hours are among the range of mean monthly hours in the double and triple combinations.

Although I can neither deny nor support the predictions from Roder (1997) and Bouahom et al. (2004) that swidden farming will be replaced with other intensive farming or non-farm jobs, it is reasonable to say that swidden farming accounts for a major portion of livelihood, and labor demand for swidden is not as elevated as they had stressed. Weeding during cropping season is arduous, which is critical for dry rice production (Roder 1997). Shortened fallow periods with population pressure increase the labor demand for weeding, which results in diminishing productivity. However, in the case of the Poung Pao village, labor demand for weeding was less likely to be higher than other livelihoods such as forage and plantations. In addition, daily working hours for swidden and other cultivations is likely to be acceptable for villagers, as their daily working hours were 4.0 to 5.3 hours.

On one hand, saving labor for weeding could result in a decrease in labor productivity in the village. Conversely, it is plausible that fallow periods may not be shortened as much as the previous research expected. As widely observed in other areas in northern Laos (Pravongviengkham 2004), swidden farming is likely to be expanded to unauthorized land, such as conservation forests (Phouyyavong et al. 2019). Although labor productivity of swidden farming, in addition to other cultivations, must be further examined, swidden farming could potentially be combined with other commercial farming regarding labor allocation.

Despite the limitation of this cross-sectional study, which does not necessarily aim to provide a clear image for the transition of livelihood in the long run, labor allocation for multiple livelihoods could be changing in a smallholder's long-range view as claimed in Ellis (2000). Although there was a tendency in the individual's labor allocation to pursue swidden, forage, and plantations, it is rather risky to say that livelihood is diversified to commercial farming or returning to subsistence. There was a wide range of variations in the labor allocation among individuals, and labor allocation may be changing along with socio-economic changes.

Some villagers claimed that swidden farming was simply idle due to competition in labor with other livelihoods, such as in a case in Malaysia where individuals left swidden farming for a couple of years when the market price of black pepper was high (Cramb et al. 2009). Flexibility to socio-economic changes could be an important facet of livelihood diversification, as socio-economic as well as natural conditions realize its flexibility should be needed to pay greater attention, even if it does not explicitly increase income (Ripoll-Bosch et al. 2014). It is well characterized that an increase in income does not necessarily improve the nutritional status of smallholders (Immink and Alarcon 1993; Wirsing 1985), but swidden farming may play a role in the flexibility.

4.5. Chapter summaries

Assets, such as land, skills, and financial capital that stem from the livelihood history ofboth ethnic group and household, are likely to exert influence on individuals' decisions regarding livelihood and labor allocation to a large extent. In addition, an increase in annual working hours at the individual level could help diversify livelihood. However, the extent of increased annual working hours does not seem to be higher than other agricultural societies; thus, the extent of labor intensification is unlikely to be high.

There were clear peaks in labor demand, mainly due to overlap in the cropping seasons of swidden, forage, and plantations. Competition in labor demand at the peak period was absorbed by an increase in working hours at the individual level. However, its amount does not seem to be extraordinarily higher than other agricultural societies. In addition, daily working hours for swidden and other cultivations is likely to be acceptable for villagers. Although labor productivity for swidden farming, in addition to other cultivations, must be examined, swidden farming could be a possible option to combine with other commercial farming practices to satisfy labor demand.

This chapter cannot propose that livelihood in northern Laos is in a transitional stage, moving entirely towards commercialized livelihood. However, the labor allocation may be changing along with socio-economic changes. Flexibility to socio-economic changes could be an important facet of livelihood diversification, so that socio-economic as well as natural conditions realize its flexibility should be needed to pay greater attention.

This study demonstrated that subsistence farming plays a pivotal role in the livelihood diversification process through an analysis on labor allocation, whereas a series of studies on livelihood diversification is inclined to focus on income diversification, then which often resulted in undermining subsistence farming in livelihood diversification. Swidden farming is likely to secure livelihood, although it has been cast in a negative light. In addition, I have contributed an important case study focused on Laos to labor allocation studies, as there are few that examine seasonality in smallholder's livelihood, particularly in Southeast Asia.

CHAPTER 5. CONCLUSION

In this dissertation, I explored the role of swidden farming in upland smallholders' livelihoods under the conditions of land constraints and marketization in northern Laos. I demonstrated diversification in crop-livestock systems, evaluated cattle productivity in combination with swidden farming and examined labor allocation for swidden farming based on livelihood diversification, while accounting for seasonality. Finally, I answered why swidden farming persists in Laos and discussed how livelihoods could become sustainable in combination with swidden farming.

5.1. Crop-livestock systems under swidden farming

The government has paid attention to northern upland Laos to input a number of policies on environmental protection, to stabilize upland shifting cultivation, and to develop the region through land/forest allocation, as well as village relocation/merging. At the same time, the government and development partners have promoted alternative livelihood options for permanent occupations in rural areas by introducing commercialized agriculture tied to the market for households to generate an income. These policies propelled farmers to move away from traditional farming systems and a subsistence economy toward a self-sufficient/cash economy in terms of their livelihood systems. These changes have occurred with regards to household assets and capacities, particularly land and labor forces.

In the case of Poung Pao, people were encouraged to move to the newly relocated village. At the same time, the atypical population increase put pressure on agricultural land use. Under the increasing pressures of land constraints and the changing market economy, cattle raisers in the village modified the free-range grazing systems based on swidden farming into three different systems: (1) grazing in fenced fallow vegetation areas during the wet

season; (2) rotation grazing in pastures in the wet season; and (3) rotation grazing in pastures in both the dry and wet seasons. These systems are likely to intensify both labor and land use due to the limitations on open areas for free grazing. The three systems of cattle raising in Poung Pao village are likely to ease tensions over land use.

According to the measurements of cattle in the three kinds of systems, none of them improved cattle body weight. However, when farmers rotated grazing in households' and groups' fenced-in pastures, and allowed their cattle to free ranging in fallow fields (which I refer to as system C), the farmers successfully increased their landholding capacity. This suggests that under the limitations of grazing areas, the newly modified system described above could help cattle holders to cope with problems and balance their crop-livestock systems, whereby cattle graze in pastures as well as fallow swidden fields.

Forage crops and fallow swidden fields complement feed sources for cattle throughout the year. Forage improves fodder in the wet season and allows smallholders to employ rotation grazing in fenced-in pasture fields. During the dry season, the amount of fodder from forage crops is likely to be smaller than that of fallow vegetation. In light of the higher productivity of this system, which integrates swidden farming and pastures, it is a more suitable choice for smallholders to balance crop and cattle production.

Under such external pressures and development interventions in relation to livestock production, the farmers have modified their crop-livestock systems. They have modified from a free-ranging system in fallow swidden fields throughout the year toward supplementation with forage cultivation, which improved the land holding capacity.

Therefore, this study demonstrated that swidden farming plays a pivotal role in upland livelihoods, as the crop-livestock system that integrates pastures with swidden farming seems to result in a higher land holding capacity. Furthermore, upland livelihoods often diversify and

include several activities. Hence, diversifying their livelihoods requires farmers to allocate their resources, particularly household labor.

5.2. Labor allocation for swidden-combined livelihood diversification

Assets such as land, skills, and financial capital stem from the livelihood history of both ethnic groups and households are likely to influence individuals' decisions regarding both on choice of livelihood and labor allocation. Hmong people tend to grow cash crops (e.g., they work on rubber plantations and engage in forage cultivation and cattle raising). In contrast, Khmu people tend to take part in swidden farming and wage labor. This confirmed labor allocation strategy could be a good indicator in representing the livelihood diversification of upland people, who combine subsistence farming with a market-oriented approach.

During the peak season of labor demand or overlapping work, according to the seasonality of farming activities, there is an increase in annual working hours at the individual level, which could diversify livelihoods and allow farmers to engage in multiple livelihood activities. However, the extent of increased annual working hours does not seem to be higher than that of other agricultural societies, so the degree of labor intensification is unlikely to be high. There is a peak in labor demand during certain months of the year along with the cropping season, mainly due to the overlapping of the cropping season for swidden farming, foraging, and planting in May, June, July, and August. Similarly, coping with the peak labor demand during the peak period is fixed by an increase in working hours at the individual level. However, the level of working hours spent in a day is acceptable and consistent with other agricultural societies. Within the village, the comparison of daily working hours of individuals who engage in multiple livelihood activities, as well as the time spent on swidden farming, are likely to be acceptable for villagers. This means that the mainstream livelihood combination did not put serious pressure on an individual regarding labor demand.

The analysis of labor allocation shows that swidden farming remains an important livelihood activity among upland farmers, as it is combined with several other economic activities. Therefore, I can neither deny nor support the predictions of development studies that swidden farming will be replaced by other intensive farming or non-farm jobs. However, it is safe to assume that swidden farming is a vital livelihood activity that farmers combine with other activities.

5.3. Swidden farming persists and remains as a major portion of upland farmers' livelihoods

Although farmers have faced pressure to stop swidden farming due to the land and forest allocation policy. Villagers' access to the forest has been restricted, resulting in a shortened fallow period, as well as a decrease in agricultural productivity. These actions make it difficult to continue swidden farming, which is expected to be replaced by other livelihood activities. Simultaneously, infrastructure and road access in the rural area have improved to promote and increase household income by replacing swidden farming with permanent farming, such as rubber plantations and the cultivation of forage crops for intensive cattle raising. These provide choices for smallholders in the village.

Even though villagers have more choices, the swidden farming in Poung Pao persists. This may be because not only do the villagers cultivate dry rice, but swidden farming represents their main source of food as many food crops are integrated with dry rice for families' daily food consumption. Furthermore, other activities are partially or fully combined with swidden farming. For instance, upland farmers who work in swidden fields often collect NTFPs, look after their cattle, or forage in the fields before or after work. Residues and natural grass in fallow swidden fields are good sources of animal feed. Therefore, this study demonstrated that swidden farming plays a pivotal role in upland farmers' livelihoods. Swidden farming is likely to secure their livelihoods, particularly for subsistence on rice, which is the staple of Laos'

people. In addition, swidden farming is flexible in labor allocation among smallholders, as it is combined with several other economic activities. Thus, smallholders proactively involved in swidden farming rather than reluctantly engage in it.

In sum, while there have been changes in upland peoples' land accessibility, they have also gained access to roads, non-farm job opportunities, the market, and cash crop production. This has encouraged them to move toward a market-oriented economy. However, policy implications – particularly regarding land use planning/allocation, as well as village relocation – have placed constraints on agricultural land use for crop-livestock systems, which upland people have engaged in for decades. Other restrictions related to financial capital, labor skills, and market integration shape the crop-livestock systems and diversify livelihood strategies. Hmong people have relatively good savings from their livelihood history, which allows them to have better financial capital and labor skills for cattle raising. This has permitted them to take part in cattle raising with modifications of traditional free-range grazing. Now, they engage in a certain degree of modernization regarding the practice systems. At the same time, the market linkage has allowed Hmong people to diversify their livelihood activities into cash crops and working on plantations. The Khmu diversified their livelihood activities by moving toward non-farm jobs, gaining job opportunities in nearby cities. However, under livelihood diversification, swidden farming remains a major part of people's livelihoods, with the aim of obtaining table food crops, such as rice. Thus, this study cannot fully conclude that upland livelihoods in Northern Laos are in a transitional stage whereby livelihoods are entirely commercialized.

Upland livelihoods have been shaped by policies, economics, and assets. Thus, any policy changes with regards to land access create an environment for commercialization agriculture and job opportunities, which could be important aspects for careful consideration. Any policy changes often affect people's livelihoods, and they respond to what happens in a

dynamic and flexible way. Regarding swidden farming, local policymakers should be aware of the adverse long-term effects of a shortened fallow period on crop-livestock systems, a consequence of all three systems currently employed in Poung Pao. Without careful management, these crop-livestock systems might not be sustainable, potentially harming villagers' livelihoods.

5.4. The applicability of sustainable livelihoods combined swidden farming

Globally, the area for swidden farming has decreased. However, changes vary by region. In some regions it has declined substantially, whereas in other areas, it has remained stable or increased. Swidden farming has diminished due to population pressure and market integration (which promotes commercial agriculture as upland farmers turn to intensive agriculture for cash crops, livestock production, and non-farm work). The intensification and commercialized agriculture have expanded agricultural production and household income, which is an aim of many countries (i.e., to promote rural development by increasing rural income).

The implementation of conservation policies and practices has accelerated changes in swidden farming, but it remains important in many areas because farmers have combined swidden farming with other livelihood activities, and used land in a multi-functional way. This has reduced risk to help them adapt to current ecological, climate, economic and political uncertainties.

The analysis of labor allocation shows that swidden farming is a critical livelihood activity in the livelihood diversification process, while a series of studies on livelihood diversification tends to focus on income diversification. Thus, the results may undermine subsistence farming in livelihood diversification. In addition, this study contributed an important case study (focused on Laos) to the labor allocation literature, as there are few

investigations that examine seasonality in smallholders' livelihoods, particularly in Southeast Asia. However, the labor productivity for swidden farming and other kinds of agricultural cultivation must be examined to determine whether swidden farming could be a possible option to combine with other types of commercial agriculture in terms of labor efficiency and satisfaction.

With the recognition of swidden farming as a crucial part of smallholders' livelihood, appropriate development approaches for upland regions should be created that work with swidden farming instead of against it, whereby swidden farming is combined with other livelihood activities. However, such combinations must provide economic, social and cultural suitability for farmers, as well as be environmentally friendly for upland regions.

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APPENDIX I. HOUSEHOLD SURVEY FORM

A. Crop-livestock

HH ID:..... HH head:.....Ethnic group:.....
Interview date: .....Interviewee.....Interviewer:.....

1. Information of HH

- Family member: ....., female.....
- Active labor:....., female.....
- Occasion labor :....., female.....
- Disable person:.....
- Migration workers.....where.....

No	Name	Relation to HH head	Sex	Age	Education
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

2. Migration history of the household

- Where did you live before moving to Poung Pao village?.....
- When did you move to live in Poung Pao village?.....
- Why did you move, spontaneously?.....

.....
.....
.....
.....
.....
.....
.....
.....

3. Land holding and land use

3.1.How many plots of Land for swidden do you have?:.....plots: please fill detail of each plots in table

No	Plot name	Distance (Hrs from home by walking)	Area (ha)	Land obtained 1=Inheritance 2=Purchase 3=Rent 4=Allocated from village authority	Year obtained
1					
2					
3					
4					
5					

3.2.What activities did you do for swidden farming and when?

Activities	Months											
	1	2	3	4	5	6	7	8	9	10	11	12

3.3.Do you have garden……How many plots?....., please fill detail of each plot in the table below.

No.	Land plots and type tree plantation	Distance (Hrs from home by walking)	Area (ha)	Land obtained 1=Inheritance 2=Purchase 3=Rent 4=Allocated from village authority	Year obtained	What crop you plant before
1						
2						
3						

3.4.How many plots of forage cultivation you have?:..... please fill detail of each plot in the table below.

ล.ด	Name of plots	Distance (Hrs by walking)	What month that you use for cattle grazing	When is the last burn for regenerating	Area (ha)	Year of the first cultivated forage	Before forage what crops did you cultivate in this plot	Land obtained 1=Inheritance 2=Purchase 3=Rent 4=Allocated from village authority	Forage is still available? How many types of forages? What are they?
1									
2									
3									
4									
5									

4. Livestock in 2016:

4.1. Do you have livestock, what are they, how many? Please fill the detail of each livestock in the table below.

No	Livestock	Female		Male		Year started raising	How did you get livestock for raising
		More than 2 years	Two years and over	More than 2 years	Two years and over		
1	Cattle						
2	Buffalo						
3	Pig						
4	Goat						
5	Poultry						
6							
7							
8							

4.2. Since 2000 until now, when did you started to raise cattle? When did you stop to raise cattle? how did you raise your cattle (Free grazing? Tethering? Fattening? etc…) please explain each raising practice when did you started and when did you stopped and why? Fill in table bellow

Year→	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1=raise cattle 0=no cattle																	
Please indicate raising system that you apply for your cattle in each year																	
Why?																	

4.3. Did you apply vaccination for your cattle? How many times a year? When, what months? By whom? How did you vaccinate for big and small cattle?

5. Income source of HHs in 2015

No	Income sources	Buyers	Selling place	Distance from village	Months of sale	Total in come	Number of cattle and Buffalo sale
1	Sell of cattle from your own farm						Cow:……. Bull:……
2	Sell of buffalo from your own farm						
3	Others livestock						
4	Crops						
5	Trading						
6	Wage labor						
7	Salary						
8	NTFPs						
9	Others, pleas indicate						

B. Labor allocation

- **HH in formation**

1. Name of HH head……..Age……Ethnic……,where did migrate from?…… when?.....why?..... ……
2. Number of family member……; Number of member presenting in family…….

3. Member who are staying in family and temporary migration for labor wage in other places.

No	Name	Relation to HH head	Age	Gender	Active labor	Occupation	Where s/he live
		1=Husband; 2=Wife;3=Father; 4=Mother;5=Son;6=Daughter 7=Son in law;8=Daughter in law;9=Relative;10=others		1=Male 2=female	1=Main 2=Minor	1=Agri.;2=Wage labor 3=Staff of factory 4=Trader;5=Govt. staff 6=others	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

- **Cattle holding, cattle raising types, cattle raising activities and labor use**

In 2016, there were three types (B, C and D) of cattle raising in Poung Pao village. Therefore, questions are used to ask about three main types and extra questions also use to ask for previous types such as type A and type E.

4. How many Cattle do you have?.....Big male……..Big female……Small male……Small female……..
5. Are you practicing free grazing for your cattle (**Type A**)? ***Yes or No***. If yes, go to question 5 and 6. If no, move to question 7.
6. How many cattle did you sell from type A?……,How much did you earn?. How many activities and labor used **for Type A**? time spent for each individual use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

7. Are you practicing *group-fenced fallow and free ranging for your cattle* (**Type B**)? ***Yes or No***. If yes, go to question 8. If no, move to question 9
8. How many cattle did you sell from type B?…….,How much did you earn?. How many activities and labor used **for Type B**? time spent for each individual use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

9. Are you practicing *individual household and communal forage for part of the year* (**Type C**)? ***Yes or No***. If yes, go to question 10. If no, move to question 11.
10. How many cattle did you sell from type C?…….,How much did you earn?. How many activities and labor used **for Type C**? time spent for each individual use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

11. Are you practicing *individual household and communal forage for whole year* (**Type D**)? ***Yes or No***. If yes, go to question 12. If no, move to question 13.
12. How many cattle did you sell from type D?…….,How much did you earn?. How many activities and labor used **for Type D**? time spent
    for each individual use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

13. Are you practicing *fattening* (**Type E**)? Yes or No. If yes, go to question 14. If no, go to question 15.
14. How many cattle did you sell from type E?…….,How much did you earn……kip?. How many activities and labor used **for Type E**? time spent for each individual use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

15. Do you have forage field? ***Yes or No***. If Yes, please continue question 16, 17and 18. If No, move to question 19.
16. How many plots you have?.....plots.
17. This year how large your forage field?.....ha, what forage types do you plant? (1) Guinea ……..%, (2) Ruzi…..……%, (3) Napier……..…%
18. How many kg of forage seed that you sell?.....,How much you earn?.....kip. Activities and labor used for forage field, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Clear land										
Burn										
Fencing										
Planting										
Weeding										
Harvest seed										
Others										

- **Land holding, land use, production and labor use.**

In Poungpao, there are several agriculture activities particularly upland crops and plantations, therefore questions are used to ask accordingly to the activities present in the village.

19. Do you have upland rice (swidden/dry rice)? ***Yes or No***. If yes, please continue question 20, 21 and 22. If No, move to question 23.
20. How many plots do you have?.....plots
21. Last year, how large your upland rice is being cultivated?.....ha, how many kg this you harvest?.....kg sell?.....kg, earn?.....kip
22. Activities and labor used for upland rice, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Clear land										
Burn										
Re-burn										
Fencing										
Sowing seed										
First weeding										
Second weeding										
Third weeding										
Harvesting										
Carrying rice to village										
Others										

23. Do you have paddy field? ***Yes or No***. If Yes, please continue question 24, 25 and 26. If No, move to question 27.
24. How many plots do you have?.....plots.
25. Last year, how large your paddy field is being cultivated?.....ha. how many kg this you harvest?.....kg sell?.....kg, how much you earn?.....kip
26. Activities and labor used for paddy field, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Prepare seed bed										
Seedling										
Clear weed										
Fencing										
Ploughing										
Transplanting										
Taking and watering										
Weed pulling										
Harvesting										
Threshing										
Carrying rice to village										

27. Do you have cornfield? ***Yes or No***. If Yes, please continue question 28, 29 and 30. If No, move to question 31.
28. How many plots do you have?.....plots.
29. Last year, how large your corn field is being cultivated?..... ha. how many kg this you harvest?.....kg sell?.....kg, how much you earn?.....kip
30. Activities and labor used for cornfield, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Clear land										
Burn										
Re-burn										
planting										
Fencing										
First weeding										
Second weeding										
Third weeding										
Harvesting										
Carrying corn to village										
Sun dry										
others										

31. Do you have job'stear field? ***Yes or No***. If Yes, please continue question 32, 33 and 34. If No, move to question 35.
32. How many plots do you have?.....plots.
33. Last year how large your job'stear field being cultivated?..... ha. how many kg this you harvest?.....kg sell?.....kg, how much you earn?.....kip
34. Activities and labor used for job'stear field, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Clear land										
Burn										
Re-burn										
planting										
Fencing										
First weeding										
Second weeding										
Third weeding										
Harvesting										
Carrying corn to village										
Sun dry										
others										

35. Do you have sesame field? ***Yes or No***. If Yes, please continue question 36, 37 and 38. If No, move to question 39.
36. How many plots do you have?.....plots.
37. Last year how large your sesame field is being cultivated?.....ha. how many kg this you harvest?.....kg sell?.....kg, how much you earn?.....kip
38. Activities and labor used for sesame field, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Clear land										
Burn										
Re-burn										
planting										
Fencing										
First weeding										
Second weeding										
Third weeding										
Harvesting										
Carrying corn to village										
Sun dry										
others										

39. Do you have teak garden? ***Yes or No***. If Yes, please continue question 40, 41 and 42. If No, move to question 43.
40. How many plots do you have?.....plots.
41. Last year how large your teak garden?.....ha. how many tree/m^3 this you harvest?..... sell?....., earn?.....kip
42. Activities and labor used for teak plantation, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Clear land										
Burn										
Plant										
Fencing										
Weeding										
Tilling										
Cut and carry to home										
Others										

43. Do you have para rubber garden? ***Yes or No***. If Yes, please continue question 44, 45 and 46. If No, move to question 47.
44. How many plots do you have?.....plots.
45. Last year how large your para rubber garden?.....ha. how many kg this you harvest?.....kg sell?.....kg, how much you earn?.....kip
46. Activities and labor used for para rubber plantation, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Clear land										
Burn										
Hole digging										
Fencing										
Planting										
Weeding										
Tapping										
Carry latex to home										
others										

47. Do you have agar wood garden? ***Yes or No***. If Yes, please continue question 48, 49 and 50. If No, move to question 51.
48. How many plots do you have?.....plots.
49. Last year how large your agar wood garden?..... ha, how many trees this you harvest?..... sell?....., earn?.....kip
50. Activities and labor used for agar wood plantation, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					
Clear land										
Burn										
Fencing										
Planting										
Weeding										
Others										

- **Other Livestock holding, activities and labor use**

51. Do you have buffalo? ***Yes or No***. If Yes, please continue question 52 and 53. If No, move to question 54.
52. How many do buffalo you have?.....Big male……..Big female……Small male……Small female……. How many buffalo did you sell?.....How much did you earn?.....kip.
53. Activities and labor used for buffalo raising, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

54. Do you have pig? ***Yes or No***. If Yes, please continue question 55 and 56. If No, move to question 57.
55. How many pig do you have?.....Big male……..Big female……Small male……Small female……. How many did you sell?.....How much did you how much you earn?.....kip
56. Activities and labor used for pig raising, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

57. Do you have goat? ***Yes or No***. If Yes, please continue question 58 and 59. If No, move to question 60.
58. How many goat do you have?.....Big male……..Big female……Small male……Small female…… How many did you sell?.....How much did you how much you earn?.....kip
59. Activities and labor used for goat raising, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

60. Do you have poultry? ***Yes or No***. If yes please continue question 61 and 62. If No, move to question 63.
61. How many poultry do you have?.....Big male……..Big female……Small male……Small female…… How many did you sell?.....How much did you earn?.....kip
62. Activities and labor used for poultry raising, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

- **Off-farm activities and labor use**

The off-farm work activities in the village are laborer for agriculture and non-agriculture as well as doing trading and teacher. The questions will ask and cover of all these activities.

63. Do you have any people in your family doing **wage** labor for agriculture work? ***Yes or No***. If Yes, please continue question 64. If No, move to 65.
64. Wage labor for agriculture work, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total time spent	Total income
		Father	Mother	Son	Daughter						

65. Do you have any people in your family doing **wage** labor for Non-agriculture works (construction work, etc…)? ***Yes or No***. If Yes, please continue question 66. If No, move to 67.
66. Wage labor for Non-agriculture works, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

67. Do you have any people in your family doing trading? ***Yes or No***. If Yes, please continue question 68. If No, move to 69
68. Labor use for doing trading, time spent for each individual, use cropping calendar to facilitate the interview of time spent for each activity.

Activities	What month the activity is taken? (Jan., Feb., Mar., Apr., May, Jun., Jul., Aug., Sep., Oct., Nov., Dec.)	Estimation of time spent (hrs) or (man-day)								Total
		Father	Mother	Son	Daughter					

69. Do you have any people in your family doing permanent/long time of contract job (teachers, staff of a factory/garment get paid as monthly salary)?
Yes or No. If Yes, please continue question 70. If No, just finished.
70. Permanent/long time of contract job.

Permanent/long time of contract job	Estimation of time spent (hrs) or (man-day)										Total income
	Father	Mother	Son	Daughter							

APPENDIX II. CATTLE MEASUREMENT FORM

HH id	Ethnic	Name of HH head	Total Cattle	Sample cattle	Cattle id	Cattle Age (month)	Cattle Sex	Body length (cm)	Shoulder girth (cm)	Feeding System (B,C,D)

APPENDIX III. CHECKLIST FOR DISCUSSION WITH KEY INFORMANTS

1. Demographic information

- How many households are there in the village?
- What are the main ethnic groups in the village? (Hmong, Khmu, Lao…)
- How many total population? Male and female? (Hmong, Khmu, Lao…)
- What is the main livelihood activities in the village? (on-farm, off-farm, non-farm…)

2. Village history

- How old this village? Has there been any merging between your village and others, or reallocation of the village?
- How many villages relocated, what are they, from when?
- Have your village faced any problems such as flood, drought, crop diseases, pest?

3. Access to public services

- What level of school do the village have?
- The village have clean water or river or other sources?
- Does the village have medical box, health care center and where is the nearest hospital to the village?
- What type of electricity does the village access? when?
- What is the main type of road that the village access? when?
- Does the village access to mobile signal?
- Is there any market place, ten-days market? where? what day of the week?
- Has there been any trader outside the village or company contacting you or village committee regarding agricultural trade information?

4. Agricultural and natural resources and land-use types

- What are the main agricultural activities in the village?

- Has there been any conflicting issue regarding agricultural land uses?
- Has there been any state-initiated rules and regulations governing access of each forest? When?
- Does the village share natural and/or communal resources?
- Is there any rule and regulation governing the communal grazing land? and how, please explain?
- Have you noticed any change in the management of the communal grazing land in the past years?
- Has there been any physical change in the communal grazing land?
- What are the common conflicts over using the communal grazing land?

5. Swidden system

- Could you please describe what are customary rules and regulation governing the allocation of upland farming area to a household?
- What is the length of the fallow period? Please specify in number of years?
- Intensification and shorten rotation due to increase of population?
- Is there still land available for slashing?

6. Large livestock

- For large animals, is there any rule or regulation governing animal grazing?
- Has there been any conflict regarding large ruminant animals damaging individual property?
- When large ruminant animals are sold, what is the role of a village committee in this transaction?

7. Development intervention

- Has there been any government or non-government project regarding agricultural extension or development? Cash crop, forage, livestock, swidden farming?

- Is there any current agricultural policy or development that the local government is particularly persuading people in the village?