



Maize boom, bust and beyond: Investigating land use transitions in the northern Thai uplands

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ABSTRACT

Over the past few decades, increasingly intensive maize farming by smallholders in the uplands of northern Thailand has produced a maize boom that has fed the country's livestock industry. Despite continuously high demand for feed maize, its cultivation has declined unexpectedly over the past decade, pointing to a major land use transition in the uplands. This study investigates the causes of this maize bust and its accompanying land use changes from the perspectives of smallholders. Drawing from fieldwork in the northern province of Nan, we examined their household-level decision-making, challenges, and future visions around land use and livelihoods. Data was collected through a survey of 347 households across 10 villages and semi-structured interviews with 45 smallholders and 8 of their children. We found that many smallholders are being squeezed out of maize because of surging production costs and labor shortages due to aging and the economic out-migration of younger household members. However, rather than abandoning farming altogether, these smallholders are investing in less labor-intensive perennial crops for livelihood security amidst an uncertain future, signaling a pivotal land use transition in the northern uplands. Our data suggests that the ability to make this transition depends on access to land and financial resources. This raises questions around policy support for smallholders with fewer resources who remain dependent on maize despite the growing production risks.

1. Introduction

The proliferation of cash crop production has transformed landscapes across Southeast Asia. In the uplands of mainland Southeast Asia, which are often characterized as forest frontiers, the conversion of shifting cultivation systems into intensified production of maize, rubber, cassava and other cash crops has led to extensive land use and livelihood changes over the past few decades (Bruun et al., 2017; Castella et al., 2023; Fox and Castella, 2013; Hepp et al., 2019; Jepsen et al., 2019; Junquera and Grêt-Regamey, 2019; Mahanty and Milne, 2016; Ornetsmüller et al., 2018; Schmidt-Vogt et al., 2009; Thouthone Vongvisouk et al., 2014; Vongpaphane Manivong and Cramb, 2008). The cultivation of these crops has expanded mainly in the form of crop booms, where the area devoted to a single monoculture multiplies rapidly before subsequently declining (Hall et al., 2011; Ornetsmüller et al., 2019). Cash incomes from crop booms have been a staple of economic development in the rural uplands and aided the agrarian transition from subsistence- to market-based economies (De Koninck, 2004; Ornetsmüller et al., 2018). However, there are also concerns that

the swift socio-ecological transformations brought about via crop booms have also fueled socio-economic differentiation and insecurity, environmental degradation, and land grabbing (Bruun et al., 2009, 2017; Hall, 2011; Mahanty and Milne, 2016; Puwadej Thanichanon et al., 2018; Ziegler et al., 2009). While much of the literature on crop booms has focused on corporation-driven large-scale land acquisitions, a growing number of studies are examining smallholder-mediated crop booms, especially given their prevalence in Southeast Asia (Castella et al., 2023; Cramb et al., 2017; Fox and Castella, 2013; Junquera and Grêt-Regamey, 2019; Ornetsmüller et al., 2018).

Maize is one of Thailand's key cash crops and is used mainly to feed the country's rapidly expanding livestock industry, especially poultry production for which maize is a key feed ingredient (Nicely and Sakchai Preechajarn, 2018). In 2018, 80% of the over 8.2 million tons of maize used in livestock feed entered the poultry sector (TFMA, 2019). About 70% of all maize produced in the country comes from smallholder farms in the rainfed uplands of the north (Hayward et al., 2018), where the shifting cultivation systems that used to dominate have been converted into intensive permanent cropping systems. Maize cultivation has

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expanded into the more marginal lands of upper northern Thailand, home to many national forest reserves, since the late 1990s (Hayward et al., 2018; Yap et al., 2017). The maize boom has been driven by industrial demand and price increases as well as policy support in the form of price guarantee policies, credit provision through the government-run Bank of Agriculture and Agricultural Cooperatives, and protectionist measures against imports of maize (Khemarat Talerngsri Teerasuwannajak and Sittidaj Pongkijvorasin, 2015; Sarinee Achavanuntakul et al., 2013). Maize smallholders have also gained easier market access due to the presence of local millers and traders and extensive road infrastructure (Benchaphun Ekasingh et al., 2004).

However, there are signs that the peak of the maize boom in upper northern Thailand has passed, and since 2015 the maize cultivation area has decreased (OAE, 2019). This contraction has occurred despite significant shortages in maize supply for the livestock industry (Hayward et al., 2018) and relatively high maize prices. While some studies have documented the maize boom in northern Thailand, no studies have examined the extent of the ongoing maize bust and its causes. A number of contributing factors are possible, as suggested by studies on the impacts of the maize boom. Intensive maize cultivation in the uplands has been found to degrade soil quality (Bruun et al., 2017), which reduces yields and productivity and increases the need for fertilizers and other inputs. As a result, the increased costs of production and the need to take out loans has contributed to smallholder indebtedness and poverty (Khemarat Talerngsri Teerasuwannajak and Sittidaj Pongkijvorasin, 2015) and made maize cultivation less tenable for smallholders, especially in the face of maize price fluctuations. There has also been public environmental backlash against maize, mainly due to its encroachment into national forest reserves, which may have pressured smallholders to switch from maize cultivation to alternative activities (Sittidaj Pongkijvorasin and Khemarat Talerngsri Teerasuwannajak, 2019). In addition, the military junta of 2014 and its succeeding government have reclaimed untitled land in forest reserves, where much of the upland maize cultivation takes place, in the name of forest restoration (Hayward et al., 2018). It is unclear how these and other potential factors might have influenced smallholder decision-making to reduce or abandon maize cultivation, and which alternative land uses and livelihoods the smallholders are turning toward instead. Our study examines these issues and provides insights into smallholder agency and land use transitions in the uplands of Thailand, addressing a lack of understanding of how smallholder agency influences land use decision-making in Southeast Asia (Lundsgaard-Hansen et al., 2018), with implications for land use sustainability and livelihoods.

This study addresses three main research questions: Firstly, what are the ongoing land use changes? Secondly, why are these land use changes occurring? And finally, what are the implications for the future of land use and livelihoods in these upland areas? We examine the maize bust and concomitant transitions to other forms of land use through the lens of smallholder decision-making, focusing on a case in Nan, a major maize-producing province in northern Thailand where the maize boom-and-bust has been evident. We also provide policy recommendations to increase equity and livelihood security during these land use transitions.

2. Materials and methods

We used a mixed-methods approach to study land use change processes at a single study site. The study site was selected because of observable changes in land use, from the historical dominance of maize cultivation in the uplands to an increase in heterogeneity of land cover since the mid-2010s. We integrated quantitative analysis to gain an overview of current land uses and household livelihood portfolios with in-depth qualitative analysis to examine land use change histories and smallholder decision-making. In addition, we used secondary land use data at the district and regional levels to situate the observed localized changes within land use trends at larger scales.

2.1. Analytical framework

We explore the interactions between structural factors and smallholder agency to explain smallholder decision-making and the resulting land use changes. Land use scientists recognize that external driving forces alone cannot completely explain land use changes (Lambin et al., 2001; Malek et al., 2019) and that land use decision-making needs to be distinguished from drivers (Mertz et al., 2008). The structure-agency framework has been used to explore land use decision-making, where agency, or the ability of a decision maker to act in pursuit of their interests (Lundsgaard-Hansen et al., 2018) is mediated by structural factors beyond the control of the decision-maker that enable or restrict certain options (Roy Chowdhury and Turner, 2006); in other words, “individual agency in response to social constraints” (Cole et al., 2019, p. 175).

Agency can be seen as a combination of motivation and abilities (Malek et al., 2019) and agency is also “temporally embedded” (Emirbayer and Mische, 1998, p. 962), as past experiences, habits and future expectations influence present decisions. In this study, we interpret motivation as the forward-looking wishes or aspirations of smallholder decision-makers, and abilities as the smallholders’ possession of or access to resources to act in the direction of those aspirations.

2.2. Study site

Data was collected from Santi Suk district in central Nan province, where maize has been a key cash crop for over forty years (Khemarat Talerngsri Teerasuwannajak and Sittidaj Pongkijvorasin, 2015) (Fig. 1). Maize is cultivated on slopes in the uplands, much of which are located in national forest reserves (*pa sa-nguan haeng chat*). In Santi Suk district, 95% of the land is classified as national forest reserves (Santi Suk DOAE, n.d.). Santi Suk district has a hilly topography and an elevation between 600 and 1200 m above sea level. Around one-quarter of the district has an inclination of at least thirty degrees (Santi Suk DOAE, n.d.). Paddy rice and rubber are the other main crops.

Nan province has a tropical savanna climate with three seasons: a rainy or monsoon season from May to October, a cold dry season from November to February, and a hot dry season from March to April (Santi Suk DOAE, n.d.). The mean annual temperature is 26 °C and the mean annual precipitation is 1,250 mm (National Center for Atmospheric

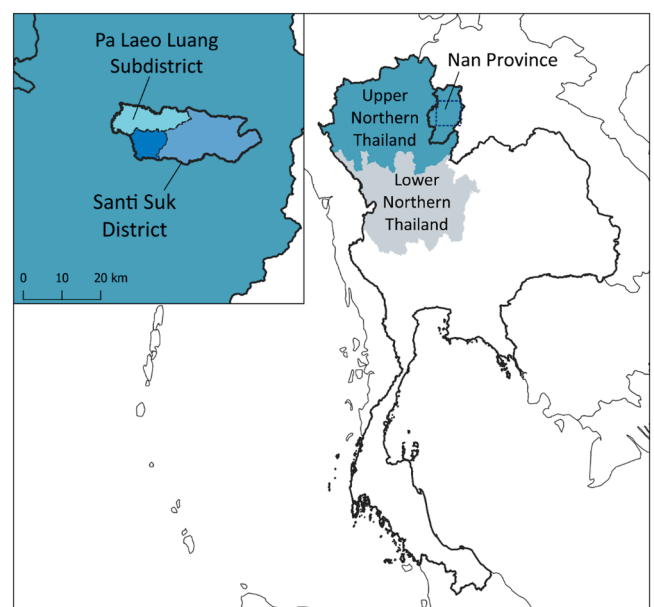


Fig. 1. Map of northern Thailand and the study site located within central Nan province.

Research Staff (Eds), 2017).

Pa Laeo Luang sub-district in Santi Suk district was selected as the study site. The population of Pa Laeo Luang sub-district is around 4,300, the vast majority of whom are of Tai Lue descent (CODI, 2019). Pa Laeo Luang sub-district covers approximately 100 square kilometers and is located 30 kilometers from Nan city. It is dissected by a highway, with nine villages sitting in the lowlands on both sides of the road and one village in an upland area. The study covered all ten villages of Pa Laeo Luang sub-district.

2.3. Data collection and analysis

Data collection took place in March 2020 and between October 2020 and January 2021. The household was used as the unit of analysis to explore land use decisions in the context of spatially and occupationally dispersed household members and livelihoods, as is commonly the case in Thailand (Rigg et al., 2016). A survey was conducted with 347 randomly selected households (24% of all households), with the number of questionnaires proportionate to the number of households in each village. The survey was deployed digitally using Open Data Kit (ODK) open-source tools (Hartung et al., 2010). The lead author and ten enumerators from Nan province carried out the survey using the ODK mobile phone application. Each questionnaire was done with a household representative who had an overview of the household's livelihood activities and land use (59% of the respondents were women). The survey topics covered livelihood activities and income generation, land use, land use changes specific to maize, and participation in land use intervention projects. The survey data was analyzed using R (R Core Team, 2021).

We conducted follow-up semi-structured interviews with 45 of the surveyed farmers. The pool of potential interviewees consisted of questionnaire respondents who had indicated that they would be willing to participate in a follow-up interview. We sampled interviewees to achieve a balance in terms of households that were still cultivating maize (49%) and households that were no longer doing so (51%), as well as in terms of gender (63% women) and age distribution (35–73 years, median age 50.5 years). The interview topics covered land use histories, land use decisions, and future aspirations and foreseen challenges regarding the households' land use and management and the livelihoods of younger generations. The interviewees were asked to draw farm plot diagrams to elaborate on land use histories. In addition, eight interviews were conducted with the children of maize farmers on their education, livelihoods and future plans. Twenty-one key informant interviews with local administration, government departments, value chain actors, and land use intervention projects were also conducted to seek their perspectives on ongoing land use changes. The interviews were conducted in the local northern Thai dialect or central Thai.

All interviews were transcribed in Thai. The data was coded using thematic analysis, integrating themes and codes that emerged from the survey results and the interview data itself. QualCoder (Curtain, 2022), an open-source qualitative analysis software, was used for the analysis. Quotes for this article were translated by the lead author.

In the following section, we first describe the maize boom in Pa Laeo Luang sub-district starting in the 1980s as the smallholders had experienced it. We then illustrate the recent and ongoing land use and livelihood changes and explain the smallholders' decision-making.

3. Results

3.1. Land use changes: from maize boom to bust

3.1.1. The maize boom in upper northern Thailand

Maize cultivation expanded into the upper provinces of northern Thailand from the late 1990s to the early 2010s (Fig. 2) (OAE, 2019). This northerly expansion indicated a spread of maize into the upland areas that are typical of the montane upper northern provinces (see

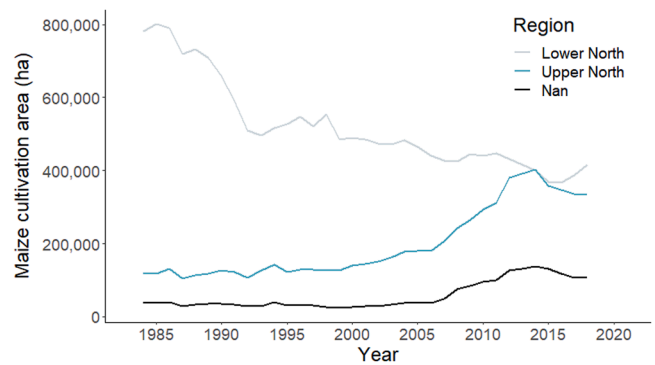


Fig. 2. Area of maize in Nan province and upper and lower northern Thailand from 1984 to 2018.

Data source: Office of Agricultural Economics.

Fig. 1). During the same period of time, the area of maize cultivated in the lower northern provinces, where lowland maize cultivation is more common, decreased by 47%. At the peak of the sub-regional maize boom in 2012–2014, Nan province was second among all northern provinces in terms of area of maize cultivation. However, this picture of the maize boom likely underestimates the extent of maize cultivation in upland areas before the mid-2010s because untitled farmland was usually not registered with the Department of Agricultural Extension (DOAE) up until then. In 2019, 83% of all maize registered with the Nan DOAE in Nan was cultivated on untitled land (signifying upland areas). In Santi Suk district, which contains the study site, that proportion was even higher, with 92% of registered maize cultivated on untitled land (statistics obtained from the Nan Department of Agricultural Extension, November 4, 2019).

3.1.1.1. The start of the boom. The smallholder interviews painted a picture of the maize boom on the ground. The farmers described a major shift in land use from extensive shifting cultivation to intensive maize farming systems at the study site within their own lifetimes. Most of the interviewees (91%) took over their parents' or in-laws' farmland between the 1970s and 2000s when they were young adults. Over half of the interviewees (62%) made the switch from upland rice to maize when they took over the farmland, either all at once or through a piecemeal transition, with most enacting this change between the 1980s and 2000s, indicating that maize cultivation here started earlier compared to much of Nan province in general. Others were unable to recall when their families had started cultivating maize on their households' land as it was their parents or even "grandparents and great-grandparents" who had started cultivating maize, and they had merely inherited the practice. A smaller number started cultivating maize in the 2010s. The interviewees' most frequently cited reason for starting maize cultivation (84%) was the need for income to pay for the household's living expenses, which increased as they started raising children and sending them to school. Maize was the default source of income because the farmers "did not know what else to do" (mentioned by 58% of the interviewees); there was no market for any other agricultural products, nor any locally situated factories or jobs for which they could be hired. A commonly cited alternative was to go to Bangkok to work as laborers if they possessed the skills for non-farm work (done or mentioned by 60% of the interviewees). According to one interviewee, "If we in the countryside didn't have maize, we wouldn't have money".

Before the 1980s, few households were growing maize. Those who did had small parcels of maize as part of their shifting cultivation farming systems, and did not use chemical inputs. Labor sharing was prevalent. One smallholder described tens of villagers chopping the weeds growing on one household's maize parcel, working in rows and eating meals communally. The maize was sold at relatively low prices (0.06–0.09 USD per kilogram).

3.1.1.2. Expansion and intensification. The growing popularity of maize among farmers and the expanding market infrastructure due to growing feed demand in the 1980s was an incentive for more farmers to start growing upland maize. Seeing the earlier maize farmers regularly selling to traders who came directly to their farms and making large sums of money, many followed suit.

Households expanded their maize cultivation by clearing areas left fallow, renting land, or obtaining land from relatives. A major reason for this expansion was the debt accumulated by maize-growing households, who had made no profit or had even incurred losses due to low market prices in certain years. Some households had entered a cycle of debt by taking out loans to renovate or rebuild their housing and to pay for school fees. Selling maize was a way to pay off the debt, but many were only able to pay off the previous year's debt by taking out new loans because of fluctuating maize prices and growing costs of living. Loans were also taken out to pay for the increasing costs of maize production due to the introduction of hybrid seeds, fertilizer, and herbicides, especially in response to deteriorating soil quality. Some households described doubling or tripling their areas of maize cultivation within a few years to keep up with debt repayments. The households took out loans from formal credit institutions (the Bank of Agriculture and Agricultural Cooperatives (BAAC) and the Santi Suk Agricultural Cooperative).

Despite this period of agricultural expansion and intensification, low maize profitability spurred a large number of villagers in Pa Lao Luang, mostly young men, to migrate to Bangkok in the 1990s for construction jobs. Their households were facing growing financial burdens from school fees and housing repairs, and the real estate boom in Bangkok provided remunerative employment. Villagers tended to migrate in groups based on their networks, with some villages experiencing more out-migration than others. During their absence, upland fields were either left fallow, used for upland rice cultivation by their aging parents, or rented out to others. Many villagers returned home following the Asian Financial Crisis in 1997 when the housing market crashed. The fields that were left fallow were cleared for maize cultivation again, leading to further expansion.

3.1.2. The maize bust and shift toward perennial cropping

In this section, we describe the recent and ongoing land use changes in Pa Lao Luang sub-district.

According to the Department of Agricultural Extension, the area of maize cultivation had declined in all sub-districts of Santi Suk district between 2014 and 2020 (Fig. 3), which follows the decline of maize cultivation in Nan province and upper northern Thailand more generally (Fig. 2). Our household survey in Pa Lao Luang reflected this decrease. At the time of data collection, 85 of the 347 households surveyed were growing maize (25%) and 174 households (50%) had grown maize in

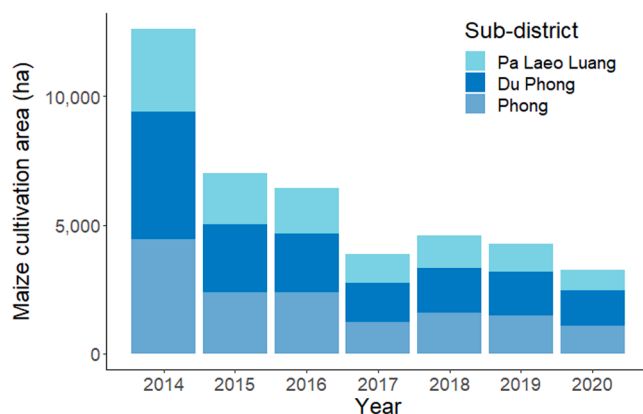


Fig. 3. Decreasing maize cultivation in Santi Suk district from 2014 to 2020. Data source: Nan Department of Agricultural Extension.

the past but abandoned it. Of all current and past maize growers, 100 households (39%) reported reducing or stopping maize cultivation since 2015. Only 25% of surveyed households planned to grow maize in the near future (2020–2025). The median area of farmland from the survey was 2.16 ha (N = 308), and the median area of upland maize was 2.4 ha (N = 85).

There was a clear ongoing shift toward perennial crop cultivation. Fig. 4 illustrates the proportions of land under different land uses since 2004 as reported by interviewees through their farm plot history diagrams. The decline in maize cultivation was compensated for by the expansion of perennial cropping. Households that were no longer cultivating maize (B) had shifted to growing fruit trees, teak and rubber instead. Even among households that were still cultivating maize (A), there was a shift toward rubber and teak production. While the survey results showed that upland maize was still the predominant land use in Pa Lao Luang sub-district, rubber was a close second (Fig. 5) and the predominant land use in three of the ten villages. Overall, there were more surveyed households growing rubber (33%) or teak (29%) than upland maize (25%) (Fig. 5). Other perennial cropping land uses included small bamboo stands, monoculture fruit orchards, and mixed cropping areas containing fruit trees and other perennial species.

3.2. Reasons for ongoing land use changes

3.2.1. Unprofitability and labor shortage

The reasons for reducing maize cultivation were economic and social: the unprofitability of maize and a shortage of household farm labor.

Survey respondents who had reduced or stopped maize cultivation (N = 100) ranked high costs of production and low maize prices as their top two reasons for doing so. Interviewees described their agricultural input expenses rising over time following the increasing market prices of hybrid seeds, fertilizers and other inputs, as well as having to use more fertilizers to compensate for soil degradation due to topsoil erosion on upland slopes. Between 2020 and 2021 alone, agricultural shops around Nan province described fertilizer prices increasing by 33% to 800 Thai baht (24 USD) per fifty-kilogram bag due to the increased prices of imported fertilizer. Using insufficient or low-quality inputs led to low maize yields that were “not worth” the effort and investment.

“To be frank, the soil in this area is not fertile. It has been cultivated for many years. Almost all the top soil has been washed away. We have to buy fertilizer, from 5 bags to 10 bags, then from 10 bags to 15 bags - it just keeps increasing. The costs increase, and the maize is unsightly. So I thought, with such expensive costs, I can't exhaust myself with this. So I stopped. It doesn't lead to anything.” (Farmer who stopped cultivating maize, aged 50)

Higher input costs coupled with market price fluctuations had left farmers unable to recuperate their investments at times. The resulting cycle of debt was an additional reason to stop maize cultivation, especially since late payments increased subsequent interest rates.

“If we don't have money then we borrow. In the end, once we've sold the maize, we don't have any left to spend. We use the money to pay off our debt. After thinking through this many times, I realized that there's nothing remaining for us. [...] We've taken out loans for many years and are paying off the debt gradually, but we can't pay it all. Our children happen to be studying, so we can't make the payments. So I thought, since the interest rates are going up, we'll just stop maize entirely. We get into debt to buy seeds, the production costs are high, it's difficult to make the payments, and the interest goes up. You see?” (Farmer who stopped cultivating maize, aged 55)

The lack of farm labor was also a major limitation to continuing maize cultivation. According to the interviewees, the farm labor shortage in their households was due to their advancing age, the absence of younger household members, and the reallocation of farm labor

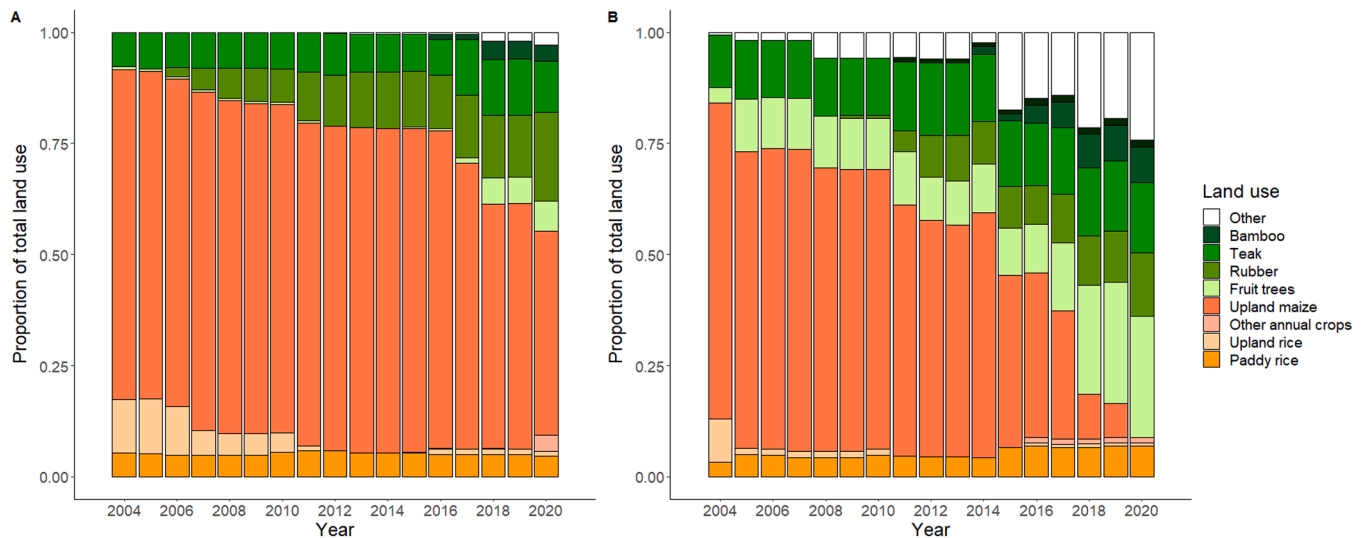


Fig. 4. Land use changes in terms of proportion of total land use, derived from interviewee’s descriptions of past and present land uses in Pa Laeo Luang sub-district, divided into (A) households still currently cultivating maize (N = 18 in 2004, N = 19 in 2020) and (B) households no longer cultivating maize (N = 20 in 2004, N = 24 in 2020).

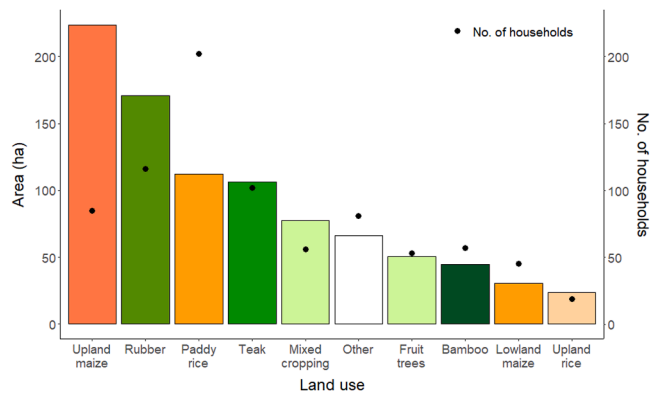


Fig. 5. Total area of different land uses from 347 surveyed households in Pa Laeo Luang sub-district, with corresponding number of households engaged in each type of land use. Note: lowland maize is typically cultivated on the same fields as paddy rice.

toward childcare. Upland maize cultivation required heavy manual labor throughout the growing season since machinery could not be used to help with land preparation, seeding, input application, and harvesting on steep slopes. Labor sharing practices had long ceased because of the high costs of feeding other villagers in compensation for their help, and households rarely hired labor because “there would be nothing left” in terms of profit. It was therefore a common practice for couples to harvest maize by themselves, spreading the process over many weeks or a couple of months. Nearly half of the survey respondents were 60 years of age or older, and many described no longer having the physical strength to carry heavy sacks of harvested maize up and down the slopes. For some, this limitation had forced them to stop maize cultivation completely. Such decisions were often supported by their children, who had migrated away for work and worried about their parents’ health. Some of the interviewees also cited the need to devote time to caring for their grandchildren, whose parents had migrated elsewhere for work, as a reason for quitting maize cultivation.

Rubber was a popular replacement for maize because it required less labor and fewer overall production costs, which suited the economic circumstances of many households. The main costs were the initial investment in seedlings and the costs of hiring labor to cut or spray weeds during the early years of growth. Once the trees had matured and shaded

the ground, weeding was done less frequently and households paid for “just fertilizer” over the trees’ productive lifespans (over two decades). The lower production costs reduced or eliminated the households’ needs for agricultural loans and therefore lightened their burden of debt. As most of the farmers were new to rubber, they had to adjust to the nocturnal tapping schedule and learn rubber-tapping techniques to increase and maintain latex yields. However, the labor was still considered manageable by households with few farming members because the same tree could be tapped at most every other day; rubber farmers could therefore rotate between sections of trees, covering a smaller number of trees within the same night. Those who were physically unable to tap their own rubber trees could obtain labor through sharecropping in exchange for half of the earnings. Another key advantage of rubber cited by interviewees was the regular income. Rubber trees were described as “ATMs” that provided a household with several thousand Thai baht (50–150 USD) every two weeks, when buyers would come to the area to collect the cup latex from rubber farmer collectives. In contrast, maize provided a lump sum once a year, which strained the spending capacity of households.

Households that turned from maize to teak, bamboo and fruit trees also cited not having to make large investments every year and the longevity of the trees as key reasons for the change. Moreover, they could harvest the fruit, bamboo shoots and wood for household consumption and sell the excess.

Households were often prompted to make the change from maize to perennial crops by the success of others around them. Interviewees described seeing early rubber adopters in their villages in the 2000s earn high incomes because of the high prices at the time and following the subsequent “rubber wave”. Interviewees who planted teak also described following others who had earned substantial incomes from sales of the premium hardwood. In many cases, the farmers were encouraged to grow these perennial crops by government agencies (the Royal Forest Department, the Rubber Authority of Thailand, and the Department of Agricultural Extension), potential buyers (e.g. for cacao), and fellow villagers.

3.2.2. Securing the future

In addition to the economic reasons above, the smallholders were also transitioning into perennial cropping as an investment for the next generation of their households. With the households having already diversified their income portfolios toward off-farm activities, perennial

cropping allowed them to maintain farming as a supplementary income source and safety net when off-farm income shrunk unexpectedly.

From the survey, the average household income increased by 48.9% from 2010 to 2020 (Fig. 6). Over the same period, the contribution of income from maize declined from 18.0% to 4.6% of the average household income. This reduction resulted from a decline in the average income from maize as well as an increase in incomes from other sources, particularly remittances. The contribution of remittances from Nan city and other provinces to the average household income increased from 32% to 48% between 2010 and 2020. Much of the remittances came from household members employed in the private and government sectors. Income from non-maize farming also increased.

Most of the smallholders interviewed did not expect their children to farm in the future because they wanted their children to obtain high levels of education and stable salaried jobs. Some interviewees expressly wished for their children to not farm because of the “laborious”, “miserable” and “risky” nature of the work. From the survey results, half (50.3%) of all household members in their thirties and almost two-thirds (64.0%) of household members in their twenties had achieved a tertiary level of education. In many cases, income from maize cultivation had funded their education. In contrast, two-thirds (67.4%) of the respondents themselves had achieved only primary-level education. Nearly two-thirds (64.6%) of household members aged 20–39 were living outside the rural homestead for education or work (Fig. 7).

Interviewees spoke of planting perennial crops as investments “for their children” that would mature “just in time” for their adult children to manage in the future. The perennial crops were meant to provide an additional source of income to their children’s salaried jobs or at least fruit that they could consume within the household. Labor could be hired to tap rubber trees and harvest fruit. The perennial crops would also provide income and food during their children’s retirement years when they returned to their family homes. Interviewees often spoke of their old age impeding them from making any plans beyond establishing perennial crops, and of being ready for their children to take over decision-making regarding the farmland in the near future. When household members of the next generation (ages ranging from 21 to 44 years old) were asked about their visions for the future, most of them expressed a desire to return to their rural homestead eventually and take up farming as a supplementary livelihood, mainly by hiring labor. They also wished to keep the land within their households’ possession.

When looking toward the future, smallholders expressed concern about the general state of the economy, low wages for new graduates, and difficulty finding work after graduation, describing the challenges their children had already faced with the high costs of living and limited employment opportunities in Bangkok. The COVID-19 pandemic and political turmoil in recent years exacerbated fears about the impact of the economy on their children’s futures. Almost 60% of the households surveyed (58.8%) had felt the impact of the pandemic on their livelihoods; in many cases their children had lost their jobs, faced salary cuts, or had difficulty going out to find work because of pandemic-related

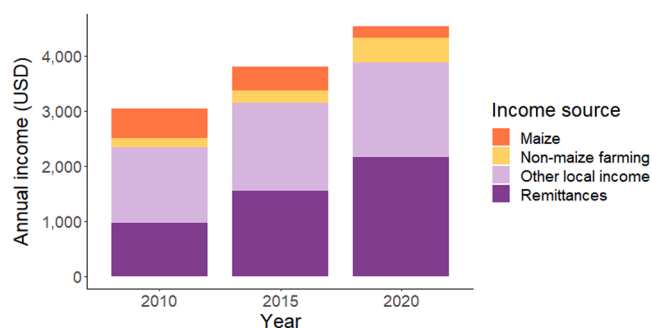


Fig. 6. Average household income by source based on 347 surveyed households in Pa Lao Luang sub-district.

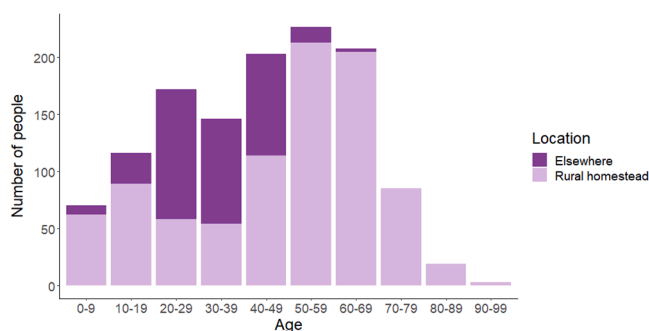


Fig. 7. Current locations of household members by age group from surveyed households (N = 347).

restrictions. Some children had returned home as a result. Many interviewees wished for their children to find salaried jobs near home so they would not have to struggle faraway from familial support, and lamented the dearth of local employment opportunities that prevented them from moving back.

“There are no jobs over there. They’re losing their jobs. The children who are in Bangkok can’t find work, and quite a few of them have gradually fallen out [and returned here]. [...] It’s difficult. My grandchild who got a university degree went abroad but there was no work. They can’t do the heavy work of farming either. They obtained a high level of education but can’t get hired. Instead of getting 15,000 baht per month [stipulated minimum wage for new graduates], there’s no work. Just 7,000 to 8,000 baht wages, which is only enough to survive. All because of COVID-19.” (Rubber farmer, aged 55)

3.3. Challenges for the maize-to-perennial cropping transition: resource restrictions and financial burdens

“Maize is unbearable, it’s tiring, but at least it makes money – better than just leaving [the land unused]. And people can send their children to school. Those who grow maize nowadays – they get the money [right away]. Not like planting fruit trees and waiting four or five years for them to start producing. From where are you going to get the money you need? So we have to grow maize, because maize will always provide for us.” (Maize farmer, aged 46)

The interview data provided insights into the challenges faced by smallholders who were still growing maize but wished to transition to perennial cropping. Not having “enough” land was an often-cited restriction. Interviewees explained that only households that had “a lot of land” were able to carry out a maize-to-perennial crop transition in a piecemeal fashion and avoid periods without income, as a plot undergoing a maize-to-perennial crop transition would not yield income during the maturation phase (several years for fruit trees, seven years for rubber trees, and decades for teak).

Apart from land restrictions, many farming households also found it difficult to give up maize even if they wanted to because of their financial situations. Households that needed money for debt repayments and other large expenses saw maize as the only feasible provider of sufficient income, arguing that only households with “self-sufficient lifestyles” were able to fully transition to rubber and other perennial crops. Interviewed households had debt ranging from 100,000 to 400,000 Thai baht (3,000–12,400 USD) and would make small, gradual payments based on “however much they could earn”, in some years making enough to cover only the interest. Some interviewees did not know when they would finish paying off their debt and relied on their working children to help. Households with school- or university-aged

children faced the extra challenge of paying tuition fees, which ranged up to tens of thousands of Thai baht per year (1,000–3,000 USD). While fluctuating maize prices did not guarantee a good profit, the potentially high earnings were considered worth the risk. On the other hand, income from rubber, while earned on a more regular basis, was considered only enough for day-to-day expenses. Some interviewees said they would only be able to afford rubber cultivation when they no longer had debt. However, there was some concern about future rubber prices because of the large number of farmers planting rubber trees. Interviewees that were reluctant to start growing bamboo cited the absence of a market and guaranteed income as a deterrent.

Other resource limitations included water shortages and the inaccessibility of plots. The lack of year-round rainwater and water storage facilities restricted the ability of households to ensure the survival of fruit tree saplings. Some of the interviewed households' fruit trees had died as a result. The long distance from more distant plots to the main road combined with the hilly terrain made it difficult to harvest and transport fruits and bamboo stems to buyers, especially since farmers were tasked with the transportation themselves, unlike with maize for which millers would provide the service.

Insecure land tenure was a particular challenge for households that had planted or wanted to plant teak. Under the Forests Act (2019), it was illegal to harvest restricted species (mostly valuable hardwoods such as teak) located outside of privately owned land. This law was a deterrent to households with untitled land. Some of the interviewees had planted teak in the hope of obtaining harvesting rights from community land titling, which almost materialized through the government in 2010 but was ultimately scrapped due to change in leadership (Chusak Wittayapak and Baird, 2018). After this failed process, the farmers described being trapped in a gridlock, not being able to harvest the teak they had planted nor use the land for other crops.

In sum, the data suggests that less access to land, financial and water resources, as well as lower plot accessibility and tenure security, reduced smallholder ability to transition from maize to perennial crop cultivation, despite any aspirations to do so.

4. Discussion

4.1. Smallholder agency and the maize boom

The structural factors described in the introduction, namely an enabling market and policy environment, played important roles in driving the maize boom in northern Thailand. However, from examining smallholder land use decision-making, it is clear that smallholder agency in taking advantage of this changing environment also contributed to the dominance of upland maize over several decades. Households were attracted to maize by the opportunities that cash crop incomes presented to pursue household aspirations, especially as the need for cash incomes increased and other income-generating occupations remained scarce. The shift to maize corresponded generally with young adults setting up new households and inheriting farmland from their parents. Other studies, using Chayanovian peasant farming theory, have used household life cycles to explain agricultural expansion in forest frontiers as the result of a growing number of dependents and a corresponding increase in household needs (Ornetsmüller et al., 2018; Walker et al., 2002). At this stage, annual crops are considered a reliable and low-risk option. The ability to participate in the boom was also facilitated by household life cycles, as the availability of young productive labor was crucial for the labor-intensive nature of maize cultivation, particularly in the beginning when farmers weeded their fields manually.

As a result, upland maize, more than any other crop, was responsible for the upward socio-economic mobility of smallholder households with little or no access to arable lowland areas. The income from maize improved immediate living conditions by funding housing repairs and

renovations and the purchasing of motorcycles that eased the long journeys to the fields. Most importantly, maize income (and loans taken out for maize farming) allowed parents to send their children to school and university. This next generation, the first to have access to higher education, has mostly out-migrated for employment in urban and industrial areas of the country, leading to the diversification of household livelihoods and incomes beyond farming. When asked about the debt they had incurred to pay for their children's education, some smallholders, while acknowledging the extensive amounts they owed, did not see their debt repayments as a source of stress. The common sentiment expressed was that debt was a part of life: everyone else around them had debt too. The payment of education fees on time, on the other hand, was a matter of urgency to them. The smallholders used their ability to access agricultural credit as a tool to equip their children for a better future. The use of maize and other cash crop incomes to improve the quality of life for smallholder household members has been documented throughout Southeast Asia (Cole and Rigg, 2019; Kallio et al., 2019; Ornetsmüller et al., 2018), and reflects the role of smallholder agency in land use decision-making and trajectories in conjunction with external economic and political drivers (Lundsgaard-Hansen et al., 2018; Singh et al., 2016).

4.2. The maize bust and northern Thailand's agrarian transition

4.2.1. The maize bust

By engaging in upland maize cultivation, rural households in northern Thailand have been integrated into a more urbanized and market-based society and therefore been part of a broader agrarian transition (De Koninck, 2004). In the first stage, the maize boom kick-started the transition from subsistence to market-based agricultural production; as the boom progressed, the income generated permitted smallholders to provide their children with opportunities to diversify into the non-farm economy. The maize bust starting in the 2010s demonstrated the decreasing viability of maize cultivation as the main livelihood activity as formerly favorable conditions of production degraded. In this phase, external economic factors squeezed farmers out of maize cultivation by making it an unprofitable endeavor. Smallholders cited the costs of agricultural inputs rising with each season, the result of land degradation and higher input prices. These large seasonal investments combined with maize market price volatilities inflated the risk of making losses. Our results mirror other studies that found soil degradation and declining yields from continuous upland maize cultivation in Thailand and other neighboring countries, with farmers increasing fertilizer use accordingly (Bruun et al., 2017; Castella et al., 2023; Kong et al., 2021; Yap et al., 2017).

In addition, the smallholders' own diminishing financial and labor resources contributed to the decline of maize. The smallholders' capacity for investing had narrowed because of accumulated debt. The financial burden often transferred to the next generation of household members whose remittances contributed toward debt repayments. A previous study on smallholder maize incomes in Nan province found that upland smallholders took out average loans of 78,547 Thai baht (2,300 USD) per year in the form of both formal and informal credit that led to "vicious cycles" of debt (Khemarat Talerngsri Teerasuwannajak and Sittidaj Pongkijvorasin, 2015). In our case study, smallholders still ended up with substantial debt even though they depended mostly on credit from formal institutions. Increased indebtedness has been a common effect of maize and other boom crop adoption in mainland Southeast Asia (Castella et al., 2023). Another disincentive for continuing maize cultivation was the diminishing household labor due to aging, out-migration, and the reallocation of farming labor toward childcare. Reduced labor capacity was also found to be an influencing factor in a case of a maize bust in neighboring Lao PDR (Ornetsmüller et al., 2018). Farm labor shortages due to generational shifts have also

been documented elsewhere in Thailand (Rigg et al., 2020). The combination of unprofitability, increased risk, and capital and labor constraints drove smallholders to cease or downscale their maize production. The labor constraints, in particular, seemed to signify the decline of farming as a livelihood.

A diminishing need for farming income also contributed to the decision to abandon maize. In many households, the children raised and educated using income from maize cultivation had reached adulthood and achieved economic independence, thereby reducing the financial burden on their households. Household incomes had also increased thanks to the contribution of off-farm remittances, sent back 'home' by the newly educated generation who had migrated elsewhere for employment. As a result, smallholders felt less pressure to invest in crops that produced hefty incomes such as maize. Life cycles and changing household configurations therefore played an important part in the decline of maize cultivation as well as the diversification of household livelihood strategies toward non-farm work, a trend that is echoed elsewhere in Thailand and Lao PDR (Ornetsmüller et al., 2018; Rigg et al., 2018).

The impact of migration on intra-household flows of income and labor proved to be an important factor in inducing the maize bust in Pa Lao Luang. These rural-urban linkages tend to be overlooked in favor of more evident proximate factors, in this case increasing production costs and indebtedness, when examining local land use changes. On the other hand, the media-spotlighted environmental backlash against maize did not emerge as a reason to reduce or abandon maize cultivation in this study.

The conditions that caused the maize bust – unprofitability due to rising costs of production, indebtedness, the reallocation of household labor toward off-farm activities, and soil degradation – seem to indicate that the process of deagrarianization has commenced at the study site (Bryceson, 1996; Hebinck, 2018). However, further findings from our study demonstrate how smallholders have navigated these unfavorable conditions while maintaining their connection to farming.

4.2.2. Transition to perennial cropping

Rather than giving up on farming altogether, households were engaging in a transition from maize to perennial crops, painting a more complex picture of the agrarian transition. The future aspirations of the smallholders interviewed pointed toward preserving agricultural land within family 'ownership' (even without land titles) and farming as a part of household livelihoods, at least for the immediate next generation. Perennial crops were used as transitional crops to hand off the farmland from aging farmers to the next generation of educated wage-workers in their households, even as the latter became removed from farming itself. This familial attachment was less sentimental and more functional in nature; in the interviews, many aging smallholders were not concerned about what their children decided to do with the land in the future, only that the land would be there to serve their aspirations.

Regardless, by starting the transition to perennial crops, the current generation of farmers was enacting agency to provide options for the following generation. The income and produce from perennial crops could act as a safety net for household members in times of economic uncertainty and job insecurity. Many households deemed maintaining farming income a necessity while younger household members navigated a challenging job market for new graduates. The importance of this safety net became even more apparent during the COVID-19 pandemic when the Thai economy took a downturn and many households lost their off-farm means of income generation. For many smallholders, this was an echo of the Asian Financial Crisis when they lost their construction jobs in Bangkok and returned to Pa Lao Luang to re-establish their farming livelihoods. Among farming households, it was the households that relied on off-farm urban incomes that had taken the biggest income hit during the crisis (Bresciani et al., 2002). Past and present experience with having farming as a backup during economic turbulence likely colored the smallholders' perception of farming and

farmland as a form of security. As farming had been their main livelihood activity, it is unsurprising that this is the livelihood option they invested in when looking toward an uncertain future, reflecting the temporally-embedded nature of agency in decision-making (Emirbayer and Mische, 1998).

Rigg et al. (2018) found a similar persistence of smallholder farming and farmland in northeastern Thailand despite increasingly unfavorable conditions because of the precarity of non-farm work carried out by out-migrated household members, illustrating what the authors termed a "truncated agrarian transition". Other scholars have questioned the inevitability of deagrarianization as capitalist development progresses, especially in the Global South where smallholder persistence is especially marked (Hebinck, 2018). However, whether the next generation will inherit this persistence remains unclear. If it does, it might be in terms of using farmland and rural homesteads not as commercially productive assets but as sites of subsistence (supplementing food purchases) and social reproduction (retirement and childcare) (Rigg et al., 2018).

Other case studies in Southeast Asia have documented the replacement of maize and other annual crops in the uplands with perennial crops, especially rubber (Castella et al., 2023; Mahanty, 2018) as well as the expansion of upland rubber plantations in general (Fox and Castella, 2013; Junquera and Grêt-Regamey, 2019). Our case study therefore reflects the rise of rubber in the region, a broader transition from annual to perennial boom crops, and a continuation of boom-bust cycles in the uplands (Castella et al., 2023).

4.3. Moving beyond the maize trap

Our study illustrates a general desire among smallholders to quit maize cultivation due to a decline in its economic, social, and environmental viability. However, the findings also suggest a marked difference between households in terms of their abilities to transition beyond upland maize farming. Households that continued to cultivate maize tended to have access to less land, large amounts of remaining debt, and higher dependency on farming income due to the expenses of raising and paying for the education of children who were also too young to contribute to income generation. These resource and economic constraints resulted in households bearing the continued risks of gambling with maize, even if they aspired to pursue alternatives. Those who did transition to perennial crops were moving toward lower-risk but less remunerative livelihoods. Greater land and resource access is known to facilitate land use diversification in other maize cultivation areas in Southeast Asia (Hepp et al., 2019; Kong et al., 2019), but household and individual heterogeneity around uncertainty and risk perception also greatly influences smallholder decision-making (Singh et al., 2016).

Castella et al. (2023) identify the bust phase of a crop boom as an important window of opportunity for interventions to help smallholders diversify their land uses as they experience setbacks with the boom crop and consider alternative livelihood activities. For our case, public and private sector measures could be implemented to support smallholder households facing challenges with exiting maize cultivation. Policies such as debt restructuring and forgiveness could help reduce their financial burden and reduce dependency on maize incomes. Securing market linkages for interim crops during the establishment of alternatives to maize, especially slow-growing perennial crops, would benefit households with limited access to land. There is also a need to invest in expanding and diversifying the local economy and job market beyond the farming sector. Increasing farming-adjacent and off-farm employment in rural areas would create alternative income-generating opportunities for smallholders and younger household members in a more holistic way that acknowledges the evolving nature of livelihoods – in terms of urban-rural connections and mobility, skills, and aspirations – and increases livelihood security across the interconnected generations that comprise a modern smallholder household.

5. Conclusion

The boom-and-bust cycle of upland maize at the study site in Santi Suk district seems to have run its course. Smallholders that have abandoned or downscaled maize cultivation have made decisions based on the economic unviability of production due to unprofitability and labor and capital constraints. They have instead diversified their livelihood strategies to adapt to the changing needs, resources and spatial configurations of their households, moving toward perennial cropping for aging smallholders at the farmstead and migration for non-farm work for younger educated household members. The shift toward perennial crops has allowed smallholder households to retain their connection to farming as a resource for the younger generation during times of economic uncertainty. However, we will have to see whether this connection will persevere into the future when the next generation become land managers for their households.

At the time of the study, a portion of smallholder households still depended on upland maize for their livelihoods because of land constraints and financial burdens. Many of these households continued to cultivate maize out of necessity but wished to pursue less risky crop alternatives. Future research could look into interventions to support these smallholders with the resources they need to transition beyond upland maize in Thailand and other areas where similar land use transitions are occurring.

The decline of maize cultivation in Nan province, despite the growing demand for livestock feed in Thailand, also raises the question of to where maize production will be displaced. Future research could look beyond site-specific land use changes to the connections between maize boom-and-bust cycles at different sites and the governance of related environmental and socio-economic impacts at regional and transboundary scales.

CRedit authorship contribution statement

Pravalprukskul Pin: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Bruun Thilde Bech:** Conceptualization, Funding acquisition, Methodology, Supervision, Writing – review & editing. **Messerli Peter:** Funding acquisition, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

Data Availability

Data will be made available on request.

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