Working Paper

Gendered impacts of falling rubber prices Changing livelihood strategies in China's rubber heartland

Yufang Su, Nani Maiya Sujakhu, Austin George Smith

Gendered impacts of falling rubber prices

Changing livelihood strategies in China's rubber heartland

Yufang Su, Nani Maiya Sujakhu, Austin George Smith

Correct citation: Su, Y., Sujakhu, N. M., Smith, A., 2022. *Gendered impacts of falling rubber prices: Changing livelihood strategies in China's rubber heartland.* ICRAF Working Paper 326. World Agroforestry China Program, Kunming, China, 2022. DOI: https://dx.doi.org/10.5716/WP22004.PDF

Titles in the Working Paper Series aim to disseminate interim results on agroforestry research and practices and stimulate feedback from the scientific community. Other publication series from World Agroforestry include Technical Manuals, Occasional Papers and the Trees for Change Series.

Published by the World Agroforestry
United Nations Avenue
PO Box 30677, GPO 00100
Nairobi, Kenya
Tel: +254(0)20 7224000, via USA +1 650 833 6645
Fax: +254(0)20 7224001, via USA +1 650 833 6646
Email: worldagroforestry@cgiar.org
Website: www.worldagroforestry.org

Working Paper No 326

About the authors

Yufang Su is a Professor at Yunnan Academy of Social Sciences and Deputy Director of the Centre for Mountain Futures (CMF). As a social scientist, she has worked with other scientists on a number of interdisciplinary research projects and published a series of interdisciplinary SCI journal articles. Dr. Su obtained her master's degree in Sustainable Development at Chiang Mai University, Thailand and PhD at Mae Fah Luang University, Thailand. Her research interests include natural resources management, local adaptation to climate change, land tenure, and rural development.

Nani M. Sujakhu is a post-doctoral researcher at the School of Ethnology and Sociology, Yunnan University, Kunming, China as well as lecturer at Goldengate International College, affiliated with Tribhuvan University, Kathmandu, Nepal. She has 8 years of experience conducting research into mountain environments, climate change, livelihoods, and ethnoecology. She received her PhD from the Kunming Institute of Botany, University of Chinese Academy of Sciences, Beijing, China. She possesses excellent analytical skills in community vulnerability and adaptative strategies to climate change. She has worked with farming communities in the Asian highlands to document perceptions of and adaptation strategies to climate change. She has also worked with diverse groups of people to study various commodities in Nepal, China, and Pakistan.

Austin Smith is Communications Officer at the China Programme for the Centre for International Forestry Research and World Agroforestry (CIFOR-ICRAF). He holds a master's degree in anthropology from Yunnan University. His research interests span actor-network theory, rural-urban migration, and agroforestry.

Abstract

Xishuangbanna Dai Autonomous Prefecture in Yunnan Province of China generates one-third of China's total rubber production. Sharing a continuous border with Myanmar and Lao PDR, rubber production in the region is of paramount importance to local smallholders, regional interests, and global supply chains. The rubber industry has become an important economic driver for lifting rural farmers out of poverty and ensuring basic living standards in a historically underdeveloped area of the country. However, in 2011, global rubber prices began to steadily decline. A confluence of factors triggered this, from equilibrating market dynamics (increased supply, decreased demand), its growing multipurpose use as an agricultural crop, timber species for forestry, applications in other industrial products, and fluctuating risk in financial derivatives. Recent research has also revealed that natural rubber is highly vulnerable to an array of forces, such as nominal interest rates, Chinese CNY appreciation, speculation, discrepancies in access to information across different markets, as well as changes in synthetic rubber and oil prices. This complex trend has extended into the modern day with serious consequences for development in the region.

In 2011, we visited 1014 households to conduct household surveys to learn more about land-use dynamics, assess potential impacts, and explore forms of good environmental governance to inform stakeholder understandings of regional drivers and dynamics. In 2020, we revisited 322 households from the 2011 study period to administer survey questionnaires and conduct focus-group sessions to investigate the impacts of falling rubber prices on local livelihoods and rubber production as well as farmer responses across Xishuangbanna, with a particular emphasis on gender-differentiated impacts. By analysing and comparing datasets from these two time periods, we found that rubber remains a primary source of income for locals, but both men and women have increased worry regarding livelihood strategies in the context of falling rubber prices and have been forced to seek out other sources of income, including planting more diverse cash crops and searching for work as off-farm labourers. Women generally bear a heavier workload while capturing a lower percentage of household income, and instead of spending disposable income on extra goods, people are once again focused on ensuring that essential living standards are first met. Conversely, men have greater vocational flexibility, dominating the migrant labour workforce largely because women have additional caretaking responsibilities at home and less available time. Women also generally work closer to home, which restricts their work opportunities, and they tend to obtain lower wages than men. Men usually have enhanced decision-making power in household farm enterprises and community leadership as they come into more frequent contact with the outside world, while women have expanded autonomy in conducting daily purchases. Thus, while the price plunge has been felt by all households in the area that rely on the rubber trade as a key source of income, it has particularly impacted the lives of women. This highlights the risks associated with farmer livelihoods that are dependent upon a global commodity with a highly volatile price. Policymakers at different levels and community leaders must fully consider gender-differentiated impacts of fluctuating market prices to heed and learn from the experiences of women in the area for better decision-making in the future.

Keywords

Xishuangbanna, Yunnan, China, gender, rubber, global economy, local adaptation, livelihood strategies

Acknowledgements

The survey and research period from 2020-2021 was carried out under the CGIAR GENDER Platform, which is grateful for the support of CGIAR Trust Fund Contributors (https://www.cgiar.org/funders/) and also part of the CGIAR Research Program on Forests, Trees and Agroforestry (FTA). FTA is the world's largest research for development program to enhance the role of forests, trees, and agroforestry in sustainable development and food security and to address climate change. CIFOR leads FTA in partnership with Bioversity International, CATIE, CIRAD, INBAR, ICRAF and TBI. This work was also funded in part by the UK Research and Innovation's Global Challenges Research Fund under the Trade, Development, and the Environment Hub project (project number ES/S008160/1). The survey in 2011 was part of the 'Mekong Futures' project funded by CSIRO.

Special thanks go to the kind-hearted local people throughout the areas who participated in our surveys. We are grateful to Li Zhengli, Wang Mingming, Yang Bin, as well as Jiang Yi and Li Xiang who led the field surveys and trained the enumerators/students who patiently conducted individual interviews in 2011 and 2020. We are very grateful for the efforts of Liu Song, Xiong Liangqiong, and Zou Yanan in data analysis and data entry, as well as Neil Burgess (UNEP-WCMC) and Antje Ahrends (Royal Botanical Gardens Edinburgh) for constructive comments. Thanks also go to Zhai Deli, Wang Jing, and Yang Huizhao for conducting group discussions in 2020. The inputs of all these collaborators were invaluable to improving the study.

Contents

Chapter 1: Introduction

Background

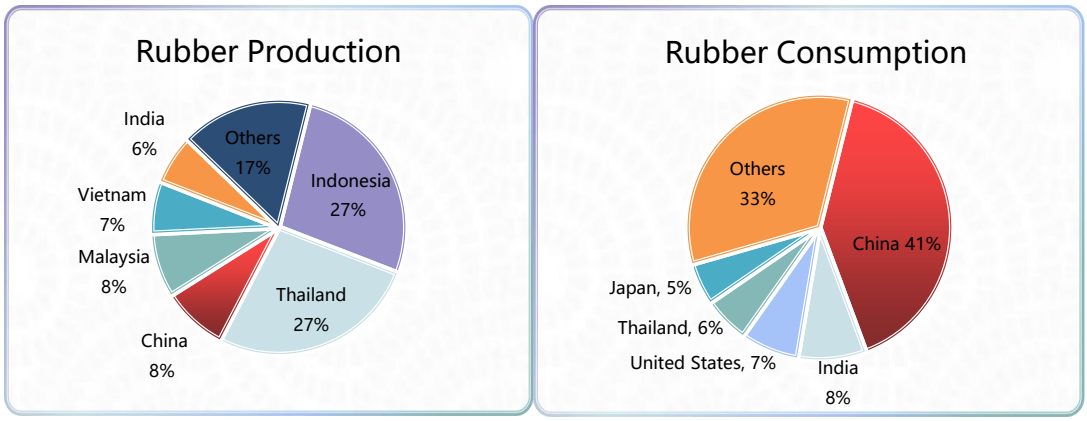
Expansion of natural rubber plantations and changes in rubber prices

Natural rubber is extracted from the para rubber tree (*Havea brasiliensis*) both in latex and coagulum form and processed into sheets, creeps, and block rubber to create an extract for further processing into various end products. It is found in numerous objects used throughout our daily lives, from car tires to clothing. Therefore, it is considered a material of strategic importance.

Para rubber trees require a tropical or subtropical climate that receives a minimum of 1200 mm of rainfall per year (Huang et al., 2017). The economic life span of rubber trees ranges between 35-40 years, and natural rubber can only be tapped and harvested 6-9 years after plantation. Natural rubber is planted across Asia, Africa, South America, and Oceania. The world's natural rubber is mainly planted in Thailand, Malaysia, Indonesia, Vietnam, China, India, Cambodia, Myanmar, Sri Lanka, Nigeria, Liberia, Cameroon, Ghana, and Gabon. Recently, rubber plantations have been rapidly expanding throughout Southeast Asia. Nowadays, 97% of the world's natural rubber is produced by rubber farms in Southeast Asia. While rubber plantations in Southeast Asia prior to the 1990s were mainly confined to southern Thailand, Malaysia, and Indonesia, plantations have recently shifted northward. This is because China's emerging car industry at the time drove the rapid expansion of monoculture rubber plantations in the Mekong region, where the crop had historically not been grown (Research and Markets, 2019). Over the last few decades, over 1,000,000 ha have been converted to rubber plantations in non-traditional growing areas of China, Laos, Thailand, Vietnam, Cambodia, and Myanmar (Fox et al., 2014). Subsistence-based farming practices have recently begun transitioning toward more commercial production models across Asia (Chen et al., 2016; Ziegler et al., 2009). According to data from the Association of Natural Rubber Producing Countries (ANPRC, 2020) (Figure 1 & Table 1), in 2019, global natural rubber output reached 13.772 million tons, with yearly 0.33% decreases, and oversupply has marginally improved. The top six countries for rubber production in 2019 were Indonesia (3,715,800 tons), Thailand (3,686,200 tons), China (1,159,000 tons), Malaysia (1,126,800 tons), Vietnam (922,800 tons), and India (866,300 tons).

Natural rubber consumption mainly occurs in Asia, Europe, and North America. International Rubber Study Group (IRSG, 2020) data from 2019 show that Asia ranks first in the world at 74.16% of global consumption; the Americas comprise the second-largest sales area, accounting for 11.96%; Europe is the third-largest sales area, accounting for 10.97%; and other regions accounted for only 2.91%. China has been responsible for the world's highest natural rubber consumption since 2002. In 2019, natural rubber consumption in China reached 5.549 million tons, accounting for 40.44% of total global consumption (followed by India, accounting for 8.33%, then the United States, accounting for 7.12%; Thailand and Japan account for 5.64% and 5.15%, respectively) (Figure 1), yet China's output in the same year comprised only 8% of total global production (Research and Markets, 2019; Jiang & Zhang, 2020). The self-sufficiency rate of China is about 20%, and virtually all natural rubber produced in China is consumed by the

domestic market. For more details, please see Table 1. It is worth noting that supply continues exceeded demand worldwide.



Source: ANPRC & IRSG, 2020.

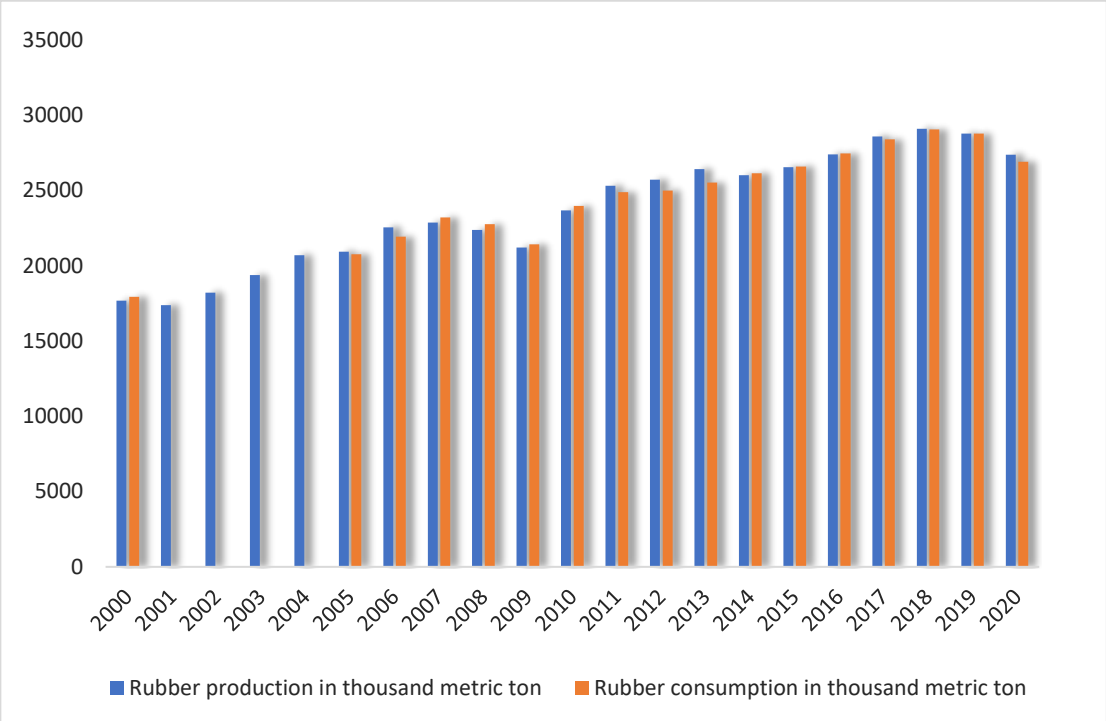
Figure 1. Proportion of rubber production and consumption

Unit: 10,000 tons

China						**Global**	
Year	Yield	Import	Export	Consumption	Supply and demand comparison	Yield	Consumption
2014	84.00	416.25	4.37	480.4	15.48	1 214.90	1 223.90
2015	79.40	410.15	4.34	478.00	7.21	1 227.10	1 225.90
2016	77.40	430.24	3.45	510.10	3.09	1 249.20	1 270.90
2017	81.40	566.5	3.30	538.60	106.00	1 335.00	1 332.70
2018	83.70	536.98	3.30	558.00	59.38	1 385.10	1 403.30
2019	81.23	504.69	3.41	554.90	27.61	1 377.20	1 372.10
2020	82.56	510.99	3.48	538.83	51.24	1 343.96	1 361.72
2021	82.29	504.82	3.52	533.83	49.76	1 334.19	1 350.58
2022	82.11	500.70	3.55	530.41	48.85	1 327.49	1 343.25

Source: ANRPC statistical data, cited in Jiang & Zhang, 2020 (2018-2022 is the forecast, as inventory is not counted).

Table 1. Supply and demand balance of natural rubber in China compared with global figures from 2014 to 2022



Source: https://www.statista.com/statistics/275387/global-natural-rubber-production/ (missing consumption data from 2001 to 2004)

Figure 2. Global rubber production and consumption

China first established a thriving natural rubber industry on the steep slopes of southern Yunnan Province in the 1950s, labelling it a crucial strategic material. Yunnan Province is now responsible for over half of China's total natural rubber production. Three-quarters of Yunnan's natural rubber is produced in Xishuangbanna Dai Autonomous Prefecture, China's 'rubber heartland' on the border of Myanmar and Laos. This one small prefecture in Yunnan supplies one-third of China's total domestic rubber production alone.

Before the implementation of the Household Responsibility System (HRS)[1] in the early 1980s, rubber plantations in Xishuangbanna were typically state-owned farms. The widespread distribution of land to farmers and rising rubber prices from 2001-2011 led to the rapid expansion of rubber plantation area, solidifying Xishuangbanna as a regional hub for rubber production. During this period, the local economy grew swiftly, accumulating a significant trade surplus. The regional economy has accordingly become highly dependent on the planting and trade of natural rubber, with land allocation primarily being based upon rubber plantation. The simultaneous overlap of peak rubber prices and production demonstrated the effectiveness of an economic model that placed rubber at the core. Lucrative rubber prices have accordingly been a major source of revenue for local governments and farmers. In 2008, rubber contributed to nearly one-third of total revenue for the People's Government of Xishuangbanna Prefecture and half of

1 The Household Responsibility System (HRS) was first implemented in rural China in the early 1980s to balance production incentives against the desire for equal access to land, and farmers' living standards greatly improved as a result. Although the earlier system of collective ownership was maintained, HRS reforms provided Chinese farmers with expanded rights to rural land. Given that land was allocated to households predominantly based upon household size figures, decision-making power over the land decentralized from the production team (of the earlier collective system) to individual households. As members of households, women were included in land allocation, but they were restricted from land rights in patrilocal marriages.

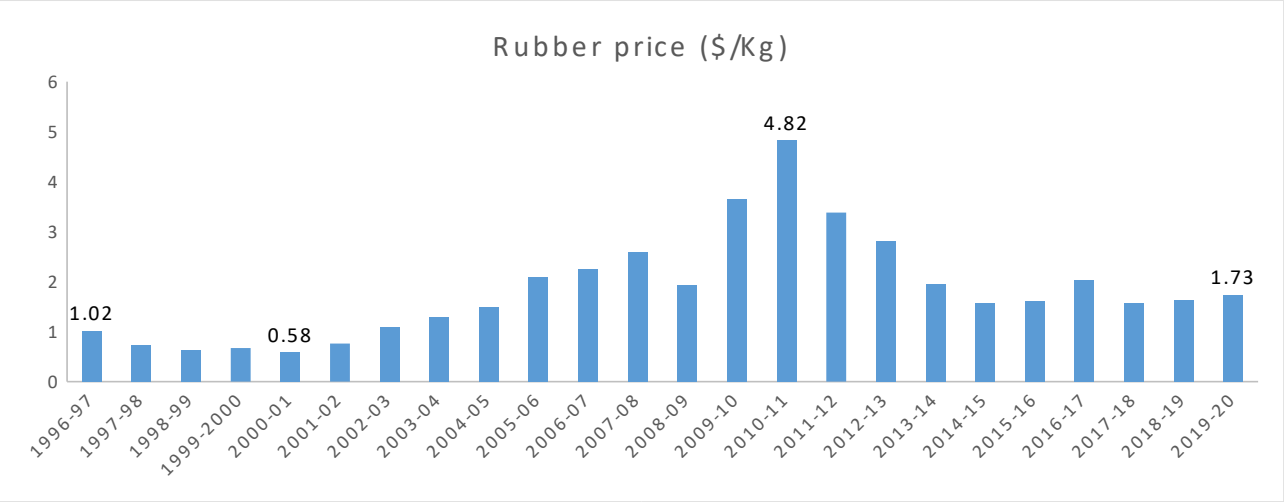
household incomes of farmers (Chen et al., 2016). Farmers have enjoyed consistently rising household incomes for years, and rubber cultivation has been a key component of poverty alleviation efforts in the region. Strong partnerships between private and public enterprises have promoted the aggressive expansion of rubber plantations not only in Xishuangbanna but also in other places in China, where rubber plantations have rapidly expanded from 0.66 million ha to 1.18 million ha (Janekunprasoot, 2020). Indeed, the economic model used for rubber has been touted across China for meeting local needs and lifting rural communities out of poverty.

Emerging issues

This newfound economic prosperity has also introduced its share of challenges, drawing the attention of conservation ecologists and economists who have sought to understand the multifaceted and interconnected issues of Xishuangbanna. The health of the Mekong River Region—a global biodiversity hotspot teeming with a rich array of animal and plant life unseen elsewhere else on the planet—is now seriously imperilled. The widespread felling of trees has caused a suite of negative effects on the land, such as loss of biodiversity, soil hardening, reduced carbon stocks, lower water availability erosion, and degradation (Qiu, 2009; Min et al., 2017a). As rubber plantations have continued to aggressively expand into intact forest ecosystems, natural forest coverage has declined from 70% in the 1970s to 50% in the 2000s. However, from 2014 to 2020, a slight increase in natural forest cover occurred for the first time as rubber plantation area decreased, indicating a mild reversal of the multi-decade trend of decreasing forest coverage and increasing rubber plantation land (Yang et al., 2021). This land-use change has overall flattened species diversity as well as accelerated rates of species endangerment. Sediment runoff and pesticide-associated pollution have also become major problems.

In addition to environmental concerns, in 2011, for the first time in decades, global rubber prices began to steadily decline, tied to increased production and falling demand for natural rubber as the primary raw material in tires. Natural rubber, as a commodity at the nexus of disparate but interconnected sectors, is characterized by volatile and difficult-to-predict pricing, given its multipurpose uses as an agricultural crop, timber species for forestry, and other applications in industrial products and financial derivatives along its entire life cycle and industry chain. Recent research (Li & Zhang, 2020; Liu et.al., 2018) has also unearthed a bevy of economic factors that affect the fluctuating price of natural rubber, such as increased vulnerability of natural rubber prices to nominal interest rates, falling prices co-related to the appreciation of the Chinese CNY, speculation dynamics uncoupled from traditional supply-and-demand fundamentals, differences in access to information between domestic and international financial markets, and a highly complex relationship between natural and synthetic rubber and oil prices.

The average market price of rubber was US$ 0.58 per kg from 2000-01. Prices trended upward until 2011, peaking at US$ 4.82 per kg (CYN 42), before falling to US$ 1.73 in 2020 (See Figure 3). This has had consequential implications for development in the region, given that policymakers in Xishuangbanna have historically leveraged a great deal of institutional support for rubber plantations as a tool for lifting locals out of poverty and generating government revenue for re-investment in large infrastructure projects. It is clear now, in 2021, after a decade of consistently falling prices, that rubber latex can no longer function as a panacea commodity for jumpstarting the economic growth of the prefecture.



Source: Singapore Exchange Ltd (SGX previously SICOM); Bloomberg; Rubber Association of Singapore Commodity E Study Group; Asian Wall Street Journal; World Bank.[2]

Figure 3. Changes in rubber price

Women's role in agriculture

Given that men are performing off-farm work in higher numbers, women are now performing a greater share of agricultural work. Data over the last four decades indicate that women comprise a higher proportion of the agricultural workforce than ever before in all regions of the world excluding Europe (Doss, 2014). Based on global statistics, 79% of women in developing countries and 48% of women globally rely upon agriculture as their primary economic livelihood (Doss, 2014; FAO, 2016). Given that women are responsible for the production of 60% to 80% of the world's agricultural produce (Doss, 2014), more research is needed on gender-differentiated impacts of fluctuating prices in the agricultural sector, particularly on the linkages between cash crops and livelihoods so as to inform national policy making in response to global price fluctuations.

The establishment of the People's Republic of China in 1949 significantly altered the status of Chinese women in society (Xie, 2013). Women were legally empowered with equal rights in marriage, encouraged to pursue education, and given pathways into the labour market. However, to this day, women still only earn 70% of male wages and occupy only 10% of village committee director positions, pointing to a significant bias for men occupying positions of political and administrative power.[3]

Despite positive changes in the recent past, the overall living standards of the 450 million Chinese women living in the countryside have not kept up with their urban counterparts (Pearson et al., 2002). Owing largely to historically entrenched gender roles, rural women are generally less educated and have fewer vocational and marital options (Pearson et al., 2002; UN Women Watch, n.d.). Rural women also tend to have the greater share of household and

2 http://data.worldbank.org/data-catalog/commodity-price-data

3 https://www.sohu.com/a/275445441_678385.

caretaker responsibilities, less stable ownership rights, and less control over productive assets all of which restrict access to income-generating opportunities that may have substantial impacts on household economic productivity. Because of these disadvantages, women tend to occupy weaker bargaining positions both in households and communities at-large.

In Yunnan, one of China's poorer and more remote provinces, paid labour, booming employment in service and manufacturing sectors, and large-scale semi-permanent migration to urban areas are all major contributors to economic growth (Zhang & Song, 2003). However, the migration of men and younger women out of rural areas has left behind many middle-aged women as the de facto heads of previously male-headed households, spurring the increased feminization of the rural agricultural sector. (Mu & van de Walle, 2011). This increased labour requirement disproportionately burdens women, given their baseline household and caretaker responsibilities. Researchers have noted that the exacerbation of these burdens can seriously affect women's physical and mental health (Mu & van de Walle, 2011; Su et al., 2017; Sujakhu et al., 2020).

There is a wide range of evidence indicating that women face less-favourable job opportunities than men for diversifying their livelihood strategies (Elin, 2015; Lanjouw et al., 2001; Smith et al., 2001; Niehof, 2004; Musinguzi, et al., 2017). In addition, restrictive financial practices and policies limit women's access to land and other assets, such as credit markets, informal risk-sharing mechanisms, and formal insurance plans (Klasen & Pieters, 2015; Kumar & Quisumbing, 2013).

Despite positive changes in the recent past and women's active role in advocating for more equitable practices and policies, no significant re-evaluation of women's limited decision-making powers in household farm enterprises or community leadership structures has taken place (Brauw & Rozella, 2008). A statistical monitoring report on the development of women in China (2011-2020)[4] reveals that the proportion of women with appointments to village committees reached 24% in 2018, marking an increase of only 0.9 percentage points over the previous year and 2.6 percentage points over 2010. Most of these political positions deal specifically with women's work and are not the type of decision-making executive role their male committee counterparts frequently undertake. Furthermore, as women move up the rungs of government hierarchy, the numbers decline even further: women comprise 9.33% of county leadership, 5.29% of city leadership, and 3.23% of provincial leadership (Lu, 2020). The male-dominated bureaucracy is thus a significant hurdle to mainstreaming more equitable gender practices and policies.

Given the labour-intensive nature of rubber cultivation, the expansion of smallholder rubber farming may influence the reallocation of family labour in the short term and the mobility of family labour in the long term (Min et al., 2017b; Kullawong et al., 2020). Since the rubber boom began in Xishuangbanna, local labourers in the region have overwhelmingly engaged in rubber plantation as the dominant livelihood strategy (Fu et al., 2009). The overall workload of women has correspondingly increased.

4 https://baijiahao.baidu.com/s?id=1652170342613399876&wfr=spider&for=pc

Gender analysis framework in agriculture

Key gender analysis concepts include the division of labour, access and control over resources, and benefits. 'Division of labour' focuses on the allocation of particular tasks to a particular gender at home, at work, and in society. 'Access' refers to the variables that increase or limit opportunities to use the resource. 'Control' examines who is able to define and decide how to use a given resource. 'Resources' refers to the materials used to produce commodities. Finally, 'benefits' are what follow from the use of said resources, including basic needs, money, assets, education, and status.

Our questionnaire specifically disaggregated gender data to shine light on the gender-differentiated division of labour occurring in Xishuangbanna households. We tailored question themes along lines of access, control, resources, and benefits to deeper probe respective topics and their intertwined nature. These topics are unpacked and examined closely in the Discussion. Data were analysed from other studies conducted in the area alongside a review of relevant literature.

Objectives

Given its importance not only to local smallholders and regional interests but also to global supply chains, local people, forests, natural resources, water, and more, rubber plantations in Xishuangbanna have been a studied landscape by international and Chinese scientists for many years (Min et al., 2019; Min et al., 2017c). However, despite the frenzy of research activity in the region from conservation ecologists and economists, little attention has been paid to the social elements that comprise villages, townships, and communities at-large. The gender-differentiated impacts of falling rubber prices on smallholding householders in Xishuangbanna remain largely unknown. Partly, this is because it is more challenging to assess impacts and attitudes toward abstracted topics—like land-use considerations, permission rights, the role of household heads, technical training, market accessibility, migration patterns, forest-land management, division of labour, and more—compared to the relative ease of quantifying impacts like forest cover loss or analysing publicly reported economic figures. Another contributing factor is the region's ethnic diversity: 13 distinct ethnic minority groups with complex cultural lineages have historically resided in Xishuangbanna (Xu et al., 2009). These groups have settled across remote mountain landscapes unevenly connected by (rapidly improving) infrastructure, isolating ethnic communities and allowing many different local dialects to remain in common use even to this day. Local dialects, sometimes with only a few thousand or even hundred modern speakers, are oftentimes mutually unintelligible with the official language of China, Mandarin, which is based on a dialect spoken in Beijing approximately 3,000 kilometres away, complicating efforts to gather reliable data.

Accordingly, our study aimed to learn more about the impacts of falling rubber prices on local livelihoods and rubber production as well as farmer responses, particularly noting divergent impacts across genders in Xishuangbanna to fill in gaps in knowledge in this long-overlooked field of research.

Structure

This working paper consists of five chapters. The first chapter provides a brief introduction to our research, including the background and objectives of the study, as well as laying out the organization of the report. The second chapter explains the methodology used in the study, including sample design, study sites, and questionnaire. The third chapter presents the results from the study based on gender statistical analysis, which includes demographic characteristics, livelihood activities, changes in household assets, and farmer responses to future changes. Following the analysis of demographic information and access to resources, the prospects for adaptation in each location are discussed using information such as the role of gender in livelihood strategies, cultural patterns, and power embedded in decision-making. The fourth chapter then uses the previously analysed information to discuss the intersection of gender and different strategies implemented by households to deal with future changes. The fifth and final chapter contains conclusions and recommendations.

It is important to note that this survey is based on responses given by the participants according to their subjective perceptions. While such responses may differ between individuals, they provide a helpful overview at the aggregate level. Therefore, specific responses presented in the text should be contextualized and viewed accordingly.

Chapter 2: Methodology

Study sites

Located in China's southwestern corner, Yunnan Province shares a contiguous border with Southeast Asia (Myanmar, Laos, and Vietnam). Yunnan is the most ethnically and biologically diverse province in China, covering a range of climatic zones and containing the headwaters of five major river systems: the Salween, Irrawaddy, Mekong, Red, and Yangtze. Its biodiversity has long been recognized—despite comprising only 4.1 percent of China's total land area, Yunnan is home to more than half of the country's floral and faunal species.[5]

Covering 19,124.5 km^2, Xishuangbanna Dai Autonomous Prefecture of southern Yunnan Province borders the Golden Triangle, which spreads across the mountains of northern Thailand, northern Laos, and northeast Myanmar. Ethnic minorities have used shifting cultivation practices in the region for at least a millennium, creating a unique ecocultural landscape. Recently, the region has been recast as a new landscape of opportunity under the monikers 'Golden Economic Quadrangle' or the 'Greater Mekong Sub-region'.

Xishuangbanna is a tropical region. For most of the year, the area is hot and moist, and during the monsoon season it receives heavy rainfall. Four bio-climatic zones characterize the region: warm temperate and moderately moist (high elevations); hot and moderately moist; extremely hot and moderately moist (middle elevations); and extremely hot and moist (low elevations) (Hammond et.al., 2015). The average temperature in Xishuangbanna ranges between

5 http://www.yn.gov.cn

20-22.5°C, with an average high temperature of 25-27°C occurring from May-June. Average precipitation falls between 1200-1800 mm annually, and the wet season lasts from May to October, during which 90% of annual rainfall occurs. Climate change projections suggest that Xishuangbanna's climate will become hotter and wetter, and the extremely hot and moderately moist as well as extremely hot and moist zones are projected to expand from covering 34% of the prefecture to almost 75% by 2050. This would dramatically increase the scope of the area in Xishuangbanna suitable for rubber plantation (Zomer et al. 2014). See Figure 4 below.

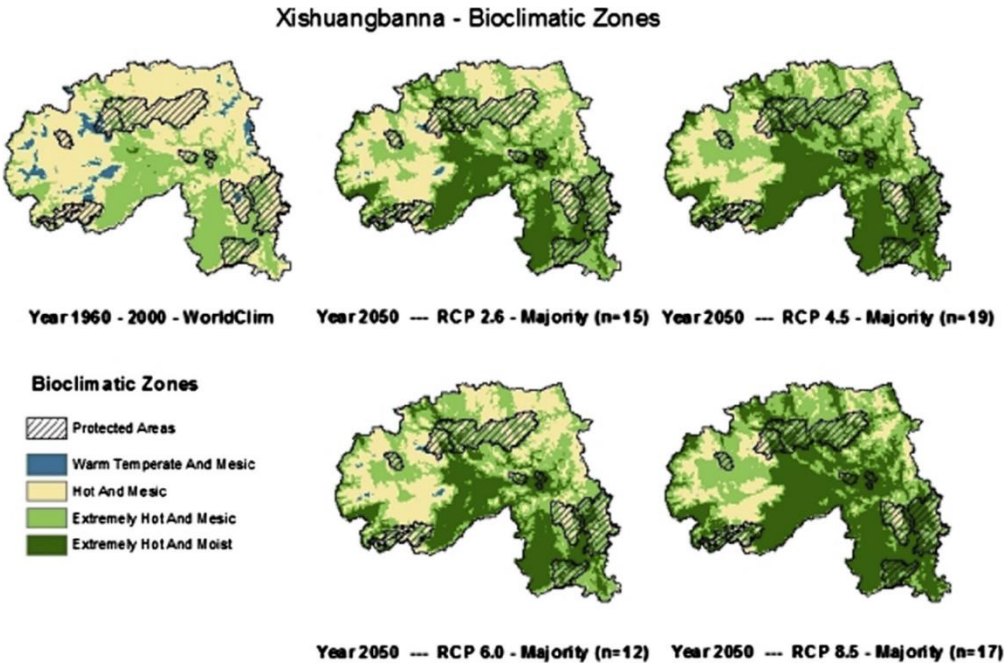


Figure 4. Predicted impact of climate change on bio-climatic zones in Xishuangbanna Prefecture in southern Yunnan Province. By 2050, almost 75% of the region will be within in the Extremely Hot and Moist or Extremely Hot and Mesic zones, providing optimal climatic conditions for rubber production (Zomer et al., 2014).

Demographic information

The prefecture is divided into three county-level areas: Jinghong Municipality, Mengla County, and Menghai County. According to the Seventh National Census in Xishuangbanna,[6] which collects comprehensive data on population, ethnic breakdown, education, and more, at the time of November 1, 2020, the permanent resident population had reached 1,301,407 in Xishuangbanna across 420,211 households, with an average population of 2.91 per household, a decrease of 0.55 per household from 2010. The male population is 684,765, accounting for 52.62% of the total population; the female population is 616,642, accounting for 47.38% of the total population. The sex ratio of the total population (100 women, male-to-female ratio) was 111.05, an increase of 3.50% over 2010. For more details, please see Table 2.

Location	Total population	Men	Women	Sex ratio	Total no. of households

6 https://www.xsbn.gov.cn/598.news.detail.dhtml?news_id=2173900

Xishuangbanna	1,301,407	684,765	616,642	111.05	420,211
Jinghong	642,737	339,650	303,087	112.06	225,912
Mengla	304,950	161,265	143,685	112.24	94,501
Menghai	353,720	183,850	169,870	108.23	99,798

Source: The Seventh National Census in Xishuangbanna.

Table 2. Population composition in the study area

Xishuangbanna is home to 13 distinct ethnic group, totalling a population of 790,200 (78% of the total population). Dai is the main ethnic group, comprising about 334,700 inhabitants (33%), while the Hani group has 210,700 inhabitants (20.8%). Jinghong is a multi-ethnic municipality home to all 13 ethnic groups: the Dai, Hani, Lahu, Bulang, Yi, Jinuo, Yao, Zhuang, Hui, Miao, Jingpo, Wa, and Han. The total ethnic population of the municipality is 304,257 (70.4%). The average annual income of rural residents was about CNY 17,615 in 2020. In Mengla, nine ethnic groups including the Dai, Hani, Yi, and Yao comprise the approximately 187,600 inhabitants (76.8%) of the county, and the average annual income of rural residents was about CNY 12,777 in 2020. In Menghai, eight ethnic groups including the Dai, Hani, Lahu, and Bulang comprise the approximately 298,000 inhabitants (88.4%) of the county, and the average annual income of rural residents was CNY 13,951 in 2020.

Among the population aged three and above in the prefecture, 119,602 people have received education at the university level (college or above); 126,620 people have received education at the high school level (including technical secondary school); 372,702 people have received education at the junior high school level; and 476,286 people have received education at the primary school level. Among the population aged 15 and above, 109,770 people are illiterate. Compared with 120,613 illiterate people in 2010, the illiteracy rate decreased from 10.64% to 8.43%.

All villages have access to roads, electricity, tap water, and affordable health care. The average life expectancy for residents of the prefecture is 71 years (Hongmei et al., 2007). There is a cultural awareness about the benefits of nutrition; there is little distinction between medicinal plants and food. One of the typical roles of women is to provide family members with good nutrition.

Agricultural practices

Traditionally, it was commonplace for farmers to perform intercropping of local plant and tree varieties. In the past, agricultural products originating from Xishuangbanna were quite diverse and managed within a crop-forest landscape. Today, this type of agricultural system is far less common, and monocropping is now the dominant land use in low- and mid-elevation areas. Nevertheless, most households still grow a variety of crops in addition to their primary cash crop.

Jinghong and Mengla Counties contain most of the lowland rubber plantations, though Jinghong has more tea at higher elevations. Mengla has more forest and nature reserves. Menghai County differs from these two areas: its valley walls are steeper (medium- and high-elevation land accounts for 95.9% of the county's land type), and the climate is unsuitable for the cultivation of rubber. In its place, the major crops are tea, rice, vegetables, and sugar cane. Menghai features denser forest coverage (68.1%) than the other two counties. It is also home to four national-,

provincial-, and county-level nature reserves. Tea plantations are important economically, second only to rubber. They do not require a large land area and are only planted above 900m. Intercropping of tea is practised by a significant minority, as tea grows well in conjunction with many tree species, including timber and rubber. Most of the remaining forest is in the upland regions, with lowland forest having been displaced by agricultural land. The upland forests feature less biodiversity than lowland forests but provide important water filtering and slow-release services.

Survey design

We first began monitoring rubber practices in Xishuangbanna in 2011. Preliminary work focused on the rapid spread of monoculture rubber plantations and their impacts on land-use transformations across the Mekong Region. At the time, a questionnaire survey was conducted across 1,014 households in the area. Through years of continued first-hand fieldwork via more extensive surveying and collecting trips, we gained a uniquely deep understanding of the drivers behind human adaptation to falling rubber prices. Recently, in the autumn of 2020, an interdisciplinary research team travelled to Xishuangbanna. During this visit, 332 households from the first survey in 2011 were re-visited. Face-to-face questionnaires and focus-group sessions across multiple villages were the primary methods for gathering knowledge.

Survey in 2011

The questionnaire designed and used in 2011 (see Annex 1) was part of a multi-country research project investigating the future of the broad Mekong Region, which aimed at informing decisions on investments at the nexus of water-food-energy by improving stakeholders' understanding of regional drivers and dynamics. The questionnaire survey attempted to capture a range of information on household resource endowments, production, household attitudes, values, livelihood strategies, and perceptions of key changes and drivers for better understanding land-use dynamics, assessing potential impacts, and exploring good environmental governance.

In 2011, the survey was conducted across 50 natural villages in 25 village committees in two counties in Xishuangbanna Prefecture[7] in Yunnan Province from March 15 to April 16, 2011.

Survey site selection

Jinghong and Mengla both feature extensive rubber plantation. Both were selected as primary research sites to satisfy research and funding considerations. The two counties contain a roughly equal number of townships: Jinghong has 11 townships, and Mengla has 10 townships. Simple random sampling across these 21 townships was unrealistic given the survey budget. Instead, we randomly selected four townships in each county, and limited the

7 At a sub-provincial level, China is divided into three levels of vertical government administration: prefectural, county and township. Below the township level, an elected village committee (村民委员会 *Cunmin Weiyuanhui*) organises and handles day-to-day affairs for clusters of contiguous villages called natural villages (自然村 *Zirancun*). Natural villages are often further sub-divided into smaller communities/village groups (社 She / 村民小组 *Cunmin Xiaozu*). Vertical government administration officially extends only to the township level, which explains the considerable heterogeneity in village administration.

selection of village committees to these townships. In Jinghong, the survey could only be administered in three townships due to time and budget constraints to represent the general status of the county.

The survey sought to include 1,014 household responses. Across the townships, we randomly selected 25 village committees, taking into account accessibility. Villages that were particularly difficult to access were excluded from the sampling framework. Most village committees contain many natural villages, and simple random sampling across natural villages was, again, unrealistic. To constrain the sample set, we randomly chose 2 natural villages or 2 village groups in each village committee. Within each natural village, we planned to select between 23-30 households. However, it was sometimes difficult to locate respondents during the busiest season of the year for rubber tapping, tea picking, and rice planting. At times, this limited our survey targets to simply selecting whoever was available in some villages.

Using this approach, survey data needed to be weighted to correct for unequal sampling probabilities. Survey data analysis techniques were built into most statistical software packages to correct for potential effects of clustering at the township and natural village levels on standard errors.

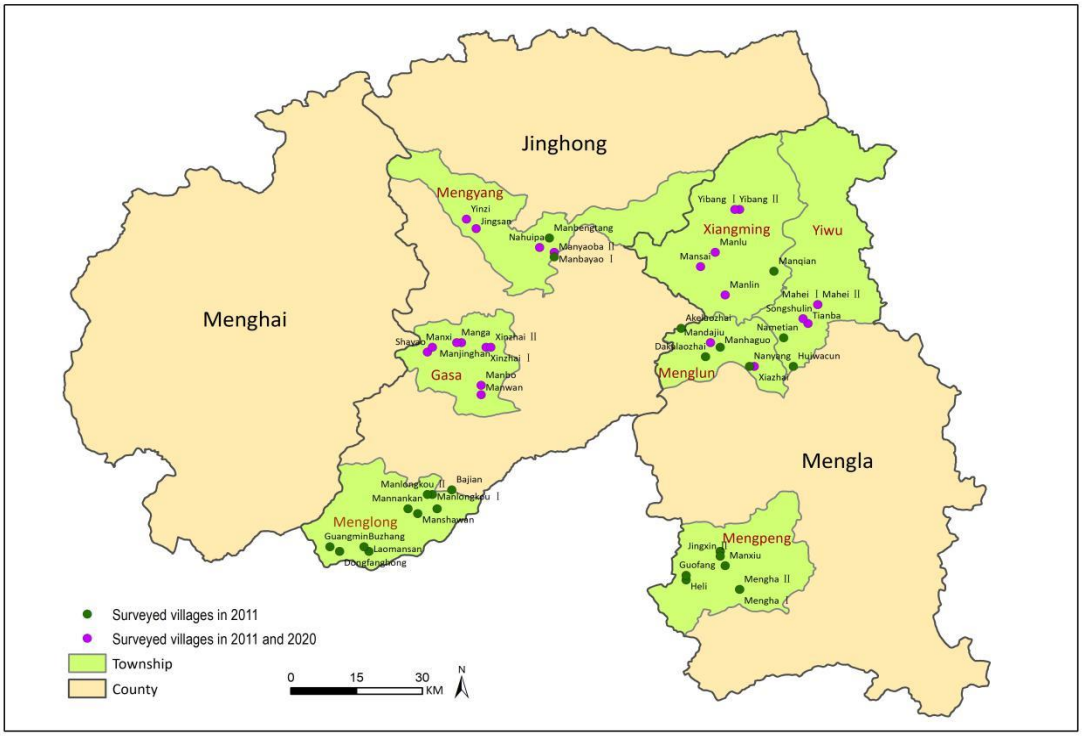
Survey in 2020

In 2020, we have retained most components of the original questionnaire, excluding the section on household attitudes and values, as these questions are subjective and not directly linked to impacts on livelihoods. However, an additional supplemental questionnaire was designed and used to capture more information on changes in livelihoods and production after rubber prices began falling (see Annex 2).

Based on the survey results from 2011, local production and livelihoods vary with altitude. In the lowlands (500-700m), rubber is the dominant crop, and more than half of mid-elevation land (701-900m) is planted with rubber. Land at higher elevations still supports forest cover, tea, and other farming systems, but rubber has become more common over the past twenty years.

Therefore, in order to capture the different impacts on local livelihoods, eight villages were randomly selected from each of the three altitude zones, taking into account accessibility. We re-interviewed approximately one-third of the farmers surveyed in 2011 at each village. In total, 332 households across 23 villages were revisited (Table 3a); one village at mid-elevation could not be revisited because of COVID-19 lockdown measures. Among these households, 22 are female-headed and 310 are male-headed (Table 3b). Though we sought to maximize the representation of female-headed households among respondents, several obstacles made this difficult. First, the objective number of female-headed households is significantly lower than male-headed households. Second, women respondents were more reluctant to engage with researchers. In 2020, 78 women and 254 men were interviewed; in 2011, 274 women and 740 men were interviewed (Table 3b). This discrepancy exists because many women redirected our queries to their husbands instead, stating that they did not know how to answer our questions. For more details, please see Tables 2 and 3. To address issues of representativeness, we organized additional focus groups and worked closely with local women leaders to ensure sufficient and respectful participation in the survey. Semi-structured discussions

were organized around three primary themes: access, control, and benefits. The map below shows surveyed village committees from both 2011 and 2020.



Map 1. Surveyed village committees in Xishuangbanna in 2011 and 2020

Location	Elevation (masl)	Survey in 2011			Survey in 2020		
		Natural Village sampled	Of the total %	Household sampled	Natural Village sampled	Of the total %	Household sampled
Low	550-700	27	54	540	8	34.8	112
Medium	701-900	8	16	164	7	30.4	105
High	901-1600	15	30	310	8	34.8	115
Total		50	100	1014	23	100	332

Table 3a. Surveyed villages by elevation

County	Township sampled	Village Committee sampled	Household sampled							
			2011				2020			
			FHHs	MHHs	Women respondents	Men respondents	FHHs	MHHs	Women respondents	Men respondents
Jinghong	3	12	28	458	138	350	9	156	34	138
Mengla	4	13	48	480	136	390	13	154	44	116
Total	7	25	76	938	274	740	22	310	78	254

Table 3b. Gender wise sampled household distribution in the study area.

FHHs = female-headed households; MHHs = male-headed households.

The questionnaire from 2011 was not originally designed for gender study, though it did gather gender-disaggregated data. To address this potential gap, we designed an additional questionnaire and conducted focus groups for men and women to capture a gendered perspective for the 2020 survey. Given that our survey in 2011 was conducted during the height of the rubber boom, while 2020 represents the lowest point of prices to date, and given the large quantity of gathered data, we believe our data are sufficient for meaningful comparison and gender analysis. Therefore, data collected in 2011 and 2020 were analysed and compared across social demographics, family assets, livelihood activities, and other factors. Analyses focused on the impacts of lower rubber prices on local livelihoods and rubber production as well as farmer responses, particularly noting divergent impacts across genders.

Throughout these analyses, MHHs refer to households that respondents stated were headed by men, and FHHs refer to households headed by women. Although ‘male’ and ‘female’ are biological terms, we use them in these analyses to help signify a household-level analysis. ‘Men’ and ‘women’ are terms used to signify respondent-level analysis. The idea that gender is socially constructed in a specific society and culture should be understood as fundamental at each level of these analyses. This working paper defines the head of the household as the individual who manages the economic and social responsibilities of a given household (Poston et al., 2014). The decision to identify the head of the household was left to individual respondents.

Chapter 3: Results

Results are presented based on differences between household data collected in both 2011 and 2020.

Demographic features

Age distribution of households

Figure 5 reveals that in both surveys (2011 and 2020), more than 60 percentage of total respondents belonged to the age group 41-60. Another 6.9% (in 2011) and 15.06% (in 2020) belonged to the age group above 60. Thus, it was noted that around 70% and 80% of respondents in the sample were older than 40 in 2011 and 2020, respectively. The higher percentage of respondents from this group reflects the fact that most of them had experiences with rubber cultivation in the study area.

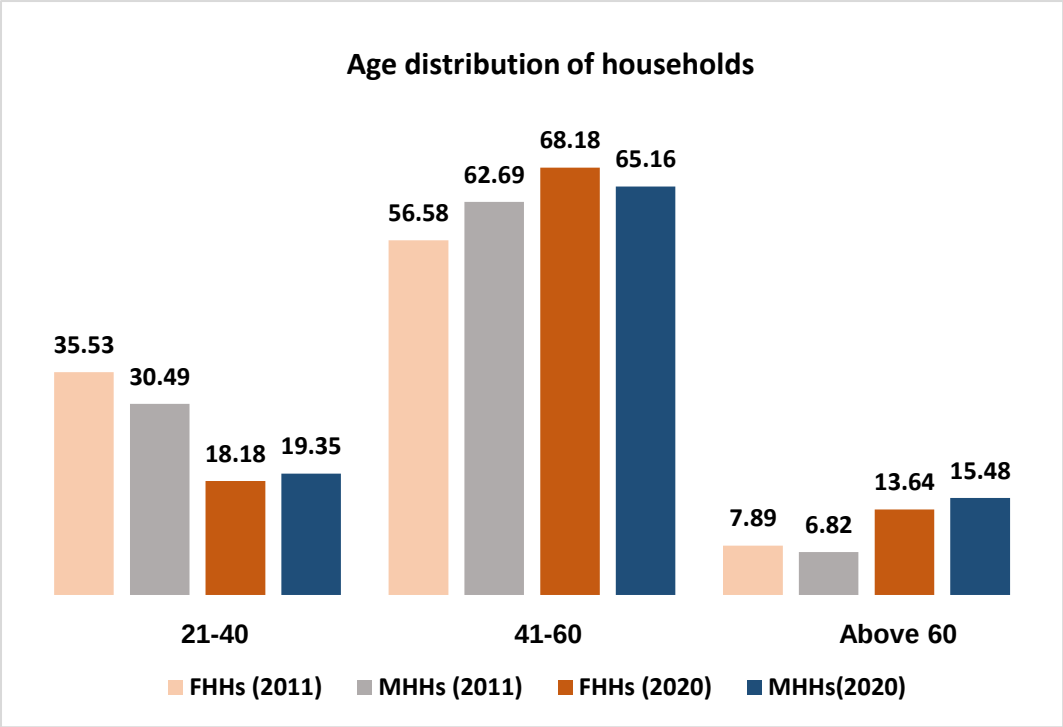


Figure 5. Age distribution of households

Gender-wise classification of the surveyed households showed that the lowest percentages were FHHs (7.49% in 2011 and 6.62% in 2020). For more details, please see Figure 6. Among FHHs, about 52% belonged to the Dai ethnic group. In Dai villages, FHHs owned a comparatively higher percentage of rubber plantations, and Dai families tend to occupy the lowland fields of Xishuangbanna (Zhang et al., 2015). Matrilocal residence, that is, husbands moving into the wife's parent's village after marriage, was more commonly seen in Dai villages, owing to traditional customs, labour shortages, and abundant rubber plantation land. This unique institution grants women enhanced power in decision-making, given the proximity to supportive family members and greater household resources (Wang et al., 2018). This type of matrimonial residence system is rarely seen in China's traditional family structures, which are overwhelmingly patrilocal and male-oriented, thwarting many gender equality efforts (Thornton & Lin, 1994). At the same time, it is important to recognize that a large number of female Dai respondents mentioned that they also support their male counterparts in rubber cultivation at various stages of rubber production, such as tapping, collection of latex, and processing of rubber sheets.

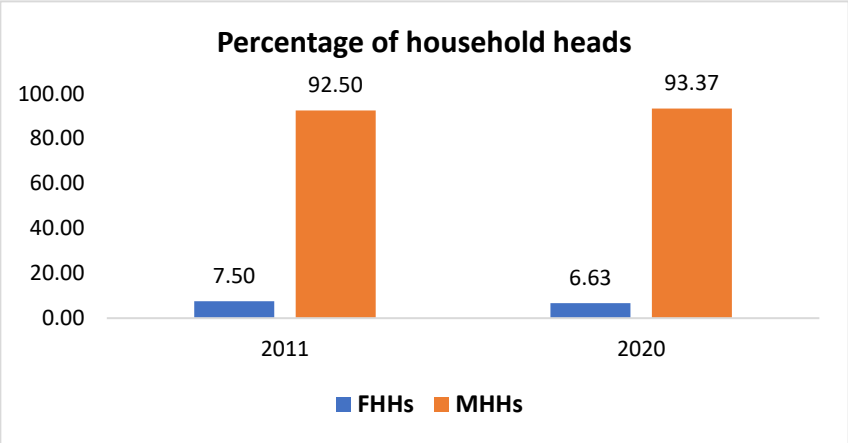


Figure 6. Percentage of FHHs and MHHs among surveyed households

Educational status of households

Examining the educational status of household heads revealed that the majority had only received primary school education. Analysis results showed that education status of FHHs was comparatively lower than that of MHHs. The highest education achievement of FHHs was basic secondary, and no FHH respondents reported receiving a high school, junior college, or university education among surveyed households in 2011 (Table 4). Dai respondents had especially low education levels compared to Han, Yi, and Hani respondents (Figure 7). This corresponds to anecdotal evidence that a high proportion of Dai people leave education early to focus on rubber farming, which remains relatively lucrative. Hammond et al. (2015) has also reported on a similar phenomenon. However, data showed that the percentage of illiterate individuals had decreased in 2020 for both FHHs and MHHs, while levels of educational achievement had risen. For instance, the secondary high school level for FHHs increased from 0 in 2011 to 22.73% in 2020, and for MHHs, it increased from 2.88% in 2011 to 22.9% in 2020, indicating that the status of education of both FHHs and MHHs had improved. Respondents revealed that they were able to afford education because of income generated from rubber plantation in the study area (Table 4).

	Percentage of households			
Education status of household heads	FHHs (2011)	FHHs (2020)	MHHs (2011)	MHHs (2020)
Illiterate	43.42	18.18	23.13	20.65
Primary	42.11	50.00	54.16	51.94
Basic Secondary	14.47	22.73	18.98	22.90
Secondary High School	0.00	22.73	2.88	22.90
College/University	0.00	4.55	0.85	0.65

Table 4. Education status of household heads

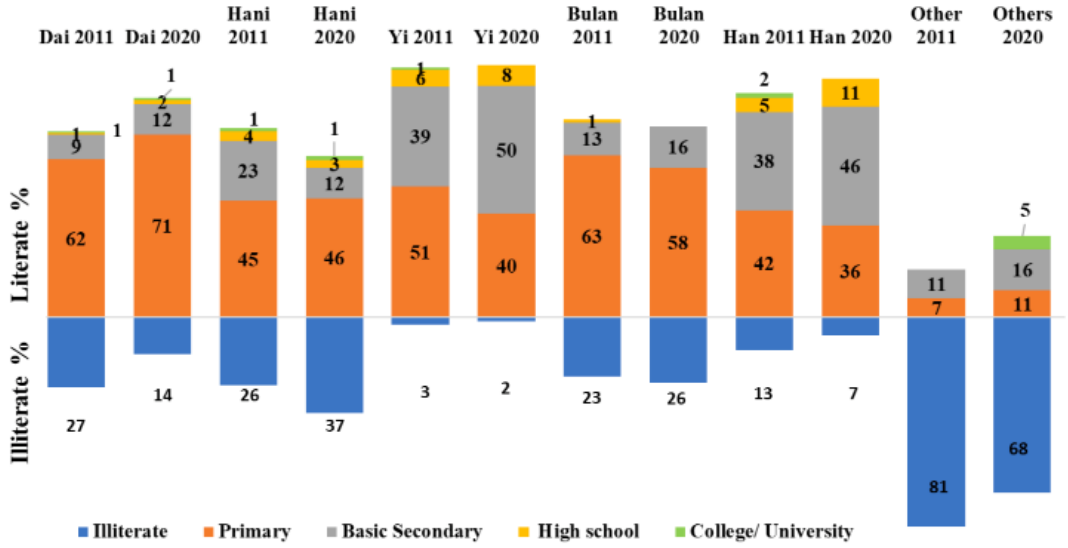


Figure 7. Percentage of households with household's highest educational achievement by ethnicity

Changes in household assets between 2011 and 2020

Assets are items owned by the farm business that have monetary value. They include the items that the farmers use to produce the products they sell. Assets include, but are not limited to, cash, grain, and feed inventories, prepaid expenses, market livestock, breeding livestock, machinery, equipment, buildings, and farmland.

Farmland used by farmers

The average land size used by farmers and land under production for MHHs are comparatively larger than that of FHHs, and land sizes as well as land under production both increased in 2020. A high percentage of both FHHs and MHHs possess 1-5 ha of land; the average farm size was 4.37 in 2011 and 5.44 ha in 2020, with production land increasing from 3.51 in 2011 to 4.12 ha in 2020 (Table 5). The average area of cultivated land per capita in the surveyed area remains at a high level compared with that of the whole country[8] largely due to the reclamation of forest.

Size of land (hectare)						Farmland under production (hectare)			
Households		FHHs		MHHs		FHHs		MHHs	
Surveyed year		2011	2020	2011	2020	2011	2020	2011	2020
Average land		3.20	5.06	4.46	5.47	2.59	3.49	3.58	4.16
Used HH land (%)	1-5 ha	86.84	59.09	73.03	60.97	89.47	77.27	80.17	72.58
	5.1 - 10 ha	9.21	31.82	19.51	26.77	9.21	18.18	15.99	20.65

8 https://www.nationmaster.com/country-info/stats/Agriculture/Arable-land/Hectares-per-capita

	10.1 -15 ha	3.95	9.09	4.80	7.42	1.32	4.55	2.45	4.84
	>15 ha	0	0	2.67	4.84	0.00	0.00	1.07	1.94

Table 5. Land size and land under production by FHHs and MHHs

Ownership of transportation and household appliances

Yunnan is a mountainous region, and motorcycles are the most common mode of transportation for traversing the steep slopes in the investigated area. It was found that nearly all households have motorcycles. Vehicle ownership in households largely depends on household sizes, income levels, and vehicle prices (Zhao & Kockelman, 2002). As the economy continues to grow and living standards improve, cars are becoming increasingly ubiquitous. The increases in percentage of ownership of mode of transport by FHHs and MHHs in 2020 than 2011, revealed that the economic condition of them has been uplifted, whereas no significant differences in % of ownership of mode of transport among MHHs in 2020 and 2011. FHHs are wealthier than MHHs with respect to ownership of transportation and household appliances (Table 6).

HH assets (%)	Motorbike	Truck	Van	Car	TV	Fridge	Water tank	Computer	Washing machine
FHHs (2011)	90.79	0.00	5.26	21.05	98.68	82.89	76.32	15.79	30.26
FHHs (2020)	100.00	4.55	4.55	68.18	100.00	95.45	90.91	36.36	90.91
MHHs (2011)	95.95	1.07	5.12	21.00	98.29	75.27	73.88	8.74	38.91
MHHs (2020)	97.42	4.52	5.16	50.32	96.77	88.06	84.84	28.39	69.68

Table 6. Asset ownership by gender in 2011 and 2020

Ownership of farm machine and fishing gear

Farm machinery, such as tractors and other devices, are used in farming to lower labour requirements. Farm machines include a variety of devices with a wide range of complexity, from simple hand-held implements used since prehistoric times to the complex harvesters of modern mechanized agriculture. Survey results reveal that the percentage of ownership of both farm machinery and fishing gear are reduced in FHHs and MHHs. The percentage of both households that use hand tractors has also decreased since 2010. Because small-handed tractors are used to prepare land for rice cultivation, this would suggest a decrease in rice cultivation. Many farmers in the region have transformed paddy land into either fruit orchards or vegetable farmland (Table 7).

Ownership of farm machine (%)	FHHs		MHHs	
	2011	2020	2011	2020
Tractor	13.16	18.18	21.11	15.16

Hand tractor	52.63	27.27	53.41	31.29
Rice- harvester	2.63	4.55	2.67	2.90
Water pump	11.84	9.09	9.70	24.52
Milling equipment	17.11	18.18	18.76	16.77
Nets	34.21	31.82	30.60	32.26
Hook line	18.42	13.64	13.11	12.90
Traps	23.68	18.18	19.08	19.03
Damming/fencing	2.63	4.55	1.28	0.97
Fishing boat	3.95	4.55	2.99	1.29

Table 7. Ownership of machine used for farming

Livelihood activities

Livelihood is defined as a set of activities essential to everyday life that are conducted across one's lifespan. Most rural households have multiple income sources from crop and livestock, farm, off-farm, and non-farm activities that differ seasonally. Agriculture is the main livelihood activity in the study area. During surveying, households were asked to identify their main livelihood activity, the most important livelihood activity (Figure 8), and the most stable activities (Figure 9). It should be noted that although one primary and one important livelihood were identified, households are often engaged in multiple activities.

Despite plunging prices, rubber plantation remains the main livelihood activity for generating income. Growing rubber and tea are the two most important and stable activities for generating income, followed by growing maize, raising livestock, and receiving remittances. However, for FHHs, the proportion of rubber as the most important crop decreased from 75% in 2011 to 63.64% in 2020, but the proportion of tea named as the important crop increased from 22.37% in 2011 to 31.83% in 2020 (Figure 9). For MHHs, the proportion of individuals who selected rubber as the most important crop decreased from 66.95% in 2011 to 52.9% in 2020, but the proportion of individuals who selected tea as the most important crop increased from 23.99% in 2011 to 28.71% in 2020 (Figure 9). At the same time, in 2020, MHHs have greater access to livelihood activities that include more diverse paid work opportunities, such as agricultural production, tea picking for other households, small family businesses, government services, construction-related activities, rental services, tourism, and other services. For more details, please see Figures 8 and 9 below. Results show that FHHs are less likely to diversify into non-agricultural paid jobs than MHHs.

Although rubber remains the most stable crop, the proportion of individuals who listed rubber as the most stable crop has also decreased across both FHHs and MHHs. Conversely, the proportion of individuals who listed tea as the most stable crop has also increased across both FHHs and MHHs. For more details, please see Figure 9.

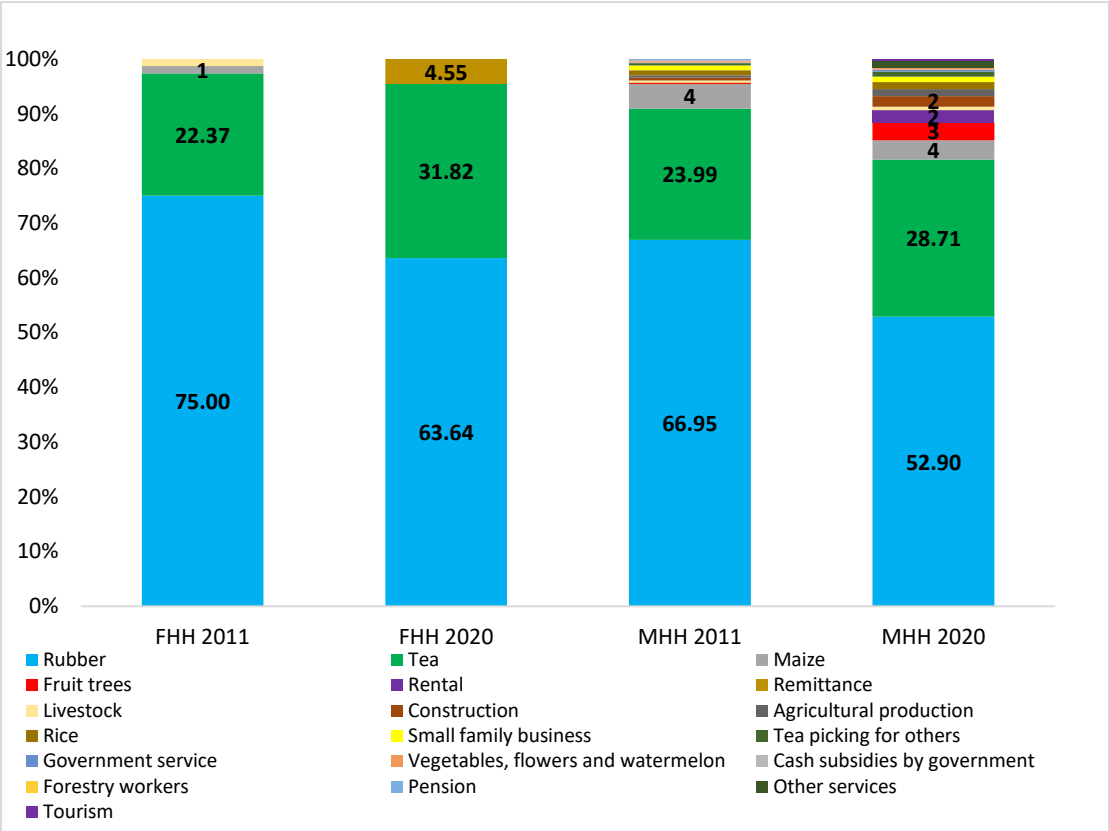


Figure 8. The most important livelihood activities

Figure 9. The most stable livelihood activities

Production activities

Rubber plantation continues to function as the main production livelihood activity for both FHHs and MHHs in 2011 and 2020; however, the percentage of both FHH and MHH rubber growers decreased by 19.26% among FHHs and 9.47% among MHHs. These growers are shifting livelihood strategies to include fruit trees and tea plantations. Fruit trees and tea growers have increased by 14.23% and 6.82% among FHHs and 9.47% and 3.38% among MHHs (Table 8), respectively. Farmers revealed that they shifted their livelihood strategies from rubber to other activities due to falling rubber prices. They also stated that households with access to tea land were found to have experienced negligible impacts from decreasing rubber prices, as rising tea prices exceed falling rubber prices, leading to growing rates of intra-village economic inequality. Similarly, the data also reveal that rice plantation has significantly decreased, followed by maize plantation and livestock raising. Lower profits, limited market demand, lack of labour force, increasing occurrences of drought, and destruction by wild elephants in the study area are several stated reasons for abandoning rice and maize plantation in 2020.

Changes	Production activities (%)	FHHs		MHHs	
		2011	2020	2011	2020
Decreased	Rubber	82.89	63.64	76.23	66.77

	Rice	39.47	9.09	42.22	20.00
	Maize	13.16	4.55	18.02	15.81
	Livestock	15.79	9.09	13.54	8.06
	Fish farming	1.32	0.00	0.85	1.29
Increased	Tea	25.00	31.82	30.49	33.87
	Fruit trees	3.95	18.18	1.17	10.65
	Vegetables, flowers, and fruits	2.63	4.55	4.48	3.87

Table 8. Changes in production activities

We have also collected additional information that was not included in the original 2011 survey to help clarify changing activities across the decade.

Changes in cash crop farming across the decade

The additional questionnaire survey focused more on cash crop production, as cash crop expansion has become an emergent global land use issue in recent decades. A cash crop is defined as a crop grown for direct or market sales, different from subsistence crops that are planted for household consumption (Kuma et al., 2016). Most cash crops in Xishuangbanna have been introduced by the local government and are mainly grown for cash sales (Shen et al., 2017).

The results also show that 4.6% of FHHs and 2.6% of MHHs had reduced rubber plantation, which was replaced by tea plantation, fruit trees, nuts, and other vegetables with market demand (Table 9). Twenty-two major cash crops, including rubber, tea, rice, and maize were listed 10 years ago, whereas 12 more cash crops have been added in the present list of cash crops. The cultivation of fruit trees, like bananas, mangos, pomelos, jackfruit, dragon fruit, oranges, konjac, coconuts, and passion fruit as well as nuts like macadamia, peanuts, cashews, and walnuts have increased in the study area. Farmers revealed that they can make a good profit from selling tea, fruit, and high-value nuts. At the same time, *Amomum villosum* and other Chinese herbal medicines that were cultivated 10 years ago have disappeared (Table 10). Similarly, rice plantation, maize, and rubber cultivation are also all reduced. According to farmers, the occurrence of drought, less water availability, lack of labour force, and lower market prices are some commonly stated reasons for cutting back on cultivation of these cash crops. Respondents also stated that they have generally converted their paddy lands into fruit orchards and vegetable land.

Cash crop	2011		2020	
	FHHs	MHHs	FHHs	MHHs
Rubber	77.27	80.65	72.73	78.39
Tea Plantation	36.36	39.68	40.91	39.35
Fruit Trees	4.55	8.39	40.91	30.65
Rice	81.82	71.94	0.00	16.77
Other	50.00	59.35	31.82	40.32

Table 9. Changes in cash crop farming during the last ten years

Cash crop	Increased area under cultivation (%)		Reduced area under cultivation (%)	
	FHHs	MHHs	FHHs	MHHs
Tea	22.73	14.52	0	1.61
Rubber	9.09	10.32	0	10
Fruit	4.55	4.52	9.09	3.55
Maize	4.55	4.84	9.09	18.71
Nuts	4.55	6.77	0	0.65
Vegetable	4.55	4.52	0	1.61
Konjac	0	0.32	0	0
Rice	0	0.65	54.55	47.10
Amomum	0	0	0	1.94

Table 10. Changes in cash crop cultivation area in last decade

Paid livelihood activities

Respondents stated that due to falling rubber prices, they have diversified their livelihood activities to direct cash-paid activities, such as tourism, wage labour (such as construction or farm work for other households), and engaging in small family businesses, such as hotels and restaurants. The data revealed that the percentage of households that started small family businesses increased by 8.37% among FHHs and 7.14% among MHHs between 2011 and 2020. For FHHs, no income was reported for renting, rubber tapping, and tea picking (Table 11).

Paid household activities	FHHs		MHHs	
	2011	2020	2011	2020
Rental Income	0.00	0.00	0.11	0.65
Rubber tapping for others	0.00	0.00	0.00	0.32
Tea picking for others	0.00	0.00	0.53	1.61
Agricultural production	1.32	4.55	2.03	4.19
Collect FP and NTFP	1.32	4.55	0.11	0.32
Construction related work	0.00	4.55	2.03	7.10
Forestry workers	2.63	4.55	1.07	2.26
Government service	2.63	4.55	3.52	3.55
Tourism	5.26	4.55	3.41	4.19
Small family business	5.26	13.64	5.12	12.26

Table 11. Paid livelihood activities

Household income

Income refers to the money earned by an individual or business in exchange for generating a product, providing a service, or investing capital. Pensions and social security also contribute to income. China's currency is abbreviated CNY and will be used for income figures henceforth. (At the time of writing, 1 CNY = 0.16 USD.)

The average income of rural people is considerably less than urban people, and a large proportion of income is derived from agricultural sources. The study finds that the average annual income from agriculture in MHHs has increased approximately 41% from 2011 to 2020 (48,957.36 CNY to 69,046.99 CNY), whereas average annual income from agriculture in FHHs only increased 1.99% from 2011 to 2020 (55,863.41 CNY) and 2020 (56,972.73 CNY). FHHs explained that they have less access to paid household activities, though data showed higher income from average annual non-agricultural income. This might be because of the small number of FHHs engaged in off-farm labour. This also explains why annual income per person in FHHs is lower than MHHs. MHHs have increased their average income per person by 32.48%.

In 2011, household debts were common, averaging about 22-27% of annual income. In 2020, though, debt increased significantly, averaging about 45.56% of annual income in FHHs and 64.17% of annual income in MHHs. It was common for farmers to borrow money from banks, relatives, and friends as adaptive strategies to cope with financial stress caused by climate hazards or falling rubber prices. Increasing household debt indicates that farmers are borrowing money more now than ever. The study also finds that MHHs bear more risk when borrowing large amounts of money as adaptation to falling rubber prices.

	FHHs		MHHs	
Sources of income	2011	2020	2011	2020
Average annual agricultural income	55,863.41	56,972.73	48,957.36	69,046.99
Average annual non- agricultural income	11,715.62	17,688.64	11,042.28	15,746.82
Average annual household income	67,579.03	75,328.64	59,999.64	85,376.44
Average of household debts	15328.77	34,318.18	16,302.69	54,791.53
Average annual income per person	18,277.96	18,640.94	15,436.74	20,451.09

Table 12. Average income & farmer debt

Results from the additional questionnaire also showed changes in household income over the past 10 years. Household incomes increased by 77.27% in FHHs and 73.55% in MHHs. The majority of both FHHs and MHHs stated that increasing prices of tea, fruit trees, and high-value vegetables have all contributed to rising household income. Conversely, 18.18% of FHHs and 21.61% of MHHs (Table 13) reported a decrease in household income due to falling rubber prices. The remaining survey respondents indicated no change in household income. The results from both 2011 and 2020 surveys reveal similar trends for household income.

HHs	Change			Causes	
	Increased	Decreased	No change	Increase	Decrease
FHHs	17 (77.27%)	4 (18.18%)	1 (4.55%)	Tea prices rose (14), increased income from off farm work (2)	Rubber price fell (2)
MHHs	228 (73.55%)	67 (21.61%)	15 (4.84%)	Tea price rose (99), increased income from off farm work (61), family business (11), gluten-free beans increase income (9)	Rubber price fell (52), droughts led to a decline in rubber production (9)

Total	245 (73.80%)	71 (21.39%)	16 (4.82%)		

Table 13. Changes in household income and causes

Changes in household income from cash crops

In the additional supplemental questionnaire, we focused more on changes in household income resulting from cash crops. Results indicated that 72.73% of FHHs and 60.97% of MHHs saw increased income from cash crops (Table 14). Furthermore, 36.36% of FHHs and 21.93% of MHHs revealed that they earn a good profit from planting tea. One of the male respondents reported that current tea prices of 1200-1300 CNY/kg far eclipse the 160 CNY/kg of previous years. At the same time, more input is required for rubber farming than tea plantation as well as planting tea provides quicker and larger returns. Finally, consistently low commodity prices in the rubber market have led to smaller profits for smallholder rubber farmers. These are all compelling reasons that help explain why many farmers find tea plantation so attractive.

Regarding changes in household incomes from cash crops and causes, 27.27% of FHHs and 27.74% of MHHs understood their falling incomes as tied to dropping rubber prices. One of the FHHs in the study area reported that they kept their rubber trees but stopped tapping latex for 3-4 years to minimize additional sunk costs. This FFH reported that in 2011 they used to earn 700-800 CNY/day, but the trees are worthless at present. In addition, 3.87% of MHHs said that due to the occurrence of frequent drought and less water availability, yields from rubber, fruit trees, vegetables, and rice are all lowering. This also negatively impacts household income. For more details, please see Table 14.

Households	No. of households			Causes	
	Increased	Decreased	No change	Increase	Decrease
FHHs	16 (63.64%)	6 (22.73%)	0 (0%)	Rising tea prices (8), increased planting varieties (1), increased planting area (6), increased dragon fruit price (1)	Rubber price fell (6, 27.27%)
MHHs	189 (60.97%)	110 (35.48%)	6 (2.90%)	Rising tea price (68), banana price increased (10), increased crop cultivation area (26)	Rubber price fell (86, 27.74%), off-farm work (28)
Total	204 (61.45%)	116 (34.94%)	12 (3.61%)		

Table 14: Changes in household income from cash crops and causes

Family expenses

Regarding costs, 90.91% of FHHs and 92.90% of MHHs stated that household expenses have been on the rise in past 10 years. Commonly cited rising expenses were educational costs, rising prices for daily household goods, farming machinery, transportation modes, health care, and other household expenses. Some of them also reported that a drier climate introduces greater risks for crop pests and diseases, and they are forced to spend more on pesticides, fertilizers, and other medicines to address these detrimental factors.

Major problems

Almost all the respondents indicated that declining prices and an uncertain climate were the main problems facing their household. This phenomenon has been noted for the last several years. Falling rubber prices have affected the lives and livelihoods of farmers in different ways. The sharp fall in natural rubber prices caused deep concern among stakeholders in Xishuangbanna, given the crucial role natural rubber plays in the prefecture as an important source of income for smallholder farmers (Hammond et al., 2015). Based on key informant interviews, both men and women expressed that their production and lives have been dramatically affected by plunging rubber prices as well as the outbreak of COVID-19. When examining female respondent data in particular, their living quality has notably decreased, while their labour intensity has increased.

Adaptive strategies

We explicitly asked about smallholder farmer strategies regarding continuing ‘business as usual’ or altering household income-generating activities/location continuity if the profit or production from the main activity halves and is likely to stay that low for at least five years. The result shows that about 50% of FHHs and 37.38% of MHHs in 2011 and 54.55% of FHHs and 54.19% of MHHs in 2020 would maintain the same set of livelihood activities and remain in their village (Table 15). Similarly, 46.05% of FHHs and 53.35% of MHHs in 2011 as well as 81.82% of FHHs and 72.90% of MHHs in 2020 would like to adjust their current set of livelihood activities if profit or production from their main livelihood activities decreases by half over at least the next five years.

	2011		2020	
Responses	FHHs	MHHs	FHHs	MHHs
Keep the same set of livelihood activities and remain in their village	50	37.38	54.55	54.19
Keep the same set of livelihood activities, but go elsewhere	0	0.30	0	0.97
Adjust their current set of livelihood activities	46.05	53.35	81.82	72.90
Replace current livelihood activities with a completely new set of activities	1.32	0.99	0	2.26

Table 15. Responses for future changes

The results indicate that 36.84% and 31.82% of FHHs would like to continue managing rubber plantations and remain in the same village for 2011 and 2020, respectively. For MHHs, 28.89% and 29.35% of MHHs would like to continue managing rubber plantations in 2011 and 2020, respectively, even if rubber production is halved. Similarly, the

percentage of HHs that would continue to plant tea has increased by 13.52% for FHHs and 12.67% for MHHS between 2011 and 2020, even if rubber production is halved (Table 15). Far fewer household heads, across both men and women, would like to continue to cultivate rice, maize, fruit, and raise livestock as well as stay in the same village if rubber production is halved. For details, please see Table 16.

	2011		2020	
Main activities	FHHs	MHHs	FHHs	MHHs
Rubber	36.84	28.89	31.82	29.35
Tea	9.21	9.91	22.73	22.58
Maize	1.32	1.81	0	2.90
Livestock	0	0.11	0	0.65
Fruit trees	0	0	0	2.26
Rice	0	0.11	0	0.97

Table 16. Continuity of the same livelihood activity and stay in the same village

In the same way, among the HHs that would like to adjust their current livelihood activities, 11.84% of FHHs and 18.55% of MHHs would like to change the crop in 2011. In 2020, this percentage of HHs willing to change crops increased significantly. The percentage of changing crop increased in the 2020 response for both FHHs and MHHs. Few FHHs and MHHs were found to be willing to change cropping calendar and crop species. Both HHs were willing to work as off-farm labour in greater numbers in 2020 than in 2011 (Table 17). Similarly, the percentage of FHHs that would like to transition current livelihood activities into planting cash crops, starting a new business, or other activities has increased in 2020 compared to MHHs. Similarly, a higher percentage of FHHs would like to manage the loss by reducing HH expenses compared to MHHs.

Adjusted activities	2011		2020	
	FHHs	MHHs	FHHs	MHHs
Change crop	11.84	18.55	40.91	31.29
Change cropping calendar	0.00	0.32	0.00	0.32
Change species grown	3.95	3.30	0.00	4.52
Look for labour	6.58	7.46	18.18	17.10
Change to cash crop	6.58	14.93	18.18	20.65
Start business	14.47	11.30	18.18	11.61
Reduce family expenses	3.95	1.49	4.55	1.94
Other	0.00	0.43	4.55	0.65

Table 17. Adjusting current sets of livelihood activities and remaining in the same village

During the additional questionnaire survey and group discussion in 2020, we probed farmer strategies for dealing with continuously falling rubber prices. Responses are as follows. For greater detail, please see Table 17.

Response 1: Keep rubber plants but do not engage in tapping.

With prices as low as they currently are, it is perhaps unsurprising that many producers have chosen not to invest their scarce labour in rubber tapping and are simply waiting for prices to rise. But as this and the next sub-section describe, this response is not as simple as it might seem. Across visited sites, respondents told us that waiting for prices to rise was the main way rubber producers were responding to low prices. Accordingly, 18.18% of FHHs and 17.74% of MHHs had stopped rubber tapping and were waiting for rubber price to increase (Table 18).

Response 2: Continue to plant natural rubber and engage in tapping.

Most respondents chose a 'business as usual' strategy – 45.45% of FHHs and 40.32% of MHHs would continue to grow rubber and tap the latex (Table 17). Many of them revealed that they use household labour for tapping. We found that those who are continuing to tap are largely doing so with household labour. Household labour is effectively 'cheaper' than hired labour, but it is not necessarily more efficient, since it involves degrees of intra-household inequality such as high dependence on women's labour (which is often valued lower by household decision-makers who are often men). This subsequently increases the workload of women.

Response 3: Partially replace rubber plantations.

There was moderate support for transforming portions rubber plantation land into cash crop farms, with 17.42% of MHHs opting for this path and transitioning to farming crops like vegetables, fruits, high-valued nuts, and tea; 8.6% of MHHs said they would like to transform part of their rubber plantation for planting fruit like grapes, mango, jack fruit, lychees, dragon fruit, and banana; 2% of them would plant high-valued nuts like macadamia, cashew, and walnuts; and 3.9% of MHHs would replace part of their rubber plantation and plant tea instead. Households with tea plantations are less impacted by dropping rubber prices. Many households with tea plantations stated that falling rubber prices did not precipitate a household economic crisis.

Response 4: Cut down all rubber trees and convert land to other crops.

If rubber prices continue to fall, few households (4.55% of FHHs and 16.77% of MHHs) would fell all rubber trees and convert all their land from rubber to other higher-value crops like bananas, nuts, and other cash crops. There are numerous obstacles to cutting down all rubber trees, and worries over sunk financial, labour, and temporal costs were often voiced among respondents. Moreover, cultivation of these rubber trees provided farmers with substantial profits in the past. Therefore, farmers might have serious reservations for cutting down all rubber trees and shifting to other crops.

Response 5: Rent land.

Renting land is traditional response strategy during periods of stress. 13.64% of FHHs and 11.61% of MHHs stated that they would rent their land and diversify their livelihood activities to off-farm activities such as daily wage labour and engaging in hotel, tourism, and miscellaneous business work if rubber prices continue to drop.

Response 6: Sell land use rights.

Land sales by poorer households were described as a 'normal and traditional' response strategy. During interviews with respondents, few MHHs expressed the willingness to sell their land and diversify their income-generating

activities if rubber prices continued to fall, and no FHHs would employ this strategy, as it is less common for women to go off-farm to seek employment.

Response of farmers if rubber prices continue to fall	FHHs (%)	MHHs (%)
Keep rubber but no tapping	18.18	17.74
Continue to grow and produce rubber	45.45	40.32
Replace some of rubber trees	0.00	17.42
Cut all rubber trees	4.55	16.77
Rent land	13.64	11.61
Land sales	0.00	0.97

Table 18. Responses to falling rubber prices

Chapter 4: Discussion

Division of labour and access to resources

Rubber production and fluctuations in price map unevenly across the local terrain of Xishuangbanna. Gender-differentiated impacts and livelihood strategies impacts are often not taken fully into account in research or policy schemes (Kusakabe & Chanthoumphone, 2021). Despite large steps taken in China's recent history toward realizing a gender-equal society, such as in enshrining gender equality rights and responsibilities into the 1949 PRC constitution, these are sometimes not the case in reality. Women have increased labour burdens, despite expanded societal, familial, and vocational roles, and remain shut out of most political decisions and local networks (Schneider 2011). Division of labour, particularly household work, is thus a useful framework for examining labour specializing in the context of gendered impacts.

Diminishing profits from rubber have forced people to look outside their villages for extra part-time work. Men in particular dominate this group of migrant labours, and one important factor is because they have better access to motorcycles, which are the main form of transportation in the vertiginous landscape. These 'motorcycle migrants' have greatly increased vocational opportunities and are readily available for work in places far from home. They generally perform construction work at remote sites, sometimes entire counties apart. Because men spend more time beyond the walls of their home due to fewer household and caretaker responsibilities and have increased exposure to on-the-ground market dynamics as well as access to alternative sources of income, they tend to have greater power in household decision-making processes than women, particularly when dealing with decisions that require action beyond the walls of their home, like off-farm labour or business and trade. The dominant division of labour ethos among households in Xishuangbanna generally prioritises male voices in having the final say on larger expenses, especially those that occur beyond the walls of the home.

Women, especially those who reside in the lowlands, seldom work far from home, as they still need to perform household chores and take care of children and elders. Besides rubber tapping, they tend to plant other cash crops

or vegetables as well as raise chicken and fish to generate additional income. Women living at higher altitudes have greater restrictions on crop selection. However, tea plantations are more plentiful in upland villages, and given surging tea prices over the last 10 years, these villages are comparatively wealthier than lowland villages that rely more heavily upon rubber plantations. Though women migrate for work in lower numbers than men, it is not unheard of. They tend to seek employment in service industries closer to home, such as hotels and restaurants. Salaries are uniformly lower for work performed by female villagers when compared to male villagers. Women, too, are generally adept at riding motorcycles. However, local cultural attitudes favour them staying close to home for caretaking and food security management. One group of interviewed male 'motorcycle migrants' commented that women were physically incapable of riding the long, arduous distances to remote job sites undertaken by men.

As rubber prices have fallen over the years, tea prices have conversely been on the rise. This has created new opportunities for intervillage seasonal migration, with smallholder farmers travelling to other plantations to look for work as agricultural labourers for other farm owners, especially since tea harvesting has become more lucrative. Men currently participate in off-farm tea picking in greater numbers than women, again owing to increased access to motorcycles.

From 2011 – 2020, men dominated household decision-making in Xishuangbanna, consistently comprising approximately 93% of household heads across the survey period. In spite of this, women have been gaining household power in several other less-obvious ways. For example, it was observed that women's voices carry greater sway in decision-making regarding the purchasing of household goods. Overall increased household revenue across the prefecture means that economic hardship is, in general, no longer a restriction on purchases. Women, in short, can buy household appliances and necessities with little to no discussion with their male counterparts. In addition, in some ethnic groups, women have expanded power in the home. Researchers met more female-headed households in Dai villages because their families tended to own more rubber trees but lacked labourers. Accordingly, many husbands to these Dai women move to the wife's village, creating a matrilocal residency system rarely seen in rural China. Since the husbands are busy working the wife's family's land, the women have more time and opportunities to come into contact with outside market dynamics, accumulating business experience and skills. These bolster their capacity to operate as household executive decision-makers. Mental and physical health are also noticeably improved in these matrilocal residency scenarios. The wife's extended family offers protection, and incidents of domestic abuse are lower in these communities (Rajan, 2018). One other commonly voiced opinion was that women were too busy performing household tasks and did not have the time nor patience necessary for rubber-latex tapping, hence, men were more suitable to receive technical training and perform manual duties on the farm.

Control over resources

The use and allocation of arable land and forestland is typically decided in discussion between married couples. However, given that men tend to have more diverse work experiences and increased contact with rubber-latex traders and marketplaces beyond the village, their opinion tends to carry more sway in discussions about performing off-farm labour. This leads to a cycle of reinforcement whereby men spend more time outside exposed to commerce and politics (such as in village and township meetings) given their past experiences working off-farm, leading to more

opportunities for technical training, while women are generally preferred to stay home and function as caregivers for children and the elderly. Because of this widespread belief, women often face difficulties in gaining access to agricultural inputs and extension services, as gender contexts are often overlooked when drafting and implementing national economic policies and priorities (Tsige et al., 2020). Another issue critical to resource control is land use rights. Most women in rural China have historically married out of their natal village into their husband's home, oftentimes forfeiting their usufructuary right to land use. This is because in China, all land is owned by the State or communities, and farming land is negotiated and allocated in 30-year intervals between farmers and village committees. Given the predominance of patrilocal marriage arrangements in China, marital outcomes place women at a heavy disadvantage in the land allocation system, since their husband's side of the family tends to maintain land ownership rights. Marrying out can even strip women of land use rights in their natal village. Resource control in the area is thus inseparable from local norms regarding traditional gender roles, and these traditional gender roles propagate the idea that women 'belong' at home while patrilocal marriage arrangements disproportionably strip them of access to land.

Declining rubber prices have required farmers to change their planting structures and production methods over the last 10 years. Rubber trees typically require six to eight years before tapping latex can provide a return on investment, which creates incentives for long-term planning and complicates land-use transformation. Further complicating the dilemma is that natural rubber plantations are considered forestland in China and cannot be easily transitioned to another crop or tree species. To that end, farmers are incorporating cash crops and trees into paddy fields to offset losses, but many remain worried that this overall trend of diversification into cash crops and fruit will lead to lower prices across numerous products as supply increases. At the same time, farmers harbour serious doubts about the viability of widespread conversion of rubber plantation land, given anxieties voiced over the sunk financial, labour, and temporal costs. There is also general reluctance to transition to another crop given how lucrative rubber tapping has been in the past. Some respondents expressed hope that prices may one day return to past heights.

Despite these misgivings, there was a significantly higher percentage of households who were willing to adjust their current set of livelihood activities if profit or production from their main livelihood activities decreased by half over at least the next five years, from 46.05% of FHHs and 53.35% of MHHs in 2011 to 81.82% of FHHs and 72.90% of MHHs in 2020. It is interesting to note that women households may be more sensitive to economic shocks, given a 36% rise in FHHs reporting a willingness to change their main livelihood activities versus only a 20% rise in MHHs. One possible explanation may be because women spend more time at home handling daily expenditures and may have a more accurate picture of household finances. Significantly, both FHHs and MHHs are more willing now to adapt to changing circumstances in 2011, after nearly another decade of falling or stagnating rubber prices, indicating increased elasticity to external market forces. For household heads to change main livelihood activities, they must also accept likely increased workloads associated with diversifying into cash crops and cash trees, adding to the strain of women, who must juggle their intensifying workloads with traditional household caretaking and fewer but now more impactful opportunities for off-farm labour.

Though both men and women engage in rubber tapping, men are thought to be more ‘skillful’ owing to ‘greater patience’ and ‘technical ability’. Moreover, greater physical strength is useful for selling rubber because it is only sold in large quantities and is a heavy commodity. Men are thus overwhelmingly responsible for transporting the rubber in bulk to marketplaces where they will sell directly to buyers. Men and women typically decide together how to best use profits. One common concern heard among women is that men sometimes use profits to consume alcohol to excess or make unwise or rash business investments, leading to occasional disagreements and stoking marital tension.

Who benefits?

Married couples tend to make financial decisions together. In Xishuangbanna familial structures span disparate ethnic groups, but it nonetheless common for the wife to function as the ‘cheque-book’ of the household. Men are occasionally granted the autonomy to independently spend money while working outside. When women work in their own capacities, for example, as hotel or restaurant staff, they overwhelmingly tend to use their salaries without input from their husband. Despite this rough trend in managing disposable income, it nonetheless remains not uncommon for both men and women to spend money free from consultation of each other.

Purchasing directions also vary. Women generally spend money on education for their children alongside daily household expenses, whereas men make purchases related to investment in cash crops or cash trees. This is different nowadays compared to the past, when it was more fashionable for women to purchase expensive clothes, shoes, cosmetics, or other luxury products, while men bought private vehicles as communicators of upgraded social status, owing to historically ascendent rubber prices, but now these goods are being forgone in place of basic living necessities. In some ways, this mirrors a return to times before the rubber boom.

Chapter 5: Conclusions and recommendations

Despite plunging prices, rubber plantations continue to comprise the main source of income for Xishuangbanna households. However, at the same time, people are now forced to seek out other income streams than in the past, taking the form of migrant labour, tea planting (uplands) or planting other crops (lowland), in some cases signalling a return to income levels that existed before the rubber boom. There is new anxiety regarding the diversification of income streams, though, given that these other crops are now being grown in greater number and could potentially undergo a similar boom-bust cycle.

Falling rubber prices exert different impacts across the varying topography of the region. Lowland residences cannot easily convert their rubber plantations to other crops because of sunk costs, long-term investments, and the protected status of the trees. These households mitigate some financial difficulties by converting their rice fields to cash crops. Highland households, on the other hand, tend to feature more tea- and cash-crop farmers, since steep slopes preclude rubber tree planting. The price of tea is on the rise, and it is now seen as a particularly lucrative agricultural product by local farmers, an ironic reversal given that during the rubber boom, tea prices were low. In general, households with tea plantations are less impacted by dropping rubber prices, as their diversified harvesting portfolio

offers enhanced resilience to market fluctuations. This trend is captured in Table 15, where the number of both FHHs and MHHs who stated they would continue to plant and harvest tea increased by 13% from 2011 to 2020, suggesting the learned value of crop diversification for local farmers adapting to market forces.

Men and women both expressed anxiety around falling rubber prices, particularly in the context of the outbreak and spread of COVID-19. Their production and daily lives have been disrupted by the pandemic. Quarantine and lockdown procedures have complicated aspects of the supply chain. Particularly in the case of women, their quality of life has stagnated: though basic living conditions are now met, slipping household incomes limit purchasing power and impose tighter budgets, while on-farm cash crops require more strenuous manual labour to plant and harvest. They now control a lower percentage of household income while being responsible for a greater share of labour. As women are expected to continue to assume responsibility for most household and caretaking tasks on top of shifting to plant more labour-intensive cash crops, they bear disproportionately heavy workloads in daily life. This is increasingly viewed as necessary in the region for households to generate supplemental income to catch up and stay abreast of China's rising financial tide. Daily lives are focused yet again on ensuring that household necessities are met, while purchases of luxury goods that communicate increased wealth and status are on the decline.

Men, while also impacted by falling rubber prices, are less so than women. Travelling off farm as 'motorcycle migrants' to job sites up to 500 km away from households, they can take advantage of higher wages at construction sites or tea plantations. This also translates into men having greater decision-making power as they come into more frequent contact with the outside world. During the rubber boom, women were able to expand power in some ethnic groups because their husbands were working on the wives' family land. Thus, while the price plunge has been felt by all, it has disproportionately impacted the lives of women.

It is clear that rubber has played an important role in lifting many rural communities out of poverty. The global marketplace obviously benefits from this as well because rubber latex is a primary material used in many mainstay products of 21st-century life.

However, another side of the picture has also eluded scientists for too long: gender- differentiated impacts of land use and trade. Mitigating the impacts of global changes must involve looking at the key divergences in the ways in which these phenomena affect different genders. While it is impossible to assess the long-term gender impact of recent changes, short- to mid-term lessons can be learned, and there is a real need to learn from the experiences of women to inform better decision-making in the future.

As mentioned earlier, Dai households provide unique insights when examining gender-differentiated impacts of land use and trade, revealing higher degrees of gender equality, with Dai FHHs owning a comparatively higher percentage of rubber plantations. The explanation is likely multifactorial. Geographically, Dai households are generally found in the lowlands with access to more irrigable land, allowing them plant different crop species like watermelon and banana to hedge against market uncertainties and buttress potential falling incomes from other crops, strengthening their general livelihood systems (Zhang et al., 2014). Furthermore, their abundant land can be leveraged as collateral to secure bank loans from rural agricultural cooperatives; as beneficiaries of advantageous geography, they are also beneficiaries of financial mechanisms for rural development. Thus, Dai families by virtue of lowland geography enjoy

access to more land and institutional lending, not insignificantly alleviating household financial worries. Taken in aggregate, while policymakers and community leaders cannot modify the geographic realities and naturally distributed resources of rural women around the world, they can, however, create collaborative lending structures that increase household resilience to market uncertainties, lessening the need for women to plant labour-intensive cash crops and ultimately reducing time poverty.

Aside from interlinked geographical and financial advantages, family structure and work arrangements are also important factors in Dai villages. Throughout China, patrilocal marital arrangements are commonplace in which women marry into the village of their husband, thereby forfeiting land tenure rights of their natal village. However, Dai women traditionally remain in their natal village post-marriage, reserving the customary right to maintain and inherent their parents' land. Labour shortages in these Dai villages incentivize matrilocal marriage arrangements in which husbands migrate into Dai households to capitalize on greater resource endowment via on-farm labour. Matrilocal residence features intergenerational alliances between wife and parents, which can significantly lesson household workloads, given parents' and other family members' proximity and willingness to assist in child and elderly caretaking. This also frees up women to spend more time outside the village, where they can accumulate market familiarity, business experience, and develop other skills. Furthermore, strong intrafamily support networks also enhance the decision-making power of the women, allowing for the fairer distribution of household and labour responsibilities as well as protection from incidents of domestic violence. More robust legal protection for women to control and inherent land use rights, such as equal and transferable land use rights, and strengthening community support networks like childcare services can allow women to reclaim decision-making power and free up time traditionally spent engaging in family care.

The above recommendations are lessons learned from Dai villages. These specific examples comprise three broader calls for action: 1) raising awareness for both women and men regarding the potential for women to learn, do, and control more beyond what is expected within the narrow scope of traditional gender roles; 2) capacity building for women—training women in different skills and technologies so as to expand their repertoire of expected activities; and 3) expanding government support for advancing gender equality and women's rights via facilitating the entry of women into leadership positions at the community, regional and national levels, while strengthening women support networks and mechanisms. These recommendations can be implemented not only across China but worldwide.

We hope this study brings greater attention to the plight of women in the area, whose lives have been uprooted by changing commodity prices and the outbreak of a viral pandemic. If we heed their experiences and learn from their lessons, we can create not only a more enabling and supportive market environment but also an environment that features gender as a core consideration, allowing women to make choices not born of desperation but of equitable opportunity and empowerment.

Appendix

Household survey instrument –Yunnan China Country code 5

Mekong Futures Project

INTRODUCTION

[ENUM: READ OUT] Hello. My name is _____. I am here doing some work for the Kunming Institute of Botany coordinating research for the benefit of people living in the Mekong Basin. We are here to ask you some questions about what you think is important for supporting you and your family. The information collected during our discussions will only be used for research purposes to assist Chinese agencies better manage Xishuangbanna land use and water catchment. I hope you don't mind if I ask you a few questions about your life and activities. All information will be kept strictly confidential. We will not record your name and nothing you say will be linked directly to you. The interviews will take about 2 hours, and your contribution is very important. Is it OK to continue?

1. Yes 2. No

[Enum: If no, move on to the next household. Please spend some time chatting with respondents to ensure they are relaxed and comfortable before starting the formal questions.]

ACTIVITIY CODES

Production activities / crops:	Paid activities / jobs:
1 = Growing rice 2 = Growing vegetables 3 = Growing fruit trees 4 = Plantation (rubber) / rubber tapping 5 = Aquaculture 6 = Livestock (any kind of livestock, cows, pigs, poultry…) 7 = Fishing 8 = Collecting other aquatic species 9 = Collecting forest products (collecting wood, honey…) 10= Making handicrafts (baskets, sawing, weaving…) 11 = Collecting / growing mushroom 12= Growing maize and other 13= Plantation (tea) 14= Plantation (forestry) 15= Growing sugarcane 16= Growing cassava 17= Growing palm oil 18 = Other (specify) _____	51 = Farm labour; 52 = Working on tree plantation; 53 = Food processing or sale of agricultural goods (not produced by you); 54 = Manufacturing industry; 55 = Construction-related activities; 56 = Mining; 57 =Tourism (accommodation, restaurants, food stalls, tours, etc.) and other services; 58 = Government employee / teacher; 59 = Food-processing or sale of fish or other aquatic animals and plants (not grown or caught by you); 60= Rubber tapping; 61 = Tea packing; 62 = Small business / farmhouse; 63XX = Remittance income from working in various industries (for example, 6354 is the remittance income from working in manufacturing and processing factories); 64 = Other remittance income; 65 = Pension; 66 = Income from land rent and other fixed assets; 67 = Government cash subsidies (grain subsidies, etc.); and 68 = Other (specify) _____

A.06 Date of survey and start time	

A.00 Survey number: 5/

A.07 Initials of Interviewer:

A.1 Household identification and location

A.01 Country code	5
A.02 County	51
A.03 Township	
A.04 Commune / village committee	
A. 05 Village name / natural village / hamlet	
A.1.1 Is HH head / family from this village?	Yes = 1 No = 0
IF NO:	
A.1.2. If no, what year did you move?	Year.
A.1.3. Did you move voluntarily?	Yes = 1 No =0
A.1.4. Where did you move form?	51 = Other parts of the same county 52 = Other parts of the province 53 = Outside the province 54 = Abroad

A.2 Members of the household (including those living away some of the time)

Relation to the HH head (code)	Lives permanently in HH (y=1; n=0)	Age (numb)	Gender 1=male 2=female	Education (code)	Activity (code)	HH ethnicity (code)

Relation	Education	See activity codes at page 1	Ethnicity
1 (head), 2 (spouse), 3 (child), 4 (child in-laws), 5 (grandchild), 6 (parents), 7 (sibling), 8 (relatives), 9 (other…)	0 (illiterate), 1 (primary), 2 (basic secondary), 3 (secondary/ high school), 4 (college/ university) 5. monastery education	on your laminated sheet	51, Dai 52 Han 53 Lahu 54, Hani 55 Bulan 56 Jinuo 57 Yi 58 Yao 59 Miao 60 others

A.3 Household assets

Please indicate which of the following is **OWNED** (not borrowed or rented) by the household.

Asset	Code
A.31 Total farm size (codes: if no = 0; if yes = size in m2)	
If yes: A.32 How much is under your production? m^2 or %	
A.33 How much is leased to others to produce m^2 or %	
A.34 How much is not worked on? m^2 or %	
Does your land include: A.35 Orchards	no = 0; yes = 1
A.36 Ponds or trenches	no = 0; yes = 1
A.37 Rice fields	0=no 1 = Irrigated 2 = Rainfed 3 = Swidden 4 = Fallow Swidden 5 = Abandoned 6 = Groundwater irrigation
A.39 Tree / forest plantation	0 = no 1= tea plantation 2= rubber plantation 3= forest plantation

	4= natural forest or public forest
A. 310 Farm animals	no = 0; yes = 1
A. 311 Vegetable, flower and other annual crops	no = 0; yes = 1
A. 311 1 Other	no = 0; yes = 1
A. 312 Do you work land you don't own?	no = 0; yes = 1
A.313 Does you HH own any of the following farm machinery	1 = tractor 2 = hand tractor 3 = rice harvester 4 = pump 5 = milling equipment 6 = write ... . 0 = no
A.314 Does you HH own any of the following fishing gear	1 = nets (cast, gill, pulling, lift, bottom) 2 = hook line 3 = traps 4 = damming/fencing 5 = fishing boat 6 = others_____ 0 = no
A.315 Does you HH own any of the following modes of transport	1 = paddle boat 2 = big boat/motorboat 3 = bicycle 4 = motorbike 5 = track 6 = van 7 = vehicle 8 = others_____ 0 = no
A.316 Does you HH own any of the following HH items	1 = TV 2 = radio 3 = CD & DVD player 4 = fridge 5 = phone 6 = solar heater 7 = computer 8 = washing machine 9 = others_____
A. 317 Does your household have any long-standing debts? codes: if no = 0; if yes = how much?	_____yuan

A. 4. Household attitudes: Family wellbeing (only used in 2011)

[Enumerator to read out] Wellbeing is usually described as being the result of aspects of life that contribute to your family happiness, quality of life and welfare.

Many of the components of wellbeing are common to all people. Health, good family and community relations, and sufficient incomes are some of the components of wellbeing. However, the needs and aspirations of different people, and the communities they contribute to, also vary in important ways.

Reflecting this diversity is not easy. Therefore, we are asking you to share with us your personal ideas on what is important in your life and what makes you satisfied or dissatisfied with the 'way things are'.

This picture presents some of the factors typically identified by people as contributing to their personal wellbeing. Could you please read through them (or enumerators reads out) and tell me which ones are the most important contributors to your family wellbeing?

What is most important to your family? ----- More than one factor can be given the same score:

Society – Family and community	Nature – Natural environment	Economy and services
A1 Family relations	B1 Air quality	C1 Work
A2 Community relations	B2 Water quality	C2 Income
A3 Personal / family safety	B3 Soil quality	C3 Housing & amenities
A4 Traditional culture	B4 Access to the natural areas	C4 Health services & insurance
A5 Personal / family health	B5 Biodiversity	C5 Recreational facilities
A6 Civil and political rights	B6 Recreational activities in the nature	C6 Roads and Public transport
A7 Personal / family education levels	B7 Fishing and collecting produce in water	C7 Land ownership
A8 Personal / family job types	B8 Hunting and collecting produce on land	C8 Training and education services
A9 Personal / family contribution to local community	B9 Beauty of the nature (mountains, rivers, forest….)	C9 Markets
A10 Social status	B 10 Condition of the nature (mountains, rivers, forest….)	C10 Electricity / upgrading rural power grids
A11 Religious belief	B11 Others_____	C11 Irrigation infrastructure improvements
A 12 Government rural policies		C12 Drinking water safety
A13 Others_____		C13 Food safety
		C14 Others_____

How satisfied are you with your life overall? (0 least to 10 most) _____

LIST List of factors most important to respondent's family:	IMPORTANCE How important is this factor to you: (1 = least / 10 = most)	SATISFACTION How satisfied are you with this at the moment: (0 = not at all / 10 = most)
(code)	1-10	0-10
	1-10	0-10
	1-10	0-10
	1-10	0-10
	1-10	0-10
	1-10	0-10
	1-10	0-10
	1-10	0-10

A.5 Personal values (only used in 2011)

Below, fifteen values are described. The explanation of each value is given in the parentheses following each value. Please indicate how important each value is for you **AS A GUIDING PRINCIPLE IN YOUR LIFE by circling one number in each row.** Use the rating scale below:

0 means the value is not at all important, it is not relevant as a guiding principle for you.

3 means the value is important.

-1 is for rating any values **opposed** to the principles that guide your life.

4 is for rating a value of supreme importance as a guiding principle in your life; usually there are no more than two such values.

The higher the number (0, 1, 2, 3, 4) the more important the value is as a guiding principle in YOUR life. Try to distinguish as much as possible between the values by using **different numbers**.

	opposed to my values	not important	of little importance	moderately important	important	supreme importance
a) EQUALITY (equal opportunity for all)	-1	0	1	2	3	4
b) A VARIED LIFE (filled with challenge, novelty and change)	-1	0	1	2	3	4
c) RESPECTING THE EARTH (harmony with other species)	-1	0	1	2	3	4
d) HONOURING PARENTS AND ELDERS (showing respect)	-1	0	1	2	3	4
e) UNITY WITH NATURE (fitting into nature)	-1	0	1	2	3	4
f) A WORLD AT PEACE (free of war and conflict)	-1	0	1	2	3	4
g) CURIOUS (interested in everything, exploring)	-1	0	1	2	3	4
h) SELF DISCIPLINE (self-restraint and resistance to temptation)	-1	0	1	2	3	4
i) PROTECTING THE ENVIRONMENT (preserving nature)	-1	0	1	2	3	4
j) WEALTH (material possessions, money)	-1	0	1	2	3	4
k) AUTHORITY (the right to lead or command)	-1	0	1	2	3	4
l) SOCIAL JUSTICE (correcting injustice, care for the weak)	-1	0	1	2	3	4

m) INFLUENTIAL (having an impact on people and events)	-1	0	1	2	3	4
n) AN EXCITING LIFE (stimulating experiences)	-1	0	1	2	3	4
o) FAMILY SECURITY (safety for loved ones)	-1	0	1	2	3	4

Part B: Household activities (livelihood strategies)*:*

In the previous year / cropping year (March to March) what were your:

HOUSEHOLD PRODUCTION ACTIVITIES

List all the livelihood activities of the HH (things they grow, caught or made themselves)

And received non-cash gifts

Activities code	Quantities produced (t, kg, number)	Quantities sold (t, kg, number)	Value sold (yuan)	Costs to produce (yuan)
B.1. Wet season				
B.2. Dry season				

B.3. NON-CASH GIFTS

Activities (code)	Quantity	Unit	Unit： 1= kilogram 2=Piece/package 3=meter

B.4 DIRECT CASH IN ACTIVITIES

List important activities respondent that directly generated cash in a previous year

Labour / wages / remittance/ rent / other income (NOT sale of self-produced items / indirect cash)

Activities (Code)	Income generated (yuan, day/month/year)	Working period (day/month)

B.5. LOCATION OF LIVELIHOOD ACTIVITIES

B.5.1. Where does your most important wet season livelihood activity take place? (code)	B.5.2. Where does your most important dry season livelihood activity take place? (code)

1= Within the village; 2=Within 2 km of my village; 3=More than 2km from my village; 4=In different places

B.6. MOST IMPORTANT ACTIVITIES: For both production and cash activities:

B.61 Which of these activities you listed is most important to your HH? (activity code)
B.62 Which of these activities you listed is most stable over time? (activity code)

Enumerator: Cross-check with drivers answer later in section C

C. Change

C.0 Perceptions of key drivers

C.0.1. Perceived likelihood of occurrence

For each driver

On a scale of

0 no way that can happen

1 very unlikely this will happen

2 unlikely this will happen

3 maybe

4 likely this will happen

5 very likely this will happen

6 it will happen for sure

(enumerator to circle as appropriate) **circle one for each factor**

Also note if change is perceived as **Positive + / Negative -**

C.0.5. Perceived relevance of occurrence to their HH

In your personal view, if any of this happens in your region in the next 5-10 years, will it affect your household?

On scale of

0 this will not affect us in any way whatsoever

1 very unlikely to affect us

2 unlikely to affect us

3 maybe

4 likely this will affect us

5 very likely this will affect us

6 it will affect us for sure

(enumerator to circle as appropriate)

(copy and paste previous table)

Also note if change is perceived as **Positive + / Negative -**

How likely is this to occur?								How likely is it to affect your HH?						
	Not at all						Very much	Not at all						Very much
1. Weather becomes more variable (rain, floods, droughts, temperature….).	0	1	2	3	4	5	6	0	1	2	3	4	5	6
2. There will be more water available all year round to grow crops.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
3. Fish, aquatic animals and plants decline from the rivers / flood plain around the village.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
4. Irrigation system will be built and everyone in the village will have plenty of water to grow crops year-round.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
5. Soil fertility declines.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
6. A lot of people in the village will move away from agriculture and be employed in industry.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
7. People from elsewhere will move into our village.	0	1	2	3	4	5	6	0	1	2	3	4	5	6

8. A lot of agricultural land is lost, covered by buildings.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
9. You will be selling your land and buying a car	0	1	2	3	4	5	6	0	1	2	3	4	5	6
10. You will be leasing your land to the large companies.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
11. Farm technology takes over and traditional farm systems are lost (no buffalos and cows).	0	1	2	3	4	5	6	0	1	2	3	4	5	6
12. Profit from farming - or subsistence production - goes up.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
13. Profit from farming - or subsistence production - goes down.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
14. You will continue to grow rice because of food security.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
15. You will continue / start to grow cash crop.	0	1	2	3	4	5	6	0	1	2	3	4	5	6
16. Water will become more polluted	0	1	2	3	4	5	6	0	1	2	3	4	5	6
17. There will be more competition for water in the future as there will be many water users, other than agriculture	0	1	2	3	4	5	6	0	1	2	3	4	5	6
18. The number of rich tourists, travelling and looking for leisure will increase.	0	1	2	3	4	5	6	0	1	2	3	4	5	6

C. Changes to household activities

What is your current main activity? _____(activity code) C1.10

C1 - Driver 1: Imagine that the profit – or production - from your main activity is halved and likely to stay that low for at least five years.

If this happens, what would you do?

C.1.1 Would you keep on doing the same activities and remain in your village?

Yes = 1 No = 0

If No go to next

C1.11. Why will you not try ***to do*** something else? Circle one code	1 = I don't have education / skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = We will be fine as we are. 12 = It doesn't affect us. 13 = Other reason - please specify_____.
C1.12. Why will you not try ***to go*** somewhere else? Circle one code	1 = I don't have education/skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = Other places will be the same.

	12 = It doesn't affect us. 13 = Other reason - please specify_____.

C.1. 2. Would you keep on doing the same activities you are doing now, but

go somewhere else to do it?

Yes = 1 No = 0

If No go to next Q

C1.21 Why will you not try ***to do*** something else here?	1 = I don't have education/skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = We will be fine as we are. 12 = It doesn't affect us. 13 = Other reason - please specify_____.
C1.22 If you move away, would you	1 = migrate temporarily / seasonally from this village. 2 = move permanently.
C1.23 Where would you move to? Circle one code	51 = Another rural area 52 = Beijing, Guangzhou, Shanghai, another city 53 = Kunming 54 = Jinghong 55 = Another country (specify_____) 56 = Industrial zone in another province (specify_____)
C1.24. What would you do with your land here? Circle one code	1 = I do not own land. 2 = Sell to family. 3 = Sell to company. 4 = Rent to family. 5 = Rent to others. 6 = Keep / have labour.

	7 = Keep, not worked on. 0 = Other.
C1.25 How much do you think you would earn per year in this new setting?	(local currency)

C.1. 3. Would you adjust your current activities here? ☐

Yes = 1 No = 0

If No go to next Q

C1.31 Would you:	1 = Change crop. 2 = Change cropping calendar. 3 = Change species grown. 4 = Look for paid labour. 5 = Change or increase economic / energy / feed crop planting. 6 = Conduct other business. 7 = Reduce family expenses. 8 = Others_____
C1.32 What would you do more of? (if not applicable = 0)	(code)
C1.33 What would you do less of ? (if not applicable = 0)	(code)
C1.34 What new activities would you start doing?	(code)
C1.35 How much do you think you would earn per year in this new setting?	(local currency)

☐

C.1. 4. Would you replace your livelihood activities with completely new activities?

Yes = 1 No = 0

If No go to next Q

C1.41. What would you start doing?	(code)
C1.42. Would you need to move in order to start doing this?	0 = No 1 = migrate temporarily/ seasonally from this village. 2 = move permanently.
C1.43. Where would you move to?	51 = Another rural area 52 = Beijing, Guangzhou, Shanghai, other big city 53 = Kunming 54 = Jinghong 55 = Another country (specify_____) 56 = Industrial zone in another province (specify_____)
C1.44 What would you do with your land here?	1 = I do not own land. 2 = Sell to family. 3 = Sell to company. 4 = Rent to family. 5 = Rent to others. 6 = Keep / have labour. 7 = Keep, not worked on. 0 = Other_____.
C1.45 How much do you think you would earn per year from these new activities?	(local currency)

C1.5 For respondents who indicate they would move:

You said you would move to …….. ,

C1.51 Why would you move there?	1 = There are jobs available there. 2 = There is land / fishing available there. 3 = I have family there. 4 = I have friends there. 5 = Other reason - please specify_____.
C1.52 Sometimes things do not work out when you move to new place. If the life is not good in the place you move to, what would you do then?	1 = Return here. 2 = Go to some other village / rural area. Where – specify. 3 = Go to some other town. Where - specify_____.

C1.53 What other things would you HH consider doing in that case?	1 = Take out a loan from relatives. 2 = Take out a loan from others. 3 = Take out a loan from the bank. 4 = Use microfinance. 5 = Other coping mechanisms: _____.

C. Changes to household activities

C2 - Driver 2: Imagine that a lot of employment in industry will be available and most people from your village will move to cities to work in factories.

If this happens, what would you do?

C.2.1 Would you keep on doing the same activities and remain in your village?

Yes = 1 No = 0

If No go to next

C2.11. Why will you not try ***to do*** something else? Circle one code	1 = I don't have education / skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = We will be fine as we are. 12 = It doesn't affect us. 13 = Other reason - please specify_____.
C2.12. Why will you not try ***to go*** somewhere else? Circle one code	1 = I don't have education / skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = Other places will be the same.

	12 = It doesn't affect us. 13 = other reason please specify_____

C.2. 2. Would you keep doing the same activities you are doing now, but

go somewhere else to do them?

Yes = 1 No = 0

If No go to next Q

C2.21 Why will you not try ***to do*** something else here?	1 = I don't have education/skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = We will be fine as we are. 12 = It doesn't affect us. 13 = Other reason – please specify_____.
C2.22 If you move away, would you	1 = migrate temporarily / seasonally from this village. 2 = move permanently.
C2.23 Where would you move to? Circle one code	51 = Another rural area 52 = Beijing, Guangzhou, Shanghai, other big city 53 = Kunming 54 = Jinghong 55 = Another country (specify_____) 56 = Industrial zone in another province (specify_____)

C2.24. What would you do with your land here? Circle one code	1 = I do not own land. 2 = Sell to family. 3 = Sell to company. 4 = Rent to family. 5 = Rent to others. 6 = Keep / have labour. 7 = Keep, not worked on. 0 = Other.
C2.25 How much do you think you would earn per year in this new setting?	(local currency)

C.2. 3. Would you adjust your current activities here? ☐

Yes =1 No = 0

If No go to next Q

C2.31 Would you:	1 = Change a crop. 2 = Change cropping calendar. 3 = Change species grown. 4 = Look for paid labour. 5 = Change or increase economic / energy / feed crop planting. 6 = Conduct other business. 7 = Reduce family expenses. 8 = Others_____.
C2.32 What would you do more of? (if not applicable = 0)	(code)
C2.33 What would you do less of? (if not applicable = 0)	(code)
C2.34 What new activities would you start doing?	(code)
C2.35 How much do you think you would earn per year in this new setting?	(local currency)

☐

C.2. 4. Would you replace your livelihood activities with completely new activities?

Yes = 1 No = 0

If No go to next

C2.41. What would you start doing?	(code)
C2.42. Would you need to move in order to start doing this?	0 = No 1 = Migrate temporarily / seasonally from this village. 2 = Move permanently.
C2.43. Where would you move to?	51 = Another rural area. 52 = Beijing, Guangzhou, Shanghai, other big city 53 = Kunming 54 = Jinghong 55 = Another country (specify_____) 56 = Industrial zone in another province (specify_____)
C2.44 What would you do with your land here?	1 = I do not own land. 2 = Sell to family. 3 = Sell to company. 4 = Rent to family. 5 = Rent to others. 6 = Keep / have labour. 7 = Keep, not worked on. 0 = Others_____.
C2.45 How much do you think you would earn per year from these new activities?	(local currency)

C2.5 For respondents who indicate they would move:

You said you would move to_____.

C2.51 Why would you move there?	1 = There are jobs available there. 2 = There is land / fishing available there. 3 = I have family there. 4 = I have friends there. 5 = Other reason – please specify_____.
C2.52 Sometimes things do not work out when you move to new place. If the life is not good in the place you move to, what would you do then?	1 = Return here. 2 = Go to some other village / rural area / where – specify. 3. Go to some other town / where - specify_____.

C2.53 What other things would you HH consider doing in that case?	1 = Take a loan from relatives. 2 = Take a loan from others. 3 = Take a loan from bank. 4 = Use microfinance. 5 = Other coping mechanisms _____.

C. Changes to household activities

C6 - Driver 6: Imagine that weather becomes variable and unpredictable (hot and dry…).

If this happens, what would you do?

C.6.1 Would you keep on doing the same activities and remain in your village?

Yes = 1 No = 0

If No go to next

C6.11. Why will you not try ***to do*** something else? Circle one code	1 = I don't have education / skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start a business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve 11 = We will be fine as we are. 12 = It doesn't affect us. 13 = Other reason – please specify_____.
C6.12. Why will you not try ***to go*** somewhere else? Circle one code	1 = I don't have education / skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start a business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = Other places will be the same. 12 = It doesn't affect us. 13 = Other reason – please specify_____.

C.6. 2. Would you keep on doing the same activities you are doing now, but

go somewhere else to do it?

Yes = 1 No = 0

If No go to next Q

C6.21 Why will you not try ***to do*** something else here?	1 = I don't have education/skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = We will be fine as we are. 12 = It doesn't affect us. 13 = other reason please specify_____.
C6.22 If you move away, would you	1 = migrate temporarily/ seasonally from this village. 2 = move permanently.
C6.23 Where would you move to? Circle one code	51 = Another rural area 52 = Beijing, Guangzhou, Shanghai, other big city 53 = Kunming 54 = Jinghong 55 = Another country (specify_____) 56 = Industrial zone in another province (specify_____)
C6.24. What would you do with your land here? Circle one code	1 = I do not own land. 2 = Sell to family. 3 = Sell to company. 4 = Rent to family. 5 = Rent to others. 6 = Keep / have labour. 7 = Keep, not worked on. 0 = Other.
C6.25 How much do you think you would earn per year in this new setting?	(local currency)

C.6. 3. Would you adjust your current activities here? ☐

Yes = 1 No = 0

If No go to next Q

C6.31 Would you:	1 = Change a crop. 2 = Change cropping calendar. 3 = Change species grown. 4 = Look for paid labour. 5 = Change or increase economic / energy / feed crop planting. 6 = Conduct other business. 7 = Reduce family expenses. 8 = Others_____.
C6.32 What would you do more of? (if not applicable = 0)	(code)
C6.33 What would you do less of? (if not applicable = 0)	(code)
C6.34 What new activities would you start doing?	(code)
C6.35 How much do you think you would earn per year in this new setting?	(local currency)

☐

C.6. 4. Would you replace your livelihood activities with completely new activities?

Yes =1 No = 0

If No go to next Q

C6.41. What would you start doing?	(code)
C6.42. Would you need to move in order to start doing this?	0 = No 1 = migrate temporarily / seasonally from this village. 2 = move permanently.
C6.43. Where would you move to?	51 = Another rural area 52 = Beijing, Guangzhou, Shanghai, other big city 53 = Kunming 54 = Jinghong 55 = Another country (specify_____)

	56 = Industrial zone in another province specify)_____
C6.44 What would you do with your land here?	1 = I do not own land. 2 = Sell to family. 3 = Sell to company. 4 = Rent to family. 5 = Rent to others. 6 = Keep / have labour. 7 = Keep, not worked on. 0 = Other_____.
C6.45 How much do you think you would earn per year from these new activities?	(local currency)

C6.5 For respondents who indicate they would move:

You said you would move to ……..

C6.51 Why would you move there?	1 = Jobs available there. 2 = Land / fishing available there. 3 = I have family there. 4 = I have friends there. 5 = Other reason – please specify_____.
C6.52 Sometimes things do not work out when you move to new place. If the life is not good in the place you move to, what would you do then?	1 = Return here. 2 = Go to some other village/ rural area / where – specify_____. 3 = Go to some other town / where - specify_____.
C6.53 What other things would you HH consider doing in that case?	1 = Take a loan from relatives. 2 = Take a loan from others. 3 = Take a loan from bank. 4 = Use microfinance. 5 = Other coping mechanism(s) _____.

C. Changes to household activities

C11 – Driver 11: Imagine the government announces payments such that you can plant native trees and become a tree farmer rather than rubber (or other as appropriate) farmer and still maintain your standard of living.

If this happens, what would you do?

C.11.1 Would you keep on doing the same activities and remain in your village?

Yes = 1 No = 0

If No go to next

C11.11. Why will you not try ***to do*** something else? Circle one code	1 = I don't have education / skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 =We will be fine as we are. 12 = It doesn't affect us. 13 = Other reason – please specify_____
C11.12. Why will you not try ***to go*** somewhere else? Circle one code	1 = I don't have education / skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = Other places will be the same. 12 = It doesn't affect us. 13 = Other reason – please specify_____.

C.11. 2. Would you keep on doing the same activities you are doing now, but

go somewhere else to do it?

Yes = 1 No = 0

If No go to next Q

C11.21 Why will you not try ***to do*** something else here?	1 = I don't have education / skills. 2 = I don't know anyone who could help me. 3 = I don't have money to start business. 4 = There is no support from government. 5 = I can't sell my land to anyone. 6 = I have a debt. 7 = I want to continue what I am doing now. 8 = Infrastructure is not available / poor. 9 = Because this is the village of my ancestors. 10 = I think our current situation will improve. 11 = We will be fine as we are. 12 = It doesn't affect us. 13 = Other reason – please specify_____.
C11.22 If you move away, would you	1 = migrate temporarily/ seasonally from this village. 2 = move permanently.
C11.23 Where would you move to? Circle one code	51 = Another rural area 52 = Beijing, Guangzhou, Shanghai, other big city 53 = Kunming 54 = Jinghong 55 = Another country (specify_____) 56 = Industrial zone in another province (specify_____)
C11.24. What would you do with your land here? Circle one code	1 = I do not own land. 2 = Sell to family. 3 = Sell to company. 4 = Rent to family. 5 = Rent to others. 6 = Keep / have labour. 7 = Keep, not worked on. 0 = Other.
C11.25 How much do you think you would earn per year in this new setting?	(local currency)

C.11. 3. Would you adjust your current activities here? ☐

Yes = 1 No = 0

If No go to next Q

C11.31 Would you:	1 = Change a crop. 2 = Change cropping calendar. 3 = Change species grown. 4 = Look for paid labour. 5 =Change or increase economic / energy / feed crop planting. 6 = Conduct other business. 7 = Reduce family expenses. 8 = Other_____.
C11.32 What would you do more of? (if not applicable = 0)	(code)
C11.33 What would you do less of ? (if not applicable = 0)	(code)
C11.34 What new activities would you start doing?	(code)
C11.35 How much do you think you would earn per year in this new setting?	(local currency)

☐

C.11. 4. Would you replace your livelihood activities with completely new activities?

Yes = 1 No = 0

If No go to next Q

C11.41. What would you start doing?	(code)
C11.42 Would you need to move in order to start doing this?	0 = No 1 = migrate temporarily / seasonally from this village. 2 = move permanently.
C11.43 Where would you move to?	51 = Another rural area

	52 = Beijing, Guangzhou, Shanghai, other big city 53 = Kunming 54 = Jinghong 55 = Another country (specify_____) 56 = Industrial zone in another province (specify_____)
C11.44 What would you do with your land here?	1 = I do not own land. 2 = Sell to family. 3 = Sell to company. 4 = Rent to family. 5 = Rent to others. 6 = Keep/ have labour. 7 = Keep, not worked on. 0 = Other_____.
C11.45 How much do you think you would earn per year from these new activities?	(local currency)

C11.5 For respondents who indicate they would move:

You said you would move to_____.

C11.51 Why would you move there?	1 = Jobs available there. 2 = Land / fishing available there. 3 = I have family there. 4 = I have friends there. 5 = other reason please specify_____.
C11.52 Sometimes things do not work out when you move to new place. If the life is not good in the place you move to, what would you do then?	1 = Return here. 2 = Go to some other village/ rural area / where – specify_____. 3 = Go to some other town / where - specify_____.
C11.53 What other things would you HH consider doing in that case?	1 = Take a loan from relatives. 2 = Take a loan from others. 3 = Take a loan from bank. 4 = Use microfinance. 5 = Other coping mechanism(s) _____.

Surveyor notes:

End time	
Length (time) of interview	
Data Checked By	
Data Input By	
Data Input Checked By	
Spreadsheet File Name	

Interviewer initials and signature

Annex 2: Additional questionnaire used in the survey in 2020.

1. Ten years ago, the main cash crops grown by your household were:

a. rubber b. tea c. fruit trees d. rice e. other

2. The main cash crop grown by your family now is:

a. rubber b. tea c. fruit trees: d. rice e. other:

3. Your family has increased the area under cultivation of _____ in the past decade and the reasons for this are:

4. At the same time, your family has reduced the area under cultivation of ____ and the reasons for this are:

5. Your household's income from cash crops (0 decrease; 1 increase) over the past 10 years and reasons for this are:

6. Your household income (0 decrease; 1 increase) over the past ten years and reasons for this are:

7. Household expenses (0 decrease; 1 increase) over the past ten years and reasons for this are:

8. For the above changes, are you worried about the future__(0 not worried;1 worried).

9. If you are worried, why are you worried? What will you do about it? // If not, why not?

10. In the face of the above changes, will your family (multiple choices):

a. Increase the cultivation of cash crops (fill in the specific crops)

b. Decrease the cultivation of cash crops (fill in the specific crops)

c. Increase the area of farmland such as rice and dry land

d. Decrease the area of farmland such as rice and dry land

e. Increase agricultural machinery input

g. Work more or go out to work

11. If the price of rubber continues to fall, you will (multiple choices):

a. Continue to plant and stop cutting rubber

b. Continue the regular planting and production of rubber

c. Cut down part of the rubber and plant (fill in the specific crops) instead

e. Cut down all rubber and plant (fill in the specific crops) instead

f. Rent out the land

g. Sell the land use rights

12. If the price of rubber starts to recover, you will (multiple choices):

a. Strengthen rubber inputs and production

b. Continue regular rubber cultivation and production

c. Buy land to grow rubber

e. Rent others' land to grow rubber

f. Switch to rubber and increase the area of rubber

g. Not increase the area

13. What changes have you seen over the past ten years in the village where you live?

a. Increasing number of cars

b. Increase in buildings

c. Decrease in traditional wooden houses

d. Increasing number of smart phones

e. Increase in rubber areas

f. Decrease in rubber areas

g. Increase in cash crop types

h. Decrease in rice cultivation

i. More and more young people go to work outside

j. Less/more/no change in edible wildlife

k. Fewer/more/no change in mushrooms in the forest

l. More/less/no change in people coming to the village to promote forest/wildlife conservation

m. Other

14. You believe the area of natural forest near your village is:

a. increasing b. decreasing c. quite good now

15. You believe the area of rubber forest near your village is:

a. increasing b. decreasing c. now is fine

16. You think the area of natural forest near your village is:

a. more b. less c. about the same:_____(Please state the approximate amount)

17. Is there any of the following forms of protected or forbidden places (which are commonly called Dragon Hill) near your village (multiple choices)?

a. Male Dragon Mountain / Land b. Female Dragon Mountain c. Yin Mountain

d. Grave Mountain/Burial Ground e. Dragon Forest f. Sacred Ground

g. Sacred mountain h. Sacred tree i. Temple forest

18. Why do you want to protect these places?

a. Taught by the village elders

b. Taught by temple Buddha

c. That's what people have been doing all the time

d. It's said that people protecting these places will be protected by the gods

e. Other _____

19. What kind of religious or ritual activities would you conduct at these Dragon Mountains?

20. Which of the following daily activities are allowed at these Dragon Mountains?

a. Cutting firewood b. Collecting firewood

c. Picking herbs d. Picking mushrooms/fruit

e. Picking honey f. Other

21. Which of the following activities are not allowed on these Dragon Mountains?

a. Cutting firewood b. Cutting trees c. Picking herbs

d. Picking mushrooms/fruit e Picking honey

f. Hunting g. Other

22. What are the rules other than the above permitted or disallowed activities?

23. Who made these rules?

a. Village rules / village regulations

b. The respected village elders

c. These were handed down from the ancestors.

d. Village committee e. Other

24. What are the punishments for breaking these rules?

25. Who will enforce these punishments?

a. Village committee b. Clan elders/respected elders c. Other

26. What kind of rituals are conducted each year on Dragon Hill? And who will participate in?

27. Compared with forests around, the forests of Dragon Hill are _ .

a. Better b. worse c. about the same

28. What is the basis for you to judge one forest is better or worse than another?

29. Do you think the forests of your Dragon Hill are better than the forests of the nearest reserve and why?

References

Association of Natural Rubber Producing Countries (ANRPC), 2020. *Natural Rubber Trends & Statistics*.

Brauw, A. & Rozelle, S., 2008. Migration and household investment in rural China. *China Economic Review*, 19(2), 320-335. https://doi.org/10.1016/j.chieco.2006.10.004.

Chen, H., Yi, Z., Schmidt-Vogt, D., Ahrends, A., Beckschäfer, P., Kleinn, C., Ranjitkar, S., & Xu, J., 2016. Pushing the limits: The pattern and dynamics of rubber monoculture expansion in Xishuangbanna, SW China. *PLoS ONE*, *11*(2), 1–15. https://doi.org/10.1371/journal.pone.0150062.

Doss, C. R., 2014. If women hold up half the sky, how much of the world's food do they produce? In A. R. Quisumbing, R. Meinzen-Dick, T. L. Raney, A. Croppenstedt, J. A. Behrman, & A. Peterman (Eds.), *Gender in Agriculture: Closing the Knowledge Gap* (pp. 69–88). Dordrecht: Springer. https://doi.org/10.1007/978-94-017-8616-4.

Elin, V., 2015. *Income diversification among female-headed farming households*. Available at: https://www.oru.se/globalassets/oru-sv/institutioner/hh/workingpapers/workingpapers2015/wp11-2015.pdf [Accessed August 8, 2021].

FAO, 2016. The female face of farming: Farmers. Workers. Entrepreneurs. Care-givers. Bread-winners. Bread-makers. Mothers. Wives. Daughters. In *Committee on World Food Security* (pp. 1–2). FAO. Available at: http://www.fao.org/cfs/home/blog/blog-articles/article/en/c/447783/.

Fox, J., Castella, J., Zieglar, A., & Westley, S., 2014. Rubber Plantations Expand in Mountainous Southeast Asia: What Are the Consequences for the Environment? *Asia Pacific Issues*, 114.

Fu, Y., Brookfield, H., Guo, H., Chen, J., Chen, A., & Cui, J., 2009. Smallholder rubber plantation expansion and its impact on local livelihoods, land use and agrobiodiversity, a case study from Daka, Xishuangbanna, southwestern China. *International Journal of Sustainable Development and World Ecology*, 16(1), 22–29. https://doi.org/10.1080/13504500902753246.

Hammond, J., Yi, Z., McLeilan, T., & Zhao, J., 2015. Situational analysis report: Xishuangbanna Autonomous Dai Prefecture Yunnan, China. ICRAF *Working Paper 194*, APRIL, 80. https://doi.org/10.13140/RG.2.1.4651.6645.

Hongmei, L., Youxin, M., Zhongfeng, G., & Wenjun, L., 2007. Land Use/Land Cover Dynamic Change in Xishuangbanna Based on RS and GIS Technology. *Journal of Mountain Science*, 3(003).

Huang, H., Liu, J., & Huang, H., 2017. Strategies for natural rubber production and development in China. *Asian Agricultural Research*, 9(7), 15–17. https://doi.org/10.19601/.cnki.issn1943-9903.207.07.003.

International Rubber Study Group (IRSG), 2020. *Rubber Statistical Bulletin.* London: IRSG.2020-01-18.

Janekunprasoot, T., 2020. Research on the countermeasures of the development of Thai natural rubber industry under the background of economic globalization. Jimei University, China, Master thesis.

Jiang, J., & Zhang, H.J., 2020. Analysis of Natural Rubber Industry Policies in China Based on the Natural Rubber Regional Competitive Capability. *Chinese Journal of Tropical Agriculture,* 40 (12), 126–132.

Klasen, S., & Pieters, J., 2015. What Explains the Stagnation of Female Labor Force Participation in Urban India? *World Bank Economic Review*, 29(3), 449-478. https://doi.org/10.1093/wber/lhv003.

Kullawong, S., Aditto, S., Chambon, B., Promkhambut, A., 2020. Farmer fertilization practices of mature rubber plantations in Northeast Thailand during a period of low rubber prices. *Forest and Society,* 4 (1), 162–180. http://dx.doi.org/10.24259/fs.v4i1.8980.

Kuma, T., Dereje, M., Hirvonen, K., & Minten, B., 2019. Cash crops and food security: Evidence from Ethiopian smallholder coffee producers. *The Journal of Development Studies*, *55*(6), 267–1284. https://doi.org/10.1080/00220388.2018.142539

Kumar, N., & Quisumbing, A. R., 2013. Gendered impacts of the 2007-2008 food price crisis: Evidence using panel data from rural Ethiopia. *Food Policy*, 38(1), 11–22. https://doi.org/10.1016/j.foodpol.2012.10.002.

Kusakabe, K., & Chanthoumphone, C., 2021. Transition from Subsistence Agriculture to Rubber Plantations in Northern Laos: Analysis of Household Livelihood Strategies by Ethnicity and Gender. *SAGE Open*, 11(2). https://doi.org/10.1177/21582440211011463.

Lanjouw, P., Quizon, J., & Sparrow, R., 2001. Non-agricultural earnings in peri-urban areas of Tanzania: Evidence from household survey data. *Food Policy*, *26*(4), 385–403. https://doi.org/10.1016/S0306-9192(01)00010-0.

Li, D., & Zhang, D., 2020. Natural Rubber Industry Development Policy Analysis: Borders and Bonus. *Issues of Forestry Economics*, 40 (2), 208-215. DOI: https://doi.org/10.16832/j.cnki.1005-9709.2020.02.012.

Liu, F., Zhou, R., & Zou, W., 2018. Analysis of the impact of oil price on natural rubber price — An empirical study based on VAR model. *Guangdong Agricultural Sciences*. 45 (12), 165-171. https://doi.10.16768/j.issn.1004-874X.2018.12.027.

Lu, S., 2020. *Pretty Lady Cadres*. *ChinaFile*. Available at: https://www.chinafile.com/reporting-opinion/features/pretty-lady-cadres-china [Accessed December 19, 2021].

Min, S., Waibel, H., Cadisch, G., Langenberger, G., Bai, J., & Huang, J., 2017a. The economics of smallholder rubber farming in a mountainous region of southwest China: elevation, ethnicity, and risk. *Mountain Research and Development,* 37(3), 281–293. https://doi.org/10.1659/MRD-JOURNAL-D-16-00088.1.

Min, S., Huang, J., Bai, J., & Waibel, H., 2017b. Adoption of intercropping among smallholder rubber farmers in Xishuangbanna, China. International Journal of Agricultural Sustainability, 15 (3), 223–237. https://dx.doi.org/10.1080/14735903.2017.1315234.

Min, S., Huang, J., & Waibel, H., 2017c. Rubber specialization vs crop diversification: the roles of perceived risks. *China Agricultural Economic Review*, *9*(2), 188–210. https://doi.org/10.1108/CAER-07-2016-0097.

Min, S., Jikun, H., Hermann, W., Yang, X. & Cadisch, C., 2019. Rubber boom, land use change and the implications for carbon balances in Xishuangbanna, Southwest China. *Ecological Economics*, 156, 57-67. https://doi.org/10.1016/j.ecolecon.2018.09.009.

Mu, R., & van de Walle, D., 2011. Rural roads and local market development in Vietnam. *Journal of Development Studies*, 47(5), 709–734. https://doi.org/10.1080/00220381003599436.

Musinguzi, L., Vianny, N., Efitre, J., & Richard, O.-O., 2017. The role of gender in improving adaptation to climate change among small-scale fishers. *Climate and Development*, 10(6), 566–576. https://doi.org/10.1080/17565529.2017.1372262.

Niehof, A., 2004. The significance of diversification for rural livelihood systems. *Food Policy*, 29, 321-338. http://doi.org/10.1016/j.foodpol.2004.07.009.

Pearson, V., Phillips, M., He, F., & Ji, H., 2002. Attempted suicide among young rural women in The People's Republic of China: Possibilities for prevention. *Suicide and Life-Threating Behavior,* 32(4), 359–369. https://doi.org/10.1521/suli.32.4.359.22345.

Poston, D., Yang, W. & Farris, D. N., 2014. *The Family and Social Change in Chinese Societies*. (D. L. Poston, W. S. Yang, & D. N. Farris (eds.); 1st ed.). Springer, Dordrecht. https://doi.org/10.1007/978-94-007-7445-2.

Qiu, J., 2009. Where the rubber meets the garden. *Nature,* 457(7227), 246–247. https://doi.org/10.1038/457246a.

Rajan, H., 2018. When wife-beating is not necessarily abuse: A feminist and cross-cultural analysis of the concept of abuse as expressed by Tibetan survivors of domestic violence. *Violence Against Women*, *24*(1), 3–27. https://doi.org/10.1177/1077801216675742.

Research and Markets., 2019. *Global and China natural rubber industry report, 2019-2025*. Available at: https://www.reportlinker.com/p04126832/?utm_source=PRN [Accessed November 9, 2021].

Schneider, A. E., 2011. What shall we do without our land? Land Grabs and Resistance in Rural Cambodia. *International Conference on Global Land Grabbing*, 36. Available at: http://www.iss.nl/fileadmin/ASSETS/iss/Documents/Conference_papers/LDPI/49_Alison_Schneider.pdf [Accessed July 25, 2021].

Shen, S., Xu, G., Li, D., Clements, D. R., Zhang, F., Jin, G., Wu, J., Wei, P., Lin, S., & Xue, D., 2017. Agrobiodiversity and in situ conservation in ethnic minority communities of Xishuangbanna in Yunnan Province, Southwest China. *Journal of Ethnobiology and Ethnomedicine*, *13*(1), 1–15. https://doi.org/10.1186/s13002-017-0158-7

Smith, D. R., Gordon, A., Meadows, K., & Zwick, K., 2001. Livelihood diversification in Uganda: Patterns and determinants of change across two rural districts. *Food Policy*, *26*(4), 421–435. https://doi.org/10.1016/S0306-9192(01)00012-4.

Su, Y., Bisht, S., Wilkes, A., Pradhan, N. S., Zou, Y., Liu, S., & Hyde, K., 2017. Gendered responses to drought in Yunnan Province, China. *Mountain Research and Development*, *37*(1), 24–34. https://doi.org/10.1659/mrd-journal-d-15-00041.1.

Sujakhu, N. M., Ranjitkar, S., Yang, H., Su, Y., Xu, J., & He, J., 2020. Quantifying farmers' climate change adaptation strategies and the strategy determinants in Southwest China. *International Journal of Climate Change Strategies and Management*. https://doi.org/10.1108/IJCCSM-12-2019-0073.

Thornton, A., & Lin, H.-S., 1995. *Social change and the family in Taiwan* (1st ed.). University of Chicago Press.

Tsige, M., Synnevåg, G., & Aune, J. B., 2020. Is gender mainstreaming viable? Empirical analysis of the practicality of policies for agriculture-based gendered development in Ethiopia. *Gender Issues*, *37*(2), 125–152. https://doi.org/10.1007/s12147-019-09238-y.

UN Women Watch., n.d. *Rural women - facts & figures: Rural women and the millennium development goals*. Available at https://www.un.org/womenwatch/feature/ruralwomen/facts-figures.html [Accessed December 13, 2021].

Wang, X., Min, S., & Junfei, B., 2018. Marry to rubber? An investigation on the matrilocal residence of smallholder rubber farmers in southwest China. *Agricultural Economics*, 0–28. https://doi.org/10.22004/ag.econ.277494.

Xie, Y., 2013. Gender and family in contemporary China. In *PSC Research Reports*. Available at https://www.psc.isr.umich.edu/pubs/pdf/rr13-808.pdf [Accessed June 21, 2021].

Xu, J., Lebel, L., & Sturgeon, J., 2009. Functional links between biodiversity, livelihoods, and culture in a Hani swidden landscape in southwest China. *Ecology and Society*, *14*(2). https://doi.org/10.5751/ES-02916-140220.

Yang, J., Xu, J., & Zhai, D. L., 2021. Integrating phenological and geographical information with artificial intelligence algorithm to map rubber plantations in Xishuangbanna. *Remote Sensing*, *13*(14). https://doi.org/10.3390/rs13142793

Zhang, K. H., & Song, S., 2003. Rural–urban migration and urbanization in China: Evidence from time-series and cross-section analyses. *China Economic Review*, *14*(4), 386–400. https://doi.org/10.1016/J.CHIECO.2003.09.018.

Zhang, L., Kono, Y., & Kobayashi, S., 2014. The process of expansion in commercial banana cropping in tropical China: A case study at a Dai village, Mengla County. *Agricultural Systems*, *124*, 32–38. https://doi.org/10.1016/j.agsy.2013.10.006.

Zhang, L., Zono, Y., Kobayashi, S., Hu, H., Zhou, R., & Qin, Y., 2015. The expansion of smallholder rubber farming in Xishuangbanna, China: A case study of two Dai villages. *Land Use Policy*, *42*, 628–634. https://doi.org/10.1016/J.LANDUSEPOL.2014.09.015.

Zhao, Y., & Kockelman, K. M., 2002. The propagation of uncertainty through travel demand models: An exploratory analysis. *Annals of Regional Science*, *36*(1), 145–163. https://doi.org/10.1007/s001680200072.

Ziegler, A.D., Fox, J.M., Xu, J., 2009. The rubber juggernaut. *Science*, 324, 1024–1025. https://doi.org/10.1126/science.1173833.

Zomer, R., Trabucco, A., Wang, M., Lang, R., Chen, H., Metzger, R., Smajgl, A., Bechschafer, P. & Xu, J., 2014. Environmental stratification to model climate change impacts on biodiversity and rubber production in Xishuangbanna, Yunnan, China. *Biological Conservation*, 170, 264-273.https://doi.org/10.1016/j.biocon.2013.11.028.

Working Paper Series

2017

252. Preferensi Petani terhadap Topik Penyuluhan dan Penyebaran Informasi Agroforestri di Indonesia http://dx.doi.org/10.5716/WP16181.PDF

253. Seri Agroforestri dan Kehutanan di Sulawesi: Keanekaragaman hayati jenis pohon pada hutan rakyat agroforestri di DAS Balangtieng, Sulawesi Selatan http://dx.doi.org/10.5716/WP16182.PDF

254. Potensi dan Tantangan dalam Pengembangan Skema Ko-Investasi Jasa Lingkungan di Kabupaten Buol, Indonesia. http://dx.doi.org/10.5716/WP17008.PDF

255. Keragaman Jenis Pohon dan Pemanfaatannya oleh Masyarakat di Kabupaten Buol, Indonesia. http://dx.doi.org/10.5716/WP17009.PDF

256. Kerentanan dan preferensi sistem pertanian petani di Kabupaten Buol, Indonesia http://dx.doi.org/10.5716/WP17010.PDF

257. Dinamika Perubahan Penggunaan/Tutupan Lahan Serta Cadangan Karbon di Kabupaten Buol, Indonesia. http://dx.doi.org/10.5716/WP17011.PDF

258. The effectiveness of the volunteer farmer trainer approach vis-à-vis other information sources in dissemination of livestock feed technologies in Uganda. http://dx.doi.org/10.5716/WP17104.PDF

259. Agroforestry and forestry in Sulawesi series: Impact of agricultural-extension booklets on community livelihoods in South and Southeast Sulawesi. http://dx.doi.org/10.5716/WP17125.PDF

260. Petani Menjadi Penyuluh, Mungkinkah? Sebuah Pendekatan Penyuluhan dari Petani ke Petani di Kabupaten Sumb Timur. http://dx.doi.org/10.5716/WP17145.PDF

261. Dampak Perubahan Tutupan Lahan terhadap Kondisi Hidrologi di Das Buol, Kabupaten Buol, Sulawesi Tengah: Simulasi dengan Model Genriver http://dx.doi.org/10.5716/WP17146.PDF

262. Analisis Tapak Mata Air Umbulan, Pasuruan, Jawa Timur. Kajian elemen biofisik dan persepsi masyarakat. http://dx.doi.org/10.5716/WP17147.PDF 29

263. Planned comparisons demystified. http://dx.doi.org/10.5716/WP17354.PDF

264. Soil health decision support for NERC digital soil platforms: A survey report. http://dx.doi.org/10.5716/WP17355.PDF

265. Seri Pembangunan Ekonomi Pedesaan Indonesia: Menanam di bukit gundul: Pengetahuan masyarakat lokal dalam upaya restorasi lahan di Sumba Timur. http://dx.doi.org/10.5716/WP17356.PDF

266. Tree diversity and carbon stock in three districts of Kutai Timur, Pasir and Berau, East Kalimantan http://dx.doi.org/10.5716/WP17357.PDF

267. Tree Diversity and Carbon Stock in Various Land Use Systems of Banyuasin and Musi Banyuasin Districts, South Sumatera http://dx.doi.org/10.5716/WP17358.PDF

268. Tree diversity and carbon stock in various land cover systems of Jayapura, Jayawijaya and Merauke Districts, Papua Province http://dx.doi.org/10.5716/WP17359.PDF

269. Modelling tree production based on farmers' knowledge: case for kapok (Ceiba pentandra) and candlenut (Aleurites mollucana) under various agroforestry scenarios. http://dx.doi.org/10.5716/WP17361.PDF

270. The Impact of Land Cover and Climate Change on Present and Future Watershed Condition. Study case: Tugasan, Alanib and Kulasihan Sub-watershed of Manupali Watershed, Lantapan, Bukidnon, Philippines. http://dx.doi.org/10.5716/WP17362.PDF

271. Tree Diversity and Above-ground Carbon Stock estimation in Various Land use Systems in Banjarnegara, Banyumas and Purbalingga, Central Java. http://dx.doi.org/10.5716/WP17363.PDF

272. Agroforestry and Forestry in Sulawesi series: Landscape Management Strategies in Sulawesi: Review of Intervention Options. http://dx.doi.org/10.5716/WP17364.PDF

273. Household Food-Security and Nutritional Status of Women and Children in Buol Regency, Central Sulawesi, Indonesia. http://dx.doi.org/10.5716/WP17365.PDF

274. Palm oil expansion in tropical forest margins or sustainability of production? Focal issues of regulations and private standards. http://dx.doi.org/10.5716/WP17366.PDF 30

2018

275. Decision analysis methods guide: Agricultural policy for nutrition. http://dx.doi.org/10.5716/WP18001.PDF

276. Supporting human nutrition in Africa through the integration of new and orphan crops into food systems: Placing the work of the African Orphan Crops Consortium in context. http://dx.doi.org/10.5716/WP18003.PDF

277. Seri Pembangunan Ekonomi Pedesaan Indonesia. Pilihan Manajemen Budidaya Kacang Tanah sebagai Upaya untuk Memperbaiki Penghidupan Masyarakat Haharu. http://dx.doi.org/10.5716/WP18004.PDF

278. Estudio de línea de base CCAFS a nivel de hogar en Nicaragua y Costa Rica Fase de diagnóstico del estudio: "Contribución de la diversidad arbórea a los medios de vida para la adaptación y la mitigación al cambio climático http://dx.doi.org/10.5716/WP18005.PDF

279. Understanding tree cover transition, drivers and stakeholder perspectives for effective landscape governance. A case study in Na Nhan commune, Dien Bien province, Vietnam. http://dx.doi.org/10.5716/WP18006.PDF

280. El Sistema “Quesungual”: Agroforestería y manejo de suelos para la producción de maíz y frijol en laderas. http://dx.doi.org/10.5716/WP18007.PDF

281: Probabilistic Decision Modelling to Determine Impacts on Natural Resource Management and Livelihood Resilience in Marsabit County, Kenya. http://dx.doi.org/10.5716/WP18008.PDF

282. Shifting discourse, shifting power: how is climate change mitigation and justice negotiated in Indonesia? http://dx.doi.org/10.5716/WP18009.PDF

283. Result of Land Use Planning and Land Administration (LULA) Implementation in South Sumatra, East Kalimantan, Central Java and Papua http://dx.doi.org/10.5716/WP18010.PDF

284. Farmers’ preferences for training topics and dissemination of agroforestry information in Indonesia. http://dx.doi.org/10.5716/WP18015.PDF

285. CSA-Diagnostic (CSA-Dx): A primer for investigating the ‘climate-smartness’ of ag-technologies http://dx.doi.org/10.5716/WP18020.PDF

286. An analysis of the vulnerability of poor communities in Yunnan Province, China http://dx.doi.org/10.5716/WP18021.PDF 31

287. Gendered space and quality of life: gender study of out-migration and smallholding agroforestry communities in West Java Province, Indonesia. http://dx.doi.org/10.5716/WP18024.PDF

288: Evaluation of UTZ certification coffee businesses in Guatemala, Honduras and Nicaragua. http://dx.doi.org/10.5716/WP18028.PDF

289. Agroforestry species of Peru: annotated list and contribution to prioritization for genetic conservation. http://dx.doi.org/10.5716/WP18029.PDF

290. Indonesia Rural Economic Development Series.Growing plants on a barren hill: local knowledge as part of land restoration in Sumba Timur, Indonesia. http://dx.doi.org/10.5716/WP18030.PDF

291. Assessing the Downstream Socioeconomic Impacts of Agroforestry in Kenya http://dx.doi.org/10.5716/WP18033.PDF

2019

292: Los árboles fuera del bosque en la NAMA forestal de Colombia. Elementos conceptuales para su contabilización. http://dx.doi.org/10.5716/WP19002.PDF

293: Gender and Adaptation: An Analysis of Poverty and Vulnerability in Yunnan, China. http://dx.doi.org/10.5716/WP19004.PDF

294: Tree Cover on Agricultural Land in the Asia Pacific Region. http://dx.doi.org/10.5716/WP19005.PDF

295: What do we really know about the impacts of improved grain legumes and dryland cereals? A critical review of 18 impact studies. http://dx.doi.org/10.5716/WP19006.PDF

296: Breeders' views on the production of new and orphan crops in Africa: a survey of constraints and opportunities. http://dx.doi.org/10.5716/WP19007.PDF

297: Biomass Resources in Rhino Camp and Imvepi Refugee Settlements and the Buffer Zone around these Settlements in West Nile, Uganda. http://dx.doi.org/10.5716/WP19031.PDF

298: Option for restocking woody biomass in refugee-hosting areas: Perspectives from communities in Rhino Camp and Imvepi Settlements, Uganda. http://dx.doi.org/10.5716/WP19032.PDF

299: Restoring ecosystems in refugee settlements using tree-based systems: The case of Rhino Camp and Imvepi Settlements in Uganda. http://dx.doi.org/10.5716/WP19033.PDF

300: A theory-based evaluation of the Agroforestry Food Security Programme, Phase II in Malawi (AFSPII): Lessons for Scaling Up Complex Agronomic and Natural 32 Resource Management Practices Developed and Tested in Research Settings. http://dx.doi.org/10.5716/WP19036.PDF

301: Fuentes semilleras y especies agroforestales de los bosques secos tropicales del norte del Perú: estado actual y prioridades futuras. (Spanish) http://dx.doi.org/10.5716/WP19057.PDF

302: Seed sources and agroforestry species of tropical dry forests of northern Peru: current status and future priorities. (English) http://dx.doi.org/10.5716/WP19058.PDF

303: Turmeric Production under Shade Management and Fertilization in Degraded Landscapes of Sumba Timur. https://dx.doi.org/10.5716/WP19066.PDF

2020

304: From Tree Planting to Tree Growing: Rethinking Ecosystem Restoration Through Trees. http://dx.doi.org/10.5716/WP20001.PDF

305: Agroforestry species of Peru: Reference list and contribution to prioritization for the conservation of agroforestry genetic resources. http://dx.doi.org/10.5716/WP20013.PDF

306: An exploratory analysis of cost-benefit analysis of landscape restoration. http://dx.doi.org/10.5716/WP20014.PDF

307: Wood fuel value chains in Kenya: a 20-year synthesis. http://dx.doi.org/10.5716/WP20026.PDF

308: Especies agroforestales del Perú: Lista referencial y contribución a la priorización para la conservación de recursos genéticos agroforestales. Documento de Trabajo número 308. Centro Internacional de Investigación Agroforestal http://dx.doi.org/10.5716/WP20041.PDF

309: Simulasi Dampak Perubahan Tutupan Lahan dan Curah Hujan di DAS Citarum Hulu dengan Model GenRiver: Kalibrasi model dan analisa sensitivitas. http://dx.doi.org/10.5716/WP20048.PDF

310: Simulating the effect of change in land cover and rainfall in Upper Citarum Watershed: calibration and sensitivity analysis of Genriver model http://dx.doi.org/10.5716/WP20049.PDF

311: Status of Perennial Tree Germplasm Resources in India and their Utilization in the Context of Global Genome Sequencing Efforts. http://dx.doi.org/10.5716/WP2020050.PDF

2021

312: The one hundred tree species prioritized for planting in the tropics and subtropics as indicated by database mining. World Agroforestry, Nairobi, Kenya. http://dx.doi.org/10.5716/WP21001.PDF 33

313: Amaruzaman S, Isnurdiansyah B L. 2021. Land-use Land-cover Change and Farming systems in the upland of Pagar Alam City, Indonesia. http://dx.doi.org/10.5716/WP21007.PDF

314: Effect of COVID-19 on rural community enterprises: the case of community forest enterprises in Cameroon. http://dx.doi.org/10.5716/WP21007.PDF

315: Assessment of women's benefits and constraints in participating in agroforestry exemplar landscapes. https://dx.doi.org/10.5716/WP21021.PDF

316: Adoption of improved grain legumes and dryland cereals crop varieties: A synthesis of evidence. https://dx.doi.org/10.5716/WP21022.PDF

317: Understanding tree-cover transitions, drivers and stakeholders' perspectives for effective landscape governance: a case study of Chieng Yen Commune, Son La Province, Viet Nam. https://dx.doi.org/10.5716/WP21023.PDF

318: Commune-level institutional arrangements and monitoring framework for integrated tree-based landscape management. Ha Noi, Viet Nam: https://dx.doi.org/10.5716/WP21024.PDF

319: Beyond carbon sequestration – local knowledge about tree functions. Case study from male and female Arabica coffee farmers in Vietnam . https://dx.doi.org/10.5716/WP21025.PDF

320: Priority landscapes for tree-based restoration in Ethiopia. DOI: https://dx.doi.org/10.5716/WP21037.PDF

321: The Farmland Biodiversity Score for consistent monitoring of biodiversity based on the measurement of trees on farms. DOI: https://dx.doi.org/10.5716/WP21038.PDF

322: Multi-stakeholder platforms for cross-border biodiversity conservation and landscape governance in East Africa: Perspectives and outlook DOI: https://dx.doi.org/10.5716/WP21039.PDF

323: Opportunities for implementing improved tree seed sourcing for forest landscape restoration, agroforestry and wider tree planting at the project design stage: Findings of a survey of planters, researchers and funders. https://dx.doi.org/10.5716/WP21041.PDF

324: A decision analysis framework for development planning and performance measurement: application to land restoration investments. https://dx.doi.org/10.5716/WP21042.PDF

325: Regulatory compliance, motivations and capacities in charcoal production in Baringo and Kitui counties, Kenya. https://dx.doi.org/10.5716/WP21043.PDF

326: Gendered impacts of falling rubber prices: Changing livelihood strategies in China's rubber heartland. https://dx.doi.org/10.5716/WP22004.PDF

World Agroforestry (ICRAF) is a centre of scientific and development excellence that harnesses the benefits of trees for people and the environment. Leveraging the world's largest repository of agroforestry science and information, we develop knowledge practices, from farmers' fields to the global sphere, to ensure food security and environmental sustainability.

ICRAF is the only institution that does globally significant agroforestry research in and for all of the developing tropics. Knowledge produced by ICRAF enables governments, development agencies and farmers to utilize the power of trees to make farming and livelihoods more environmentally, socially and economically sustainable at multiple scales.

United Nations Avenue, Gigiri • PO Box 30677 • Nairobi, 00100 • Kenya
Telephone: +254 20 7224000 or via USA +1 650 833 6645
Fax: +254 20 7224001 or via USA +1 650 833 6646
Email: worldagroforestry@cgiar.org • www.worldagroforestry.org