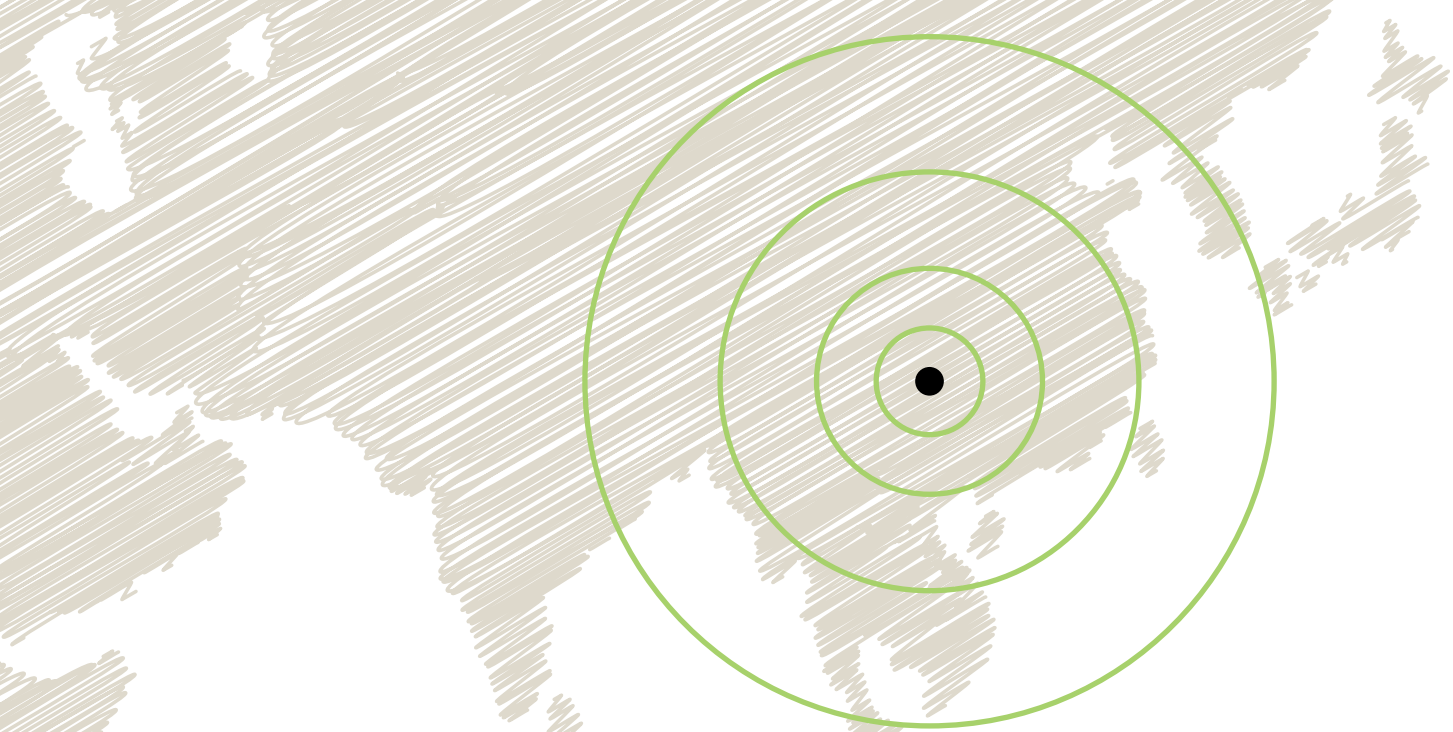

Smallholder farming systems in southwest China

Exploring key trends and innovations for resilience

Yiching Song, Yanyan Zhang, Xin Song and Krystyna Swiderska

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All over the world, we are rapidly losing a diversity of locally adapted crops and traditional knowledge, which provide resources for resilience and adaptation to climate change. The SIFOR project (Smallholder Innovation for Resilience) aims to strengthen traditional knowledge-based innovation systems for food security in the face of climate change. This report presents findings from a baseline study conducted in 18 communities in Southwest China, which explored trends in livelihoods, crop diversity, social capital and climate, and traditional knowledge-based innovations. These include innovations developed jointly by ethnic communities and external partners, notably Participatory Plant Breeding and Community Supported Agriculture, which have strengthened resilience by enhancing food security, incomes and crop diversity.

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Summary

The Smallholder Innovation for Resilience (SIFOR) project aims to strengthen traditional knowledge-based innovation systems for food security in the face of climate change. Traditional knowledge and local crop varieties provide important resources for resilience and innovation by smallholder farmers for climate adaptation - yet they are fast disappearing. In China, long-existing traditional farming and local seed and innovation processes are threatened by modern farming policies and subsidies. The spread of hybrid monocultures to remaining areas of crop diversity in southwest provinces presents a risk to national food security as the genetic basis for plant breeding and climate resilience is becoming increasingly narrow.

This report presents the findings of a comprehensive baseline study conducted in 18 poor ethnic villages in Guangxi and Yunnan, Southwest China, as part of SIFOR. Using qualitative methods and quantitative household surveys (involving 344 households), it explored key trends in livelihoods, migration, food security, cropping systems, seed systems, crop diversity and climate. It also explored traditional knowledge based or 'biocultural' innovations developed in response to climatic and socio-economic challenges. The study was conducted from January 2013 to July 2014. As well as providing baseline data for monitoring and evaluation of the SIFOR project, the study sought to understand the context for innovation, and identify key TK-based innovations and conditions that support innovation.

The findings show that overall trends of growing out-migration, and feminisation, ageing and shrinking of the agricultural labour force continued between 2002 and 2012, particularly in Guangxi. Migration to cities contributes to about half of household income in both provinces. Incomes are much higher in Guangxi than in more remote Yunnan villages, but the difference between income and expenditure has grown consistently in both provinces since 2002. Income from agricultural production has generally declined in both provinces. However, given the high living expenses in urban areas, crop production and sales are still the most important livelihood activities for income and food security. Food self-sufficiency has declined as access to food markets has become easier. Farmers rely mainly on saved seed for landraces, and on markets for hybrid seed, with women playing a major role in selecting and saving seed for all types of crops.

Farmers still grow significant crop diversity – 1235 varieties in 11 Guangxi villages, and 463 varieties in 7 Yunnan villages; nevertheless, the percentage cropping area with landraces is higher in Yunnan (e.g. nearly 90% for soybean). However, crop diversity is declining – there has been a rapid decline in the area planted with maize landraces since 2002 in both provinces; and a decline in the area planted with rice landraces in Guangxi, and wheat landraces in Yunnan. The loss of crop varieties trippled (to 61 varieties) in 2000 when China joined the WTO, and remained high in subsequent years, due to promotion of hybrids and subsidies for intensive agriculture. The yield of hybrid seeds, coupled with limited scientific investment in improving local varieties, leads to the frequent replacement and disappearance of more resilient and diverse local varieties. However, farmers are still conserving some local varieties, mainly due to their good taste and high yield and resilience in the local environment (under less than optimal conditions). For example, maize landraces survived the severe spring drought of 2010 in Guangxi, but hybrid maize varieties did not.

Native language – an important carrier of traditional knowledge – is still spoken by 100 per cent of households surveyed in Yunnan, and 95.5 per cent in Guangxi. However, it is no longer taught in primary schools. Overall, traditional culture appears stronger in Yunnan where nearly 100% of houses are built in traditional style (due to customary laws), and more people wear traditional clothing. But there is a trend away from traditional farming (eg. use of cattle tillage, intercropping, manure) towards modern farming techniques in both provinces.

More than half the households surveyed reported changes in rainfall, temperature, drought and insects/pests in recent years – with over 90% reporting changes in rainfall. In Yunnan, where there has been spring drought for 5 consecutive years (2010–2014), over 70% of households reported drought in the last 10 years compared to 24% reporting it before the last 10 years. In Guangxi, more households observed cloud burst in the last 10 years than previously.

Farmers have responded to these climatic and livelihood challenges through a number of traditional knowledge-based or 'biocultural' innovations. The survey identified a total of 542 innovations – 233 technical, 210 market

and 99 institutional innovations (although some of the market innovations are not strictly TK-based). These include 'internal' innovations developed by farmers alone based on traditional knowledge and biocultural heritage, such as drought tolerant landraces, water saving technologies, crop management and labour saving innovations. Key innovations to remain resilient in the face of drought include continually improving drought-tolerant landraces of maize, wheat and rice, selecting varieties for a diversity of planting times, switching crops and changing cropping patterns. Some informal institutional and market innovations have also emerged, e.g. vegetable groups, folk music and dancing groups, and revival of traditional community organisations and seed exchanges. Collective innovation by farmers is increasing in recent years in both provinces.

Two joint innovations – Participatory Plant Breeding (PPB) and Community Supported Agriculture (CSA) - supported by CCAP in Guangxi since 2000 and 2005 respectively, have had significant impacts on food security, climate resilience, incomes and crop diversity, and have stimulated a number of 'internal' innovations. Through PPB, scientists have worked directly with farmers to develop new maize and rice varieties with increased yields and resilience. The new PPB maize varieties have 15–30% higher yield compared to landraces, and higher drought and pest resistance than hybrids. The random household survey results show that average yields of rice and maize landraces increased between 2002 and 2012 (by 16% for rice), but for wheat (which was not part of PPB), landrace yields declined.

By linking farmers directly with urban consumers through ecological/fair trade restaurants, CSA has tripled farm incomes of participating households and led to the return of some young people to villages. The wider household survey shows that incomes from crop production and sale in Guangxi have increased slightly since 2007, reversing the downward trend of the previous five years. The findings also show that PPB and CSA are reversing trends of crop diversity loss, and revitalising traditional agroecological farming practices due to market demand. Since 2007, the area planted with maize hybrids has declined in Guangxi; while the rice landrace area has grown – in one village it grew by 70% in 10 years. Furthermore, villagers have re-introduced heritage varieties of vegetables, grains and animals which had gone locally extinct. Food self-sufficiency is significantly higher in villages with organic farmer groups than in neighbouring villages. PPB and CSA have also stimulated the formation of farmers' cooperatives and womens' empowerment. The involvement of leading scientists in PPB has led to wider transformational changes: China's national seed law now recognises farmers' rights to save, exchange and sell conventional seed at local level; while the Guangxi Maize Research Institute has introduced a budget to support PPB.

Traditional basic values and beliefs are core factors supporting the local innovation and adaptation process, for both internal and joint innovations. Therefore support for climatic and socio-economic resilience in these communities should prioritise strengthening their biocultural heritage.

Strengthening biocultural innovation systems in China is important to enhance food security and resilience to climate change, not only in smallholder farming communities, but also within national agricultural systems by providing a wide and resilient evolving gene pool. Clear policy support and incentives are needed to promote PPB within formal agricultural systems at provincial and national level, and to strengthen market linkages. The new National Farmer Seed Network can play an important role in scaling up PPB, CSA and farmer innovations in China; and in promoting more supportive policies and dialogue between different stakeholders. China's successful PPB and CSA approaches provide important models and tools for achieving food security, climate adaptation, poverty eradication, biodiversity conservation, sustainable agriculture and transformational change in other Southern countries.

Stone Village, Yunnan, by Yiching Song, April 2013

Background and methods

1

Many smallholder farmers are already adversely affected by climate change, particularly those living in harsh environments such as mountains and drylands. These farmers have traditional knowledge-based strategies for resilience and adaptation, including a diversity of locally adapted crops, that have enabled them to survive in difficult and variable environments over centuries. Such strategies have important, yet largely untapped, potential for addressing today's climatic challenges. However, traditional knowledge is being lost due to modernisation and lack of recognition, and local crop diversity is being lost with the spread of a few commercial varieties and monocultures. Smallholders' own innovation systems are also being weakened as a result of top-down agricultural research and extension services, undermining their longer term adaptive capacity and self-reliance.

The Smallholder Innovation for Resilience (SIFOR) project

The Smallholder Innovation for Resilience (SIFOR) project aims to strengthen traditional knowledge-based or 'biocultural' innovation systems that smallholder farming communities draw on for food security. This five year project, initiated in 2012 with funding from the European Union, is coordinated by the International Institute for Environment and Development (IIED) with partners in China, India, Kenya and Peru. SIFOR works with indigenous and traditional farming communities, often in remote and risk-prone environments, that still sustain significant agrobiodiversity and traditional knowledge for adaptation to climate change. It is a participatory action-research project with four specific objectives:

i) to identify traditional knowledge-based innovations that enhance productivity and the conditions that support innovation;

ii) to develop tools to make innovation systems more resilient and improve rights security;

iii) to strengthen the capacity of smallholders, including indigenous farmers and women, to sustain resilient innovation systems and agrobiodiversity; and

iv) to enhance scientists' and policy makers' understanding of biocultural innovation systems and promote more supportive policies and institutions.

In China, SIFOR is working with ethnic mountain communities in Guangxi and Yunnan provinces in the southwest, to strengthen innovation systems (see Box 1).

BOX 1. SIFOR CHINA: SUPPORTING BIOCULTURAL INNOVATION IN GUANGXI AND YUNNAN

SIFOR is supporting China's first Participatory Plant Breeding program, which was initiated by CCAP in Guangxi in 2000. This, together with a Community Supported Agriculture programme for market linkages, have stimulated a number of innovations, including the development of more resilient and productive maize and rice varieties, revival of agro-ecological farming practices such as duck-in-rice and inter-cropping, and establishment of farmers' cooperatives and seed fairs. These successful innovations – which have tripled incomes and reversed the loss of crop diversity – are now being scaled up to Yunnan.

The SIFOR project is working to support biocultural innovation at all levels. At the village level in Yunnan, we are documenting traditional landraces as well as traditional processing methods. For example, we are researching local traditional ways of processing walnut oil which had completely stopped, traditional ham curing techniques, tofu processing techniques using pickle juice rather than chemical salts now routinely used, and traditional alcohol fermentation processes that rely on herbal fermentation techniques. SIFOR is documenting these and plans to conduct trainings for households wishing to revitalise these traditional processing approaches. Externally, we are also supporting research into market channels for some traditional crops, and planning trainings for farmers in certain value-addition activities. For example, processing pelargonium citrosa into oil, internal medicine, perfume, and incense, rather than selling it directly as a raw material. We are also supporting efforts to scale up the CSA and farmers market approaches started in Guangxi through a farmers' market and organic restaurant in Lijiang.

Additionally, we are directly involved in the National Farmer Seed Network and advocating for a strong, clear policy environment supporting biocultural innovation for climate resilience, including reform of the national seed law to protect farmers' rights and seed systems. Through this national network, CCAP's PPB and CSA innovations are being spread to smallholder communities across China.

SIFOR Baseline Study

This report presents the research framework, methodology, and key findings of a comprehensive qualitative and quantitative baseline study conducted in 18 SIFOR project villages from January 2013 to July 2014. The aims of the study were both to provide baseline data for monitoring and evaluation, and to explore key trends and innovation responses. It focused on two main areas:

i) trends in livelihoods, crop diversity, social capital and climate, in the past 30 years (largely between 2002 and 2012), and

ii) biocultural innovations developed in response to these trends, along with the factors that supported the innovations.

'Biocultural innovations' are new technologies or ways of doing things. Innovations arise in two main ways. 'Internal' (or 'endogenous') innovations emerge from interactions between the components of biocultural heritage (i.e. traditional knowledge, biodiversity, landscapes, cultural and spiritual values and customary laws). 'Joint' (or 'collaborative') innovations arise from the interaction between traditional knowledge and science, where traditional knowledge contributes at least half of the innovation.

This baseline study builds on previous surveys conducted in Guangxi and Yunnan by CCAP. That research showed clear trends in: 1) migration to urban areas, resulting in a shrinking, increasingly feminised, and ageing agricultural labour force, and 2) the spread of hybrid monocultures and reduction in the area planted with landraces (Song and Li 2011). Much of China's agricultural 'bread belt' is now under intensive monocultures. This supports national food security but has resulted in loss of crop diversity, environmental pollution, water scarcity and health problems (Cook and Buckley 2015). The spread of hybrids to remaining areas of evolving crop diversity and fragile environments in Southwest China, presents a risk to local and national food security, as the genetic basis for plant breeding (including hybrid breeding) is becoming increasingly narrow. Alternative approaches are needed in China's Southwest provinces to enhance productivity and food security, whilst also sustaining crop diversity and ecosystem services for climate resilience and adaptation. This report presents such alternative innovations pioneered by CCAP and ethnic communities in Guangxi and Yunnan. Participatory Plant Breeding and Community Supported Agriculture have significantly enhanced crop resilience, productivity and incomes while, reversing prevailing trends of crop diversity loss and migration to cities.

The policy context in China

China has a long farming history characterised by a huge number of small-scale farmers with extremely small farm sizes and diversified contexts. The national average farm size is only about 0.6 ha with huge geographic and socioeconomic diversification between the east and west, coast and inland. The farmers' seed system is the foundation of this long-standing farming civilisation. In the past few thousand years, the farmers' seed system has continued through adaptation, evaluation and innovation, and has accumulated a very rich agricultural biodiversity and resilient tradititional farming system to ensure and support human survival and continuity. Nevertheless, in the last two decades, China's agriculture has undergone rapid and in some respects, dramatic change. In very large areas of the country farming has become firmly embedded in national and international market economies (Song *et al.*, 2013). This process has been steered by the state in the form of modernisation and reform policies, rural development programmes and agricultural science and technology policies and programmes. The country's macroeconomic development dynamics have led to rapid and mass processes of industrialisation and urbanisation. These, in turn, have contributed to a changing face of agriculture characterised in many rural areas by the feminisation and ageing of the rural population (Song *et al.*, 2006; Song and Vernooy, 2010).

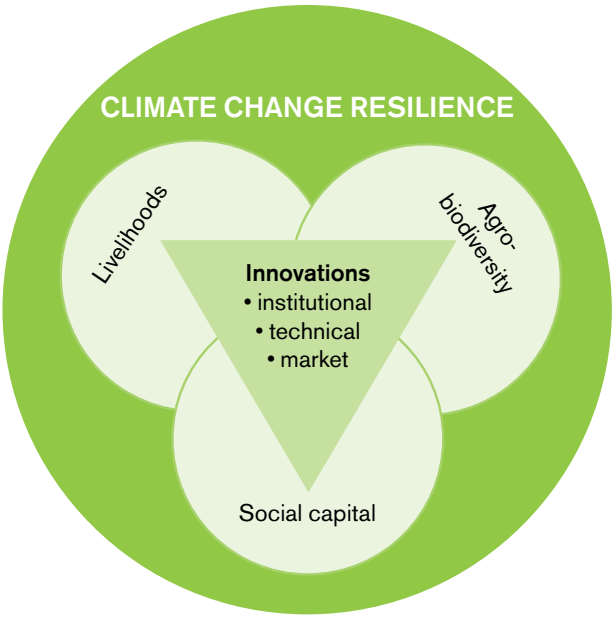
The long-existing traditional farming and seed system and farmers' innovation processes are threatened or even disappearing due to some modern farming policies. For example, national policies only recognise breeders' rights over high-yielding hybrid seeds and not farmers' rights over local varieties, provide subsidies for the production and distribution of only hybrid seeds, and subsidise inputs such as chemical fertilisers and machinery. These policies do not protect the rights of smallholder farmers over the landraces they have domesticated, improved and conserved, or support local seed systems and traditional agroecological farming practices. At the same time, agricultural research policies focusing only on hybrids of a few staple food crops have a direct influence on breeders' incentives and an adverse impact on the diversity of local crops and varieties. Joint ventures between foreign seed companies and domestic companies for crop breeding and plant variety protection (PVP) are also increasingly incentivising hybrid breeding. One PVP protected maize variety has wiped out half the remaining maize landraces in Guangxi province since 2002 (Song and Li 2011). However, in November 2015, China's national seed law was revised to support local seed systems by including a provision allowing farmers to save, exchange and sell conventional seed at local level.

In recent years, the state has developed an overall new strategic goal of 'ecological civilisation'. Under this, some policies and programmes supporting circular farming and ecological agriculture have been introduced by the Ministry of Agriculture (MOA), and a series of policies supporting farmer co-operatives have had some positive impact on farmers' seed systems and innovation processes. The public in China is also increasingly aware of these problems of farmers' rights and is experiencing a process of conceptual change, from a focus on food security to an understanding of the importance of food sovereignty and seed sovereignty. Some leading scientists from the public research system, with different research backgrounds, have great interest in working with communities and dialogue with different stakeholders. They have added their voices to the state-level policy and legal discussion. For example, the recent suggestions for the revision of the national seed law to protect farmers' rights were made by leading scientists through the National Farmer Seed Network in China, a multi-stakeholder platform which also involves the Ministry of Agriculture and Ministry of Environment (Song and Guanqi, 2015). This interest amongst leading scientists to support local seed systems has emerged following their involvement CCAP's PPB programme, which was initiated in Guangxi in 2000.

A research framework for biocultural innovation

Figure 1 provides a visual representation of biocultural innovation systems for resilience. Within it, climate change provides an overarching field of inquiry for research into institutional, technical and market innovations. These innovations occur in three main aspects or components of the system: in livelihoods, in agro-biodiversity, and in social capital. For example, Participatory Plant Breeding (PPB) can be seen as an agro-biodiversity component of China's biocultural innovation system for climate resilience. This component is supported by institutional, technical and market innovations. Similarly, Community Supported Agriculture (CSA) can be guided by its role as a livelihood aspect of the system, with research focusing on the specific institutional, market and technical innovations that it applies.

Figure 1: A framework for researching biocultural innovation systems for resilience



Study sites and communities

Guangxi and Yunnan provinces are in Southwest China (see Figure 2), a region that is home to most of China's rural poor ethnic minority communities. Eighteen farming villages were chosen for the SIFOR project and baseline study: 11 in Guangxi and 7 in Yunnan, spanning 7 counties in the two provinces. These villages were chosen for the project because they still maintain high levels of crop diversity and traditional knowledge. The villages in Guangxi are at 800–1000 metres above sea level (masl) and include some that are fairly close to urban areas, as well as more remote villages in the Karst mountains with rocky terrain and limited arable land. Many of the villages in Yunnan, particularly those that form part of the Stone Village[1], are at higher altitude (1800–2800masl) in a more remote and mountainous area of the Himalayan foothills. Most of the 11 Guangxi villages have been involved in CCAP's Participatory Plant Breeding programme since 2000 and in Community Supported Agriculture since 2005, although they include a few 'new' villages which joined in the two years before the survey was conducted. All the villages in Yunnan were 'new' villages which were not part of the CCAP's PPB and CSA programme before the SIFOR project started in mid 2012. The survey was also conducted in eight additional 'control' villages for M&E purposes: 2 in Yunnan and 6 in Guangxi.

[1] The Stone Village is an 'administrative village' which comprises a number of 'natural villages'.

Figure 2: Map of China showing Yunnan and Guangxi Provinces

Research approach

We followed SIFOR's common research approach and questionnaires developed for the baseline study, to enable comparison between countries and inform international policy makers. However, some small adjustments were made to adapt them to the local context. A mixed methods approach was used, combining qualitative and quantitative surveys, to provide complementary and supporting data for a more complete understanding. The more open-ended qualitative survey was conducted first to enable the types of biocultural innovations in the communities to be identified to inform the design of the quantitative survey. Both surveys focused on the same main indicators: status and trends in livelihoods and migration, farming systems, crop diversity, social capital, climate change, and innovations. The indicators were chosen not only for monitoring and evaluation of the SIFOR project's impacts, but also to understand the key challenges facing communities as the context for innovation, and innovation systems and the conditions that support them. In the analysis, we tried to see if certain conditions (such as high levels of crop diversity and traditional knowledge, and strong cultural values and collective institutions) are associated with higher levels of innovation. Gender aspects were integrated across the survey in a number of indicators.[2]

The baseline study was conducted from January 2013 to July 2014, using surveys, interviews and focus groups at both household and village levels. The qualitative study involved identification of individual 'innovators' through focus groups and interviews, followed by more in-depth semi-structured interviews. For the quantitative household survey, we interviewed 123 households in Yunnan and 221 in Guangxi, totalling 344 households which were randomly selected. These were mainly Zhuang and Naxi, but the survey covered 9 different ethnic groups in total. Table 1 shows the primary characteristics of the villages studied, including the total number of households, ethnic group and primary crops produced. The data for all years, including 2002, 2007, 2012 and before, was obtained through this same survey conducted in 2013–14.

[2] The SIFOR quantitative surveys can found here: community level http://pubs.iied.org/G04037 and household survey http://pubs.iied.org/G04038.

Table 1: Characteristics of villages studied in the two provinces

COUNTY NAME	VILLAGE NAME	NUMBER OF HOUSEHOLDS IN VILLAGE	ETHNIC GROUPS	PRIMARY CROPS PRODUCED
Guangxi Province				
Duan	Nonlv village	125	Zhuang, Yao,	Rice, potato,wheat, maize, soybean
Duan	Nonshe village	32	Yao, Zhuang, Miao	Maize, sweet potato, soybean, wild grape
Mashan	Guzhaishanggula village	65	Yao, Zhuang	Maize, beans, sweet potato,vegetables
Mashan	Guzhaizhonggula village	50	Yao, Zhuang, Han	Maize, beans, sweet potato, vegetables
Mashan	Guzhaixiagula village	76	Yao, Zhaung, Miao	Maize, beans, sweet potato, vegetables
Hengxian	Chengtang village	250	Zhuang, Han	Rice, beans, vegetable, maize
Henxiang	Sancha Village	76	Zhuang, Han	Rice, maize, beans, maize
Luocheng	Gumao Village	155	Muolao, Zhuang,	Rice, maize, soybeans, sweet potato,
Wuming	Wentan Village	129	Zhuang, Yao, Han	Maize, rice, cassava, vegetables, beans, fruits
Yizhou	Huaiyuan Village	100	Zhuang, Han	Maize, vegetables, rice
Dahua	Napou Village	108	Zhuang, Yao, Miao	Maize, sweet potato, beans
Yunnan Province				
Lijiang	Meiquan village	128	Naxi, Lishu	Maize, wheat, beans, grass, vegetables
Yulong	Stone village Natural V1	36	Naxi, Yi, Tibetan	Maize, rice, wheat, beans, Tibetan barley, millet, sorghum, citrosa
Yulong	Stone village Natural V2	51	Naxi	Maize, rice, wheat, beans, Tibetan barley, millet, sorghum, citrosa
Yulong	Stone village Natural V3	50	Naxi	Maize, rice, wheat, beans, Tibetan barley, millet, sorghum, citrosa
Yulong	Stone village Natural V4	39	Naxi	Maize, rice, wheat, beans, Tibetan barley millet, sorghum, citrosa.
Yulong	Stone village Natural V5	52	Naxi	Maize, rice, wheat, beans, Tibetan barley millet, sorghum, citrosa
Yulong	Stone village Natural V6	38	Naxi	Maize, rice, wheat, beans, Tibetan barley, millet, sorghum, citrosa
	NUMBER OF VILLAGES SURVEYED	NUMBER OF HOUSEHOLDS INTERVIEWED	NUMBER OF ETHNIC GROUPS SURVEYED	PRIMARY CROPS IN STUDY
	18	344	9	Maize, rice, wheat, beans, potato, sweet potato, vegetables

Livelihoods, food security and cropping systems

Meiquan Village in Yunnan, by Simon Lin, June, 2013

2

The qualitative survey showed that livelihood strategies are shifting in Guangxi and Yunnan provinces, with increasing diversification of income sources and out-migration to urban areas. It found that about two-thirds of farmer households had one or more family members working in cities, and on average, about half of farmer household income is derived from off-farm activities. Levels of out-migration and non-farm income had increased compared to 10–20 years earlier in both Guangxi and Yunnan, with the greatest increase in Guangxi. As off-farm incomes have increased, the income gap has also increased between different villages, with lower incomes in more remote, ethnic villages where people are less able to access higher paying jobs in urban areas. Income gaps within villages, for example between women and men and young and old, are also increasing, with young people and men better able to take advantage of urban incomes. The growing income divide between rural and urban areas has resulted in decreasing interest in and value placed on small-scale, village-level agriculture and food production. Local people emphasize investment in houses, children's education, and starting small businesses, and put less capital and labour into agriculture. In most of the communities, land-use rights are being transferred between households, so that fewer farmers are working larger consolidated farms. At the village-level, agriculture has increasingly become the work of women and elders, while men and youth are away in school and higher-paying jobs. These trends are supported by the results of the quantitative survey, presented next.

Trends in Livelihoods and Migration

Trends in household income and spending

In the decade prior to 2012, both average annual household income and spending increased rapidly, with a faster rate of increase since 2007 in both Guangxi and Yunnan provinces. In both provinces, average income increased 3.4 times and average spending grew to 4.1 times the 2002 figure by 2012. Both income and spending were much higher in absolute terms in Guangxi than in Yunnan. However, the difference between income and expenditure (net income) has grown steadily in both provinces.

Table 2: Average household incomes and spending

YEAR	YUNNAN		GUANGXI	
	AVERAGE INCOME (CNY)	AVERAGE SPENDING (CNY)	AVERAGE INCOME (CNY)	AVERAGE SPENDING (CNY)
2002	9067	5106	16186	10414
2007	17718	9828	28966	17845
2012	31558	20854	55698	42389

Figure 3: Per cent of households with women and over 60 year olds in farming

Households with women and over-60-year-olds in farming

The data for both provinces together shows that the percentage of households with women farmers and with over-60-year-olds in farming has grown since 2002 because men increasingly go to cities to work, leaving women and elders in the village to farm.

Trends in migrant labour

In Yunnan province, the percentage of people in the labour force migrating to cities for work slightly declined from 44.1 to 43.4 per cent between 2002 and 2012, but in Guangxi this percentage grew quickly from 41.4 to 69.2. Migrant farmers are usually younger than those who stay at home farming. In the Stone Village, the average age of the farming labour force is 42.6 years old; whereas that of migrants is 30.4 years.

The percentage of women out of total migrants increased both in Guangxi and Yunnan, and is higher in Yunnan.

For the purposes of this study, 'labour force' was defined as the total number of people who are eligible to work in farming: men aged 16–60, and women aged 16–55. Students were not considered part of the agricultural labour force as they generally do not participate in farming.

Household income structure and trends

Recent years also show some significant changes in household income structure. In Yunnan, employment in tourism provides a rapidly growing source of income, and agricultural income (crop and livestock production and sales combined in Table 4 below) has reduced from 33.3 per cent to 18.2 per cent, with livestock income halved. Income from crop production has decreased in both provinces since 2002, although in Guangxi, it has decreased less and has increased since 2007, probably due to CCAP support for market linkages (Community Supported Agriculture, see section on Market Innovations p. 48).

Table 3: Migrants in the farming labour force and gender

	YUNNAN			GUANGXI		
YEAR	2002	2007	2012	2002	2007	2012
Percentage migrants in the agricultural labour force	44.1%	43.4%	43.4%	41.4%	60.9%	69.2%
Percentage of migrant agricultural workers who are female	43.4%	43.2%	49.7%	32.9%	38.2%	40.8%

Table 4: Household income structure and trends

	YUNNAN			GUANGXI		
INCOME COMPONENT	2002	2007	2012	2002	2007	2012
Crop production and sales	22.7%	13.1%	13.1%	20.0%	15.4%	15.9%
Livestock production and sales	10.6%	7.9%	5.1%	14.5%	15.9%	18.6%
Milk production and sales	0.0	0.0	0.0	0	0	0
Labour in urban areas	31.1%	33.0%	31.5%	50.3%	55.7%	47.1%
Agricultural labour	2.8%	1.8%	1.7%	1.7%	1.3%	1.1%
Employment in the village surroundings	8.4%	6.7%	7.0%	8.8%	7.7%	9.0%
Small business	0	0	0	0.2%	0.5%	2.4%
Petty trade, e.g. market stalls	0.2%	0.7%	0.9%	2.0%	1.4%	2.1%
Employment in tourism	0.6%	14.0%	21.1%	0	0	0
Housework	0	0	0	0	0	0
Rent out the property,	0	0	0	0.1%	0.3%	0.4%
Other (disability benefits, welfare income, sales of home-made wine, trucking, garage services etc.)	12.2%	12.7%	12.3%	1.8%	1.3%	2.7%
13=Pension	11.3%	10.2%	7.3%	0.6%	0.5%	0.7%

As Table 5 shows, household food security mainly relies on farming, with the three most important livelihood activities for securing food, being crop production, livestock production, and labour in urban areas, in order of importance.

In terms of household income generation, the three most important livelihood activities are: crop production, labour in urban areas, and livestock production. Table 4 shows how labour in urban areas accounts for over about 40 per cent of household income, on average. However, migrants (ie. household members working in cities) also have increased living expenses while in urban areas, which leaves them with lower savings to bring home. Therefore, crop production and sale is still the main source of net income for villagers, as indicated in Table 5.

Household consumption/spending patterns

Household spending has shown a number of changes in recent years. Spending on some items has fallen as costs have also fallen, such as for food, education and communication. Spending on some items has grown, e.g. housing has become the main part of household expenditure. Spending on food, education, and interpersonal communication costs have become lower (eg. due to a government subsidy for education in outlying poverty-stricken areas).

Table 5: The most important livelihood and food security activities

SOURCE OF INCOME	NET INCOME GENERATION	HOUSEHOLD FOOD SECURITY
	NUMBER OF HOUSEHOLDS	NUMBER OF HOUSEHOLDS
Crop production and sales	264	319
Livestock production and sales	181	190
Milk production and sales	0	0
Labour in urban areas	186	92
Agricultural labouring	35	23
Employment in the village surroundings	86	52
Small business	4	4
Petty trade, e.g. market stalls	14	7
Employment in tourism	12	6
Housework	0	1
Rent out the property	8	1
Other	26	12
Pension	33	11

Table 6: Household spending categories as a percentage of total household spending

CATEGORY	2002	2007	2012
Food	33.62%	30.52%	19.77%
Interpersonal communication cost	8.64%	9.14%	7.19%
Education	16.85%	15.83%	8.79%
Health	5.05%	8.32%	9.27%
Clothing	0.31%	0.43%	0.14%
Agriculture means of production	17.28%	13.09%	13.11%
Transport	0.38%	0.49%	1.45%
Housing	17.59%	17.63%	38.83%
Other	0.25%	4.53%	1.46%

Food security

Food self-sufficiency and trends

Since 2002, staple, vegetable, and meat self-sufficiency rates have gradually declined in both provinces. Staple food self-sufficiency has declined the most, from 93.9 per cent in 2002 to 80.6 per cent in 2012 overall. Convenient transportation and easier access to market has made villagers rely less on self-production, and buy more food from markets. Guangxi and Yunnan used to have the 'a pig for a year' custom. Now villagers can buy fresh meat easily, so they are cutting back on bacon consumption. On the other hand, cooking oil self-sufficiency is going up, because the villagers are more aware of food safety issues, and have realised that self-produced cooking oil is more reliable.

In Guangxi we compared the food self-sufficiency of villages with organic farmer groups and that of neighbouring non–organic villages for four main food types: staple food, vegetables, meat, and cooking oil. Table 8 shows that villages engaged in organic cultivation are more self-sufficient than non-organic farming villages.

Number of crop varieties grown in 2012

In 2012, about half the crop varieties grown in the two provinces were landraces and introduced improved varieties (landraces)[3]. Although the proportion of landraces and improved landrace varieties was higher in Yunnan, the total number of different crop varieties grown was higher in Guangxi: 1235 varieties compared to 463 in Yunnan (this may partly reflect the larger sample size in Guangxi).

Table 7: Percentage households that are food self-sufficient in Guangxi and Yunnan

YEAR	STAPLE FOOD SELF-SUFFICIENCY	VEGETABLE SELF-SUFFICIENCY	MEAT SELF-SUFFICIENCY	COOKING OIL SELF-SUFFICIENCY
2002	93.89%	95.30%	73.89%	58.52%
2007	88.26%	94.44%	71.67%	59.07%
2012	80.56%	92.85%	69.37%	63.70%

Table 8: Self-sufficiency in organic farmer groups and neighbouring farmers in Guangxi in 2012

SELF SUFFICIENCY IN:	STAPLE FOOD	VEGETABLES	MEAT	COOKING OIL
Villages with organic farmer groups*	89.1%	92.6%	26.7%	31.6%
Neighbouring villages**	75.3%	79.3%	15.3%	22.0%

* Villages with organic farmer groups: Sancha village in Heng county, Shanggula Village in Mashan county, Nonglv village in Du'an county.
** Neighbouring villages: Pingmapen village in Heng county, Guzhai Benli village in Masha county, Lantang village in Du'a county.

Table 9: Crop varieties, landraces and improved varieties grown in Guangxi and Yunnan, 2012

	TOTAL NUMBER OF VARIETIES	LANDRACE AND IMPROVED VARIETIES
Yunnan	463	264 (57%)
Guangxi	1235	581 (47%)
Combined	1698	845 (50%)

[3] Introduced improved varieties are landraces introduced less than 10 years ago whose seed can be saved for the next season.

Trends in the area of maize, wheat and rice landraces planted

The area planted with maize, wheat and rice landraces by the surveyed villages varied notably from 2002 to 2012. For **maize**, the area planted with landraces and introduced improved varieties declined rapidly from 2002 to 2012 in both Guangxi and Yunnan villages. In Yunnan, the area planted with maize hybrids rose over the ten years, whereas in Guangxi it rose between 2002 and 2007 and then fell between 2007 to 2012. This suggests that PPB and CSA activities in Guangxi have had a positive impact on crop diversity.

In our survey, only farmers in Yunnan planted **wheat**, and from 2007 to 2012 the area growing wheat landraces dropped from 203.8 mu (13.6 ha) to 157.6 mu (10.5 ha).The area planted with improved wheat varieties also dropped from 11.7 mu (0.78ha) to 4.1 mu (0.27ha).The area planted with hybrid wheat varieties reduced from 14.4 mu (0.96ha) to 11.9 mu (0.79ha).

Rice was mostly grown in Guangxi. The area planted with landraces fell between 2002 and 2007 and then rose in 2012, probably as a result of the impacts of PPB and CSA activities. The areas planted with improved rice varieties expanded significantly while hybrid rice areas combined for Guangxi and Yunnan villages fell from 462.9 mu (30.9ha) to 309.4 mu (20.6ha) between 2002 and 2012.

Figure 4: Area of maize grown in surveyed villages in Yunnan and Guangxi (Unit: Mu, 15 mu =1 ha)

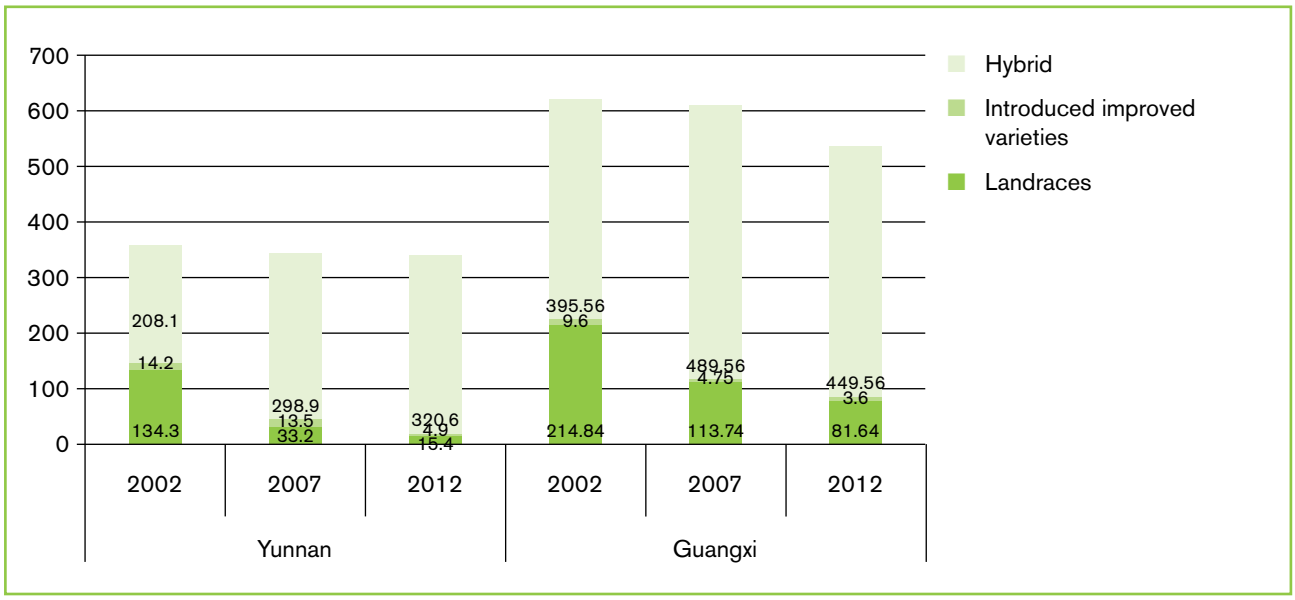


Figure 5: Area of wheat grown in surveyed villages in Yunnan (surveyed farmers in Guangxi do not plant wheat) (Unit: Mu)

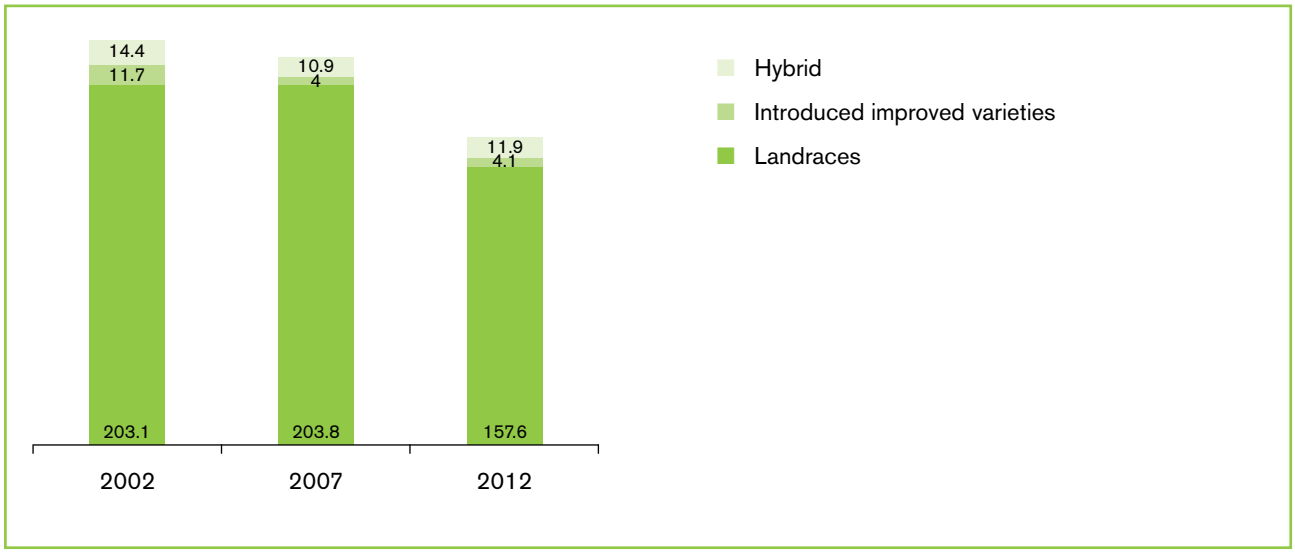
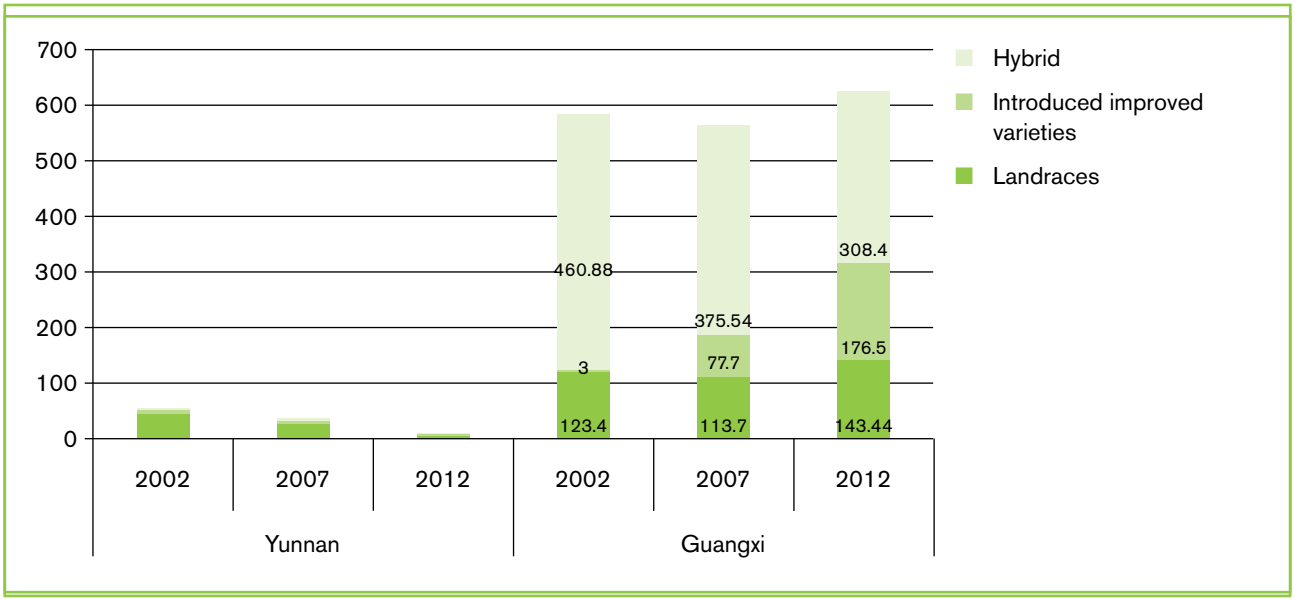


Figure 6: Area of rice grown in surveyed villages in Yunnan and Guangxi (Unit: Mu)



Trends in yield

From 2002 to 2012, yields of maize and rice landraces increased, but wheat yields decreased from 226.3kg/mu to 219.1 kg/mu (Table 10). This suggests that as landraces of maize and rice were gradually improved by farmers and scientists (through PPB), their yields rose. The yield increase of rice landraces was relatively rapid (16%). But wheat landraces are in decline, suggesting they have not received enough improvement efforts.

Land ownership trends

We surveyed ownership of farmland at village and household levels. At the village level, the amount of farmland did not change much particularly in Yunnan. Guangxi has four villages contributing a total fall of 51 mu, and 1 village has 200 mu more farmland. The reasons for the decline in village land are road/house construction, returning farmland to forest, and an increase in wasteland. Conversely, the increase in village land has been due to cultivation of wasteland for sugarcane. At the household level, we found the land villagers own has not changed much but the land 'circulation' is quite active (see Table 11), probably because out-migration is on the rise (Table 3).

Agricultural production in 2012

We analysed over 300 household surveys on the crops grown in 2012 in both Guangxi and Yunnan provinces, and summarised the data in Table 12. The top three crops farmers cultivated were maize, rice, and sugarcane. Rice and wheat are mostly for household consumption; maize is mainly grown for livestock feed, while sugarcane, cassava, potatoes, vegetables and spices are mainly grown for sale.

Staple foods/key food crops

The household survey findings (Figure 7) show changing patterns in food consumption compared with 30 years ago (based on the memory of the household informants). In recent years consumption of rice, wheat and meat has risen, while consumption of maize, potato, broad beans, wild vegetables and pumpkin has fallen.

The community survey findings show that in Guangxi rice and maize are now the staple food crops and that the four communities of Shanggula, Zhonggula, Xiagula and Benli have switched from rice to maize. In Yunnan, wheat and rice used to be the top two staple food crops, but because of drought and reservoir construction that encroached on paddy fields, the staple food crops have now shifted to wheat and maize.

Table 10: Average Landrace yields per Mu in Guangxi and Yunnan

YEAR	MAIZE (KG/MU)	RICE (KG/MU)	WHEAT (KG/MU)
2002	305	322.8	226.3
2007	320.7	374.5	206.9
2012	331.9	382.4	219.1

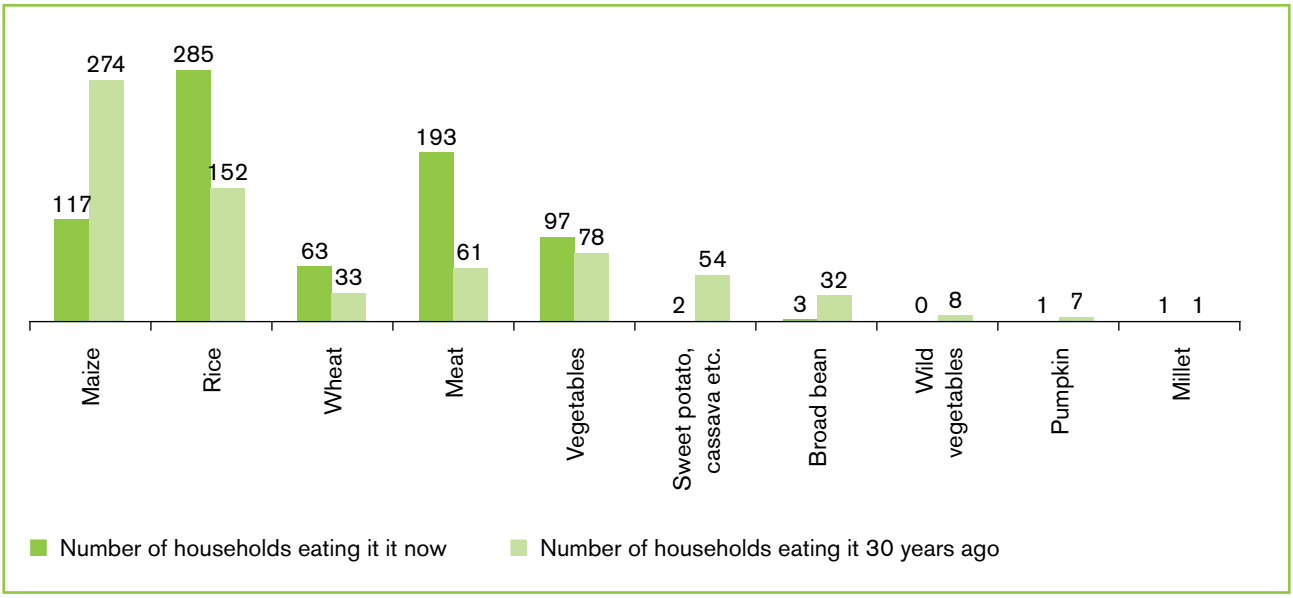
Table 11: Household land ownership and rental patterns in Guangxi and Yunnan

YEAR	LAND OWNED BY HOUSEHOLDS	LAND RENTED FROM OTHER INDIVIDUALS	LAND RENTED TO OTHER INDIVIDUALS
	UNIT: MU	UNIT: MU	UNIT: MU
2002	1877.3	93.87	54.53
2007	1890.7	174.17	83.3
2012	1881.09	448.37	232.93

Table 12: Agricultural production in 2012 in Guangxi and Yunnan

CROP	TOTAL AREA (MU)	AVERAGE YIELD (KG/MU)	HOUSEHOLD CONSUMPTION	LIVESTOCK FEED	SOLD TO MARKET OR NEIGHBOURS	PRICE (¥/500 G)
Maize	879.80	765.15	11.35%	**72.58%**	15.39%	1.29
Rice	645.64	780.91	**58.98%**	5.77%	34.33%	2.47
Wheat	182.30	441.83	**73.48%**	19.98%	3.65%	1.69
Soy Bean	83.90	308.54	26.40%	28.77%	44.83%	1.73
Sugar Cane	364.60	9281.65	0.00%	0.00%	**100.00%**	0.25
Cassava	152.40	5659.76	0.11%	1.07%	**98.82%**	0.26
Peanut	86.45	379.21	50.81%	0.96%	46.65%	4.38
Potatoes	8.30	1620.48	5.16%	24.73%	**69.35%**	0.77
Pulses	64.45	356.59	7.02%	77.32%	15.64%	1.18
Vegetables	24.31	1283.18	16.96%	8.49%	**74.35%**	2.74
Spices	103.80	6.39	0.00%	0.00%	**100.00%**	384.17

Figure 7: Trends in Household staple food crop consumption



Trends in meat consumption

In 2002, farmers were breeding livestock mainly to supply their households with meat, but by 2012 about two thirds was for markets. The income from livestock sales has also increased rapidly: income from sales in 2012 was 4.1 times that of 2002, which reflects growing meat consumption (as well as more convenient access and more farmer engagement in professional livestock rearing).

Trends in cropping practices

From planting to harvest is one cropping season. In some parts of Guangxi, there are three harvests a year, ie. three cropping seasons. We analysed farmers' cropping seasons over the past 20 years by asking about the situation in 2012, 2002 and 1992. This generated the following findings:

a. Less maize, rice and wheat is now planted in the first and second seasons, and the trend indicates that food crop diversity and cultivation area have decreased in general.

b. Yields from the first and second seasons have increased (for example for sugarcane and cassava, both cash crops), while the number of households using traditional farming methods of intercropping and crop rotation has fallen by about 9 per cent (for both techniques). Continuous cropping has risen in the first season but fallen in the second season, implying that some farmers have given up the second season cultivation.

c. Farmers grow fewer local varieties in the first and second seasons, and have introduced more improved varieties and hybrids.

d. Use of paddy field, dryland and wasteland has increased in the first season. In the second season, paddy land use fell, and use of dryland and mountainous wasteland remained unchanged. In Guangxi province, some areas encountered drought in the second half of the year, so farmers either

Table 13: Average figures per household of livestock consumed at home and sent to market in Guangxi and Yunnan

YEAR	HOME CONSUMPTION OF MEAT	MEAT PRODUCTION SENT TO MARKET	TOTAL INCOME FROM LIVESTOCK (CNY)
2002	61.5%	32.1%	560,385
2007	47.2%	48.5%	1,062,649
2012	31.6%	66.7%	2,321,774

used paddy fields to plant dryland crops, or left land uncultivated.

e. More cash crops, such as sugarcane, tobacco, geranium and silkworm are grown. The labour force is reduced and crop production and sales generate lower incomes than 20 years earlier. Some farmers in Guangxi like to use home-made peanut oil due to health and food safety concerns, and due to project support for more TK use in daily life. Cassava production has fallen due to difficult times for sales, while soybean production has fallen due to low yields and poor sales.

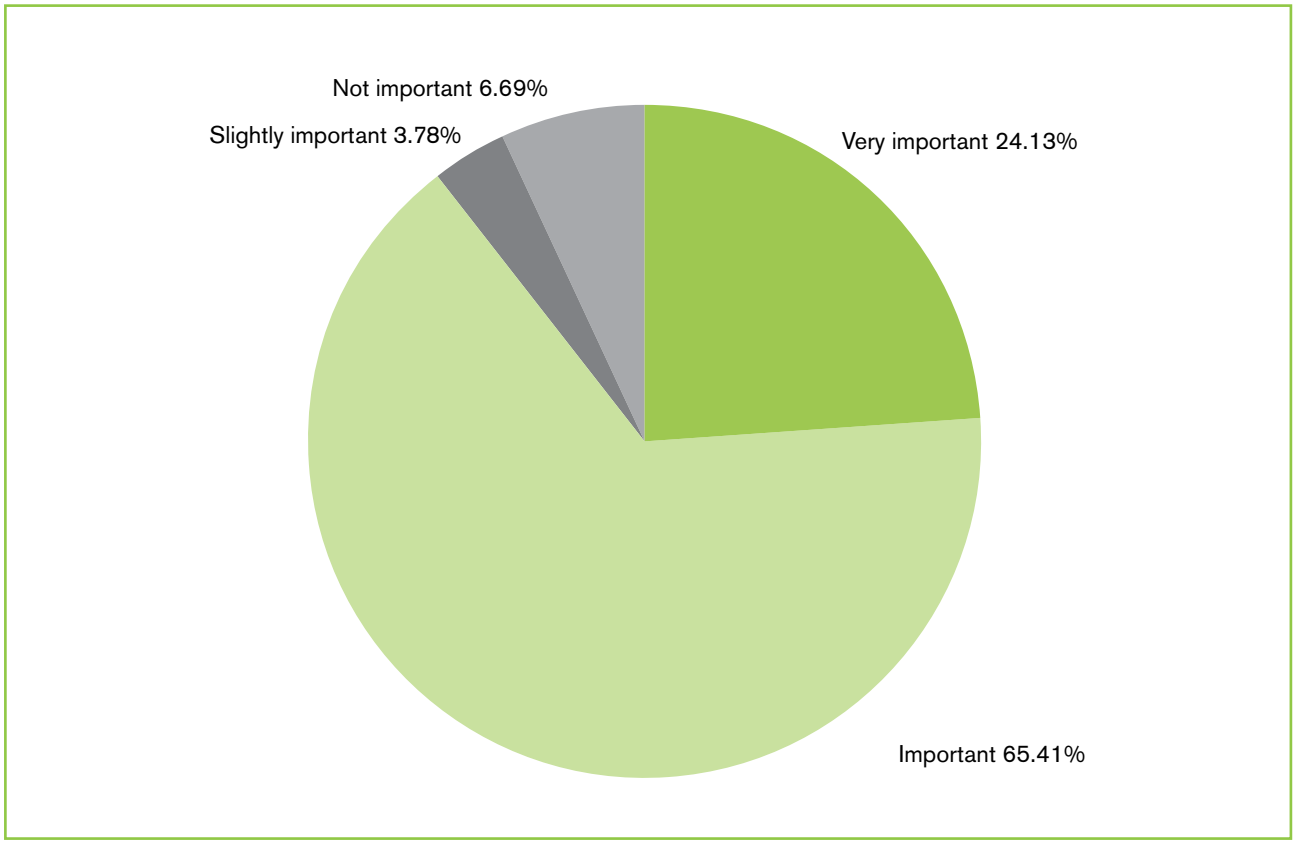
f. Farmers are planting cash crops annually without intercropping (the decrease in planting sweet potato, soybean or other crops has contributed to the decrease in intercropping, as has labour shortages).

g. Farmers plant more hybrids for economic reasons and due to their high yield. Some low yielding local varieties have been eliminated, and replaced by higher yielding improved varieties and hybrids.

How farmers value food self-production and self-sufficiency

Generally speaking, farmers valued food self-production and self-sufficiency. Of the farmers surveyed, 90 per cent considered food self-production and self-sufficiency either "very important" or "important", showing that they recognized the importance of producing food themselves for food security.

Figure 8: How farmers viewed food production and self-sufficiency in Guangxi and Yunnan



Crop diversity

Photo 3: Stone Village in Yunnan, By Yiching Song, August 2013

3

About 30% of households surveyed in Guangxi and 20% of those surveyed in Yunnan have given up traditional intensive farming methods such as inter-cropping, double cropping and rotational cropping, in favour of labour-saving chemical intensive mono-cropping techniques. This has led to degradation and loss of agrobiodiversity. These findings are generally supported by the more detailed quantitative survey results presented next.

Trends in landraces of staple food crops: analysis in three communities

In the Stone Village in Yunnan farmers define landraces as varieties from which they can save seeds. Landraces are very well maintained for rice and wheat, and have grown in number in 2002, but maize landraces are disappearing very quickly, and the proportion of the maize crop planting area planted with landraces has also declined considerably.

In Guzhai Shanggula in Mashan county, Guangxi, the major food crop is maize. Between 2002 and 2012 the number of maize landraces decreased, and the proportion of the maize planting area planted with landraces also fell.

In Nonglv in Du'an county, Guangxi, the major food crop is rice. Between 2002 and 2012 the number of rice landraces planted decreased from seven to three, but the proportion of rice planting area with landraces expanded considerably, from 10 per cent in 2002 to 80 per cent in 2012. Project support for PPB, market linkages, and ecological farming methods, including the rice-duck-model for pest control, has helped rice landraces regain recognition.

The number of soybean varieties

Soybean is one of the most important crops in China. Back in the days of meat shortage, soybean provided a rich plant protein to farmers. In the survey, we found that farmers in the Southwest region still retain soybean landraces as their favourite soybean varieties. The number and proportion of soybean landraces remains high, and the proportion of soybean cultivation area planted with landraces is still as high as 89.4 per cent. This continued use of landraces offers an important source of evolving genetic material to enable the soyabean industry to enhance resilience and recover from possible crop failure or disease outbreaks.

Table 14: Landraces planted in the Stone Village administrative area 2002–2012

	MAIZE		RICE		WHEAT	
	Number of landraces	% of crop area planted with landraces	Number of landraces	% of crop area planted with landraces	Number of landraces	% of crop area planted with landraces
2002	6	56%	5	100%	3	100%
2007	*	*	10	100%	5	100%
2012	2	2.2%	15	100%	5	100%

* = No data

Table 15: Landraces planted in Guzhai, Mashan and Nonglv, Du'an 2002–2012

	GUZHAI, MAIZE		NONGLV, RICE	
	Number of landraces	% of crop area planted with landraces	Number of landraces	% of crop are planted with landraces
2002	6	80%	7	10%
2007	3	30%	3	15%
2012	2	50%	3	80%

Number of crop species and varieties lost and introduced in the past 30 years

After the year 2000, the public breeding system and private seed companies both led a trend that popularized hybrid seeds. 2000 was also the year that China joined the WTO, leading to increased subsidies for modern intensive agriculture. Hybrid seeds have higher yields which, coupled with the limited investment in improving local varieties, leads to hybrids frequently replacing local seeds, allowing landraces to disappear as they are no longer grown. Through survey data statistics, we found that in 2000 and 2006 villages in Guangxi lost the highest number of local varieties; while in Yunnan the highest losses were in 2008 and 2010, due to the local agricultural policy. After 2000, the number of introduced varieties increased notably each year, in both Guangxi and Yunnan. Guangxi villages had the most varieties introduced in 2010 and 2012; whereas for Yunnan the peak years were 2005, 2008 and 2009.

Number of varieties introduced in the last 10 years (before 2012)

We analysed the varieties introduced between 2002 and 2012, and found that the main crop introductions are hybrids and improved varieties of maize and rice (see Table 16). Newly introduced maize varieties accounted for nearly 50 per cent of the introduced varieties. Table 16 shows the adoption of new maize varieties is very fast.

Trends in the area planted with different crops

The area planted with staple food crops, such as maize, rice, wheat and soybean have declined, while the cash crop (sugarcane) planting area has increased (Table 18, p. 28). There are two related reasons for this: cash crops can bring more revenue, so farmers are inclined to reduce the area of staple food crops; and the government has promoted cash crops (as in Wuming County, Guangxi),in order to promote economic development.

Table 16: Soybean varieties and landraces and percentage soybean cultivation area with landraces in 2002, 2007 and 2012 in Guangxi and Yunnan

YEAR	NUMBER OF SOYBEAN VARIETIES PLANTED	NUMBER OF SOYBEAN LANDRACES PLANTED	% OF SOYBEAN AREAS GROWING LANDRACES
2002	54	40	95.79%
2007	47	42	93.33%
2012	55	40	89.41%

Figure 9: Number of local crop varieties lost since 1970 in Guangxi and Yunnan.

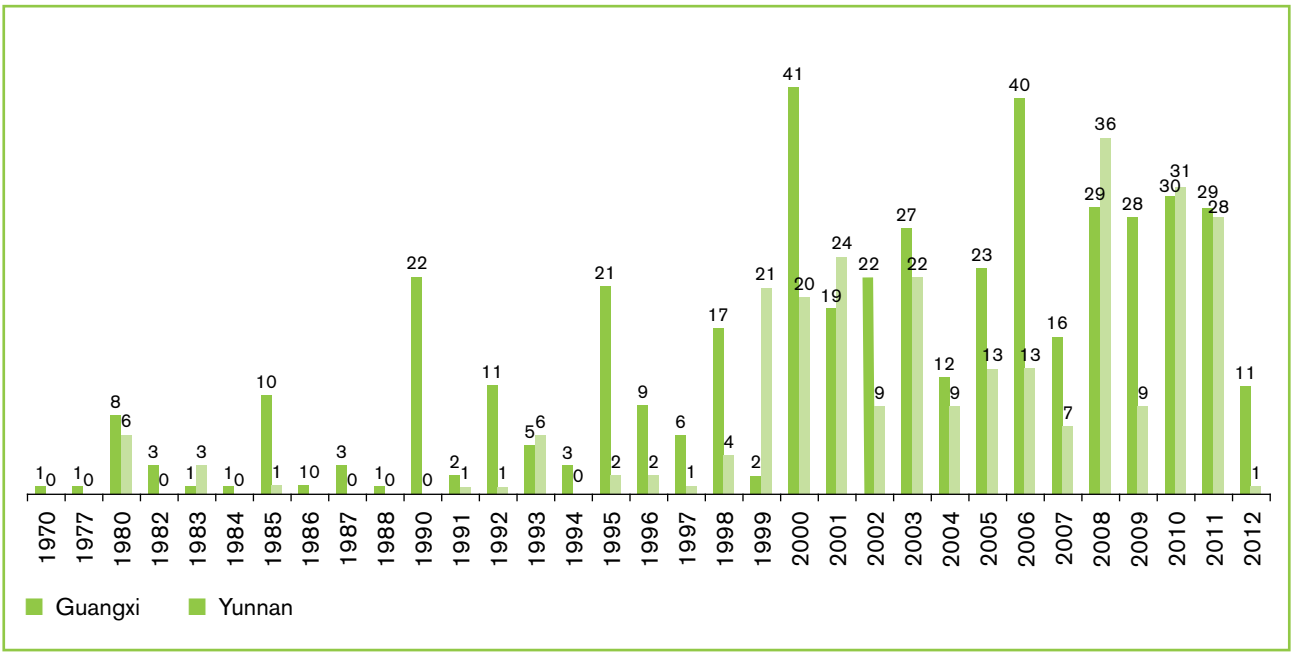


Figure 10: Number of crop varieties introduced in last 30 years in Guangxi and Yunnan

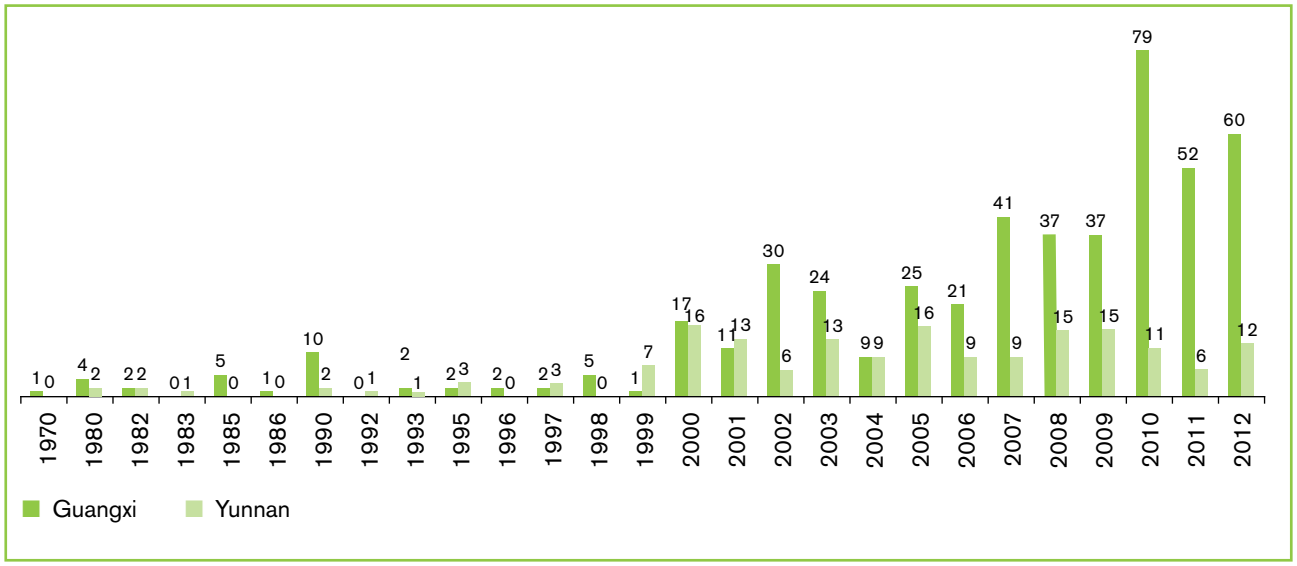


Table 17: Numbers of varieties introduced in Guangxi and Yunnan from 2002–2012

CROP	NUMBER OF NEWLY-INTRODUCED VARIETIES	PERCENTAGE OF ALL INTRODUCTIONS
Maize	337	49.41%
Rice	189	27.71%
Wheat	1	0.15%
Soybean	9	1.32%
Sugar Cane	38	5.57%
Cassava	5	0.73%
Peanut	24	3.52%
Potatoes	2	0.29%
Pulses	3	0.44%
Vegetables	1	0.15%
Spices	21	3.08%
Other	52	7.63%

Table 18: Area planted with each crop in all the surveyed villages

CROP	2002	2007	2012
	MU	MU	MU
Maize	5576	3995	4575
Rice	4495	4359	3060
Wheat	2549	2549	1971
Soy Bean	1413	793	308
Sugar Cane	480	1820	4036
Cassava	950	450	350
Peanut	20	20	45
Potatoes	5	20	25

Note: data for maize, rice and wheat comes from community level survey.

Reasons farmers give for conserving local landrace varieties

Farmers give a variety of reasons for conserving landrace varieties, as shown in Table 19, but the main reasons are good taste and high yield in their particular farming environment. This finding allows us to better understand farmers' needs and to prioritise these two aspects when helping farmers to improve landraces in future collaboration.

Table 19: Reason farmers give for conserving local varieties

REASONS GIVEN	NUMBER OF HOUSEHOLDS
Good taste	311
Good yield	204
Low input	63
High income	45
Feed	31
Cultural value	22
Crop quality	22
Drought resistance	14
Pest/disease resistance	13

Seed systems and seed security

4

Seed sources

Our surveys found that farmers obtain different types of seeds from different sources. As shown in Table 20, hybrid seeds are mainly purchased from township extension stations; improved varieties mainly come from saved seed, PPB and local markets; and the main source of landraces is farmers' locally saved seeds.

Who selects and saves seeds?

Under the traditional Chinese family structure, women play a major role in selecting and saving seeds. The survey data confirms this point, showing that in more than 60 per cent of households, women play a role in seed selection and storage, followed by men and the elders. Interestingly, men play a slightly bigger role in selecting hybrid seeds than selecting landraces and improved varieties. This may be because hybrid seeds come from the outside market, and men tend to interact with the outside world more frequently.

Ease of access to seeds

Farmers now have easy access to new varieties – 96 per cent of those questioned said they could easily access new varieties in a short time at little cost. This shows seed distribution works smoothly, but this kind of convenience also makes farmers value landraces less and become insensitive to the importance of ensuring seed access.

Table 20: Seed sources in Guangxi and Yunnan (% of total households surveyed)

SEED SOURCES	HYBRID SEEDS	INTRODUCED IMPROVED VARIETY SEEDS	LANDRACE SEEDS
Self improved	0.18%	2.70%	3.18%
Self saved	0.54%	**55.86%**	**84.48%**
Community improved	0.54%	1.80%	0
Purchased	**53.57%**	6.31%	6.16%
Exchanged with other farmers in the same community	0	5.41%	0.60%
Exchanged with farmers from other community	0	0.90%	0.40%
Obtained from relatives (from mother side)	0	5.41%	0.20%
Gifts and Remittances	0	0	0
Local market	14.46%	9.91%	2.19%
Local extension station	**27.50%**	3.60%	0.80%
Barter markets	0	0	0
NGO Direct	0	0	0
NGO Voucher	0	0	0
Food aid grain	0	0	0
Government Input Program	0	0	0.60%
Private Firms (Contract)	1.07%	0.90%	0
Public research institution	1.43%	7.20%	1.19%
Other	0.71%	0	0.20%

Table 21: Who selects the seed? (% responses out of total households surveyed)

	TOTAL VARIETIES	HYBRIDS	INTRODUCED IMPROVED VARIETIES	LANDRACES
Men	25.64%	33.16%	32.79%	21.74%
Women	61.06%	55.44%	59.84%	62.61%
Boy	0.22%	0.00%	0.00%	0.00%
Girl	0.15%	0.00%	0.00%	0.35%
Elder	11.66%	10.13%	6.56%	13.91%
Other	1.27%	1.27%	0.81%	1.39%

Table 22: Who saves the seed? (% responses out of households surveyed)

	TOTAL VARIETIES	INTRODUCED IMPROVED VARIETIES	LANDRACES
Men	21.02%	39.51%	23.25%
Women	64.34%	55.56%	61.61%
Boy	0.00%	0.00%	0.00%
Girl	0.23%	0.00%	0.22%
Elder	13.12%	4.93%	13.60%
Other, Please Specify,	1.29%	0.00%	1.32%

Table 23: Percentage of Households reporting on ease of access to seed

EASE OF ACCESS	PERCENTAGE OF HOUSEHOLDS
Easily accessed in a short time at little cost	96.14%
Difficult to access requiring lengthy time and a degree of cost	3.42%
Very difficult to access requiring luck or large expenditure	0.45%

The importance of seed security

During the survey, we found that most farmers are not very concerned about seed security – ie. ensuring access to seed. Fewer than 8 per cent of farmers were 'very concerned' and this might be due to the current ease of access to seeds.

The number of cash crop varieties

Different communities' cash crops vary greatly, but when we combined data on all cash crops we found that cash crops such as 'wild'grape[4], hemp, honeysuckle, apple, bamboo and sweet potato are usually grown from landraces; whereas cash crops such as sugarcane, cassava, mulberry, tobacco, geranium and sunflowers are mainly grown using introduced varieties. Figure 12 shows that the number of cash crops grown from landraces has increased only a little in recent years, whereas the number of 'introduced variety' cash crops has shown a sizable increase.

[4] This grape was wild before, farmers started planting it when they found they can use it to produce wine, but they still call it 'wild grape'

Figure 11: The importance of seed security to farmers (all households)

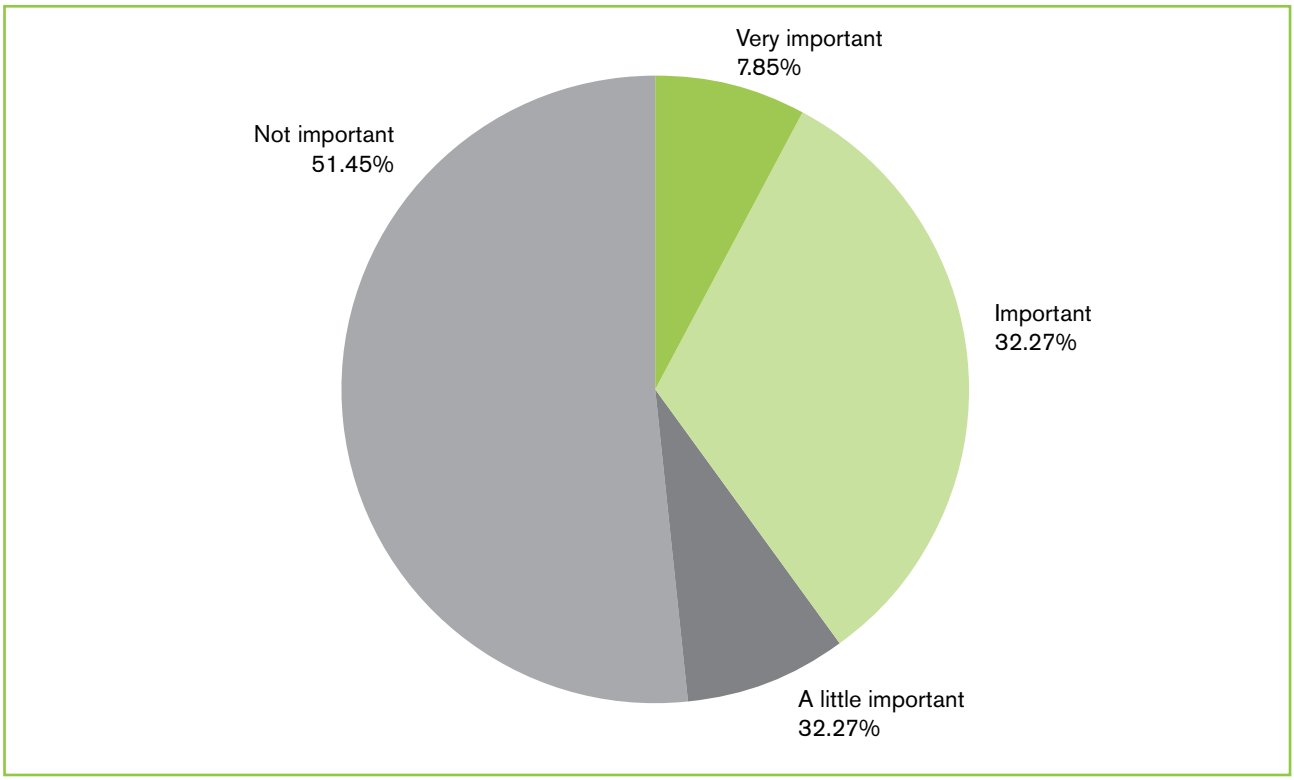
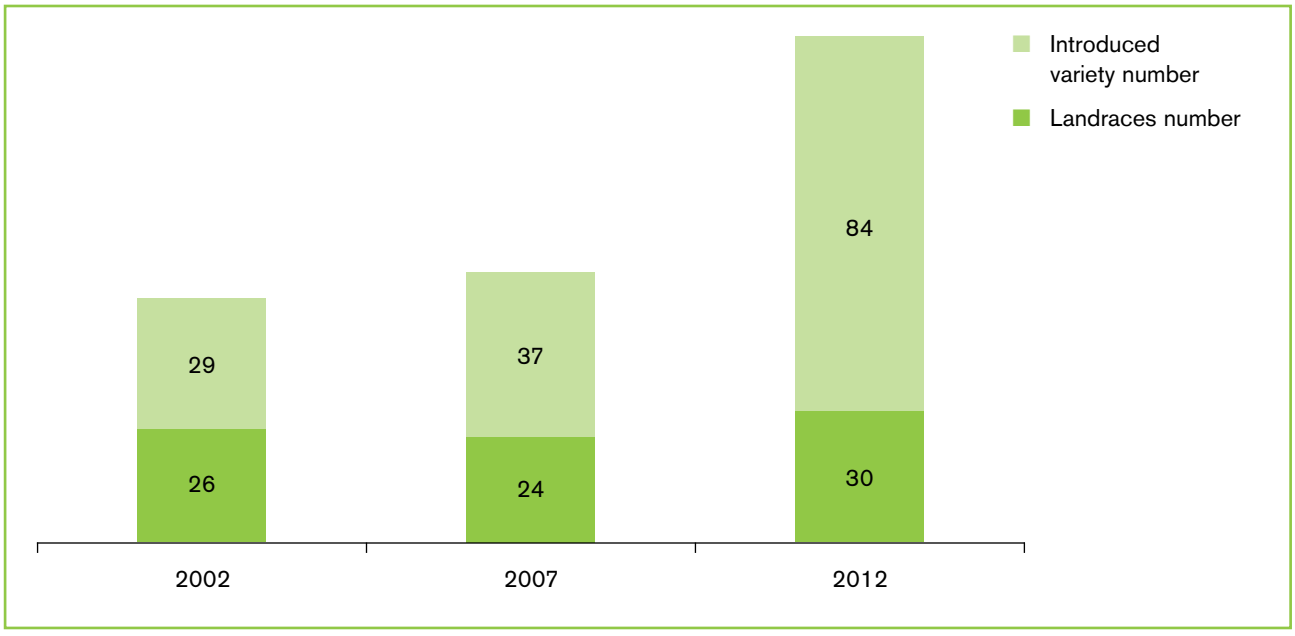


Figure 12: Number of cash crop varieties grown by surveyed households in Guangxi and Yunnan in 2002, 2007 and 2012



Obtaining seed for replanting in case one crop fails

We investigated how farmers can get new seeds in case of crop failure, hoping to see how farmers ensure seed access. The findings show that 74.3%of farmers will choose to re-purchase seeds, 20.7% will use their own saved seeds, and 5% will choose to exchange seeds with other farmers. The percentages indicate farmers' dependence on markets for accessing seed in the event of crop failure.

Climate change and Adaptation

5

The study surveyed farmers' perceptions of climatic changes over the past 10 years and before. Although farmers' perceptions do not provide scientifically precise measurements, the percentage households reporting different changes can reveal distinct trends, and provide site specific evidence to complement scientific methods. The data is subject to farmers' understanding, opinions and attitudes, but to some extent the group discussions (qualitative survey) can balance errors caused by individual differences.

Climatic changes have affected villages in both Yunnan and Guangxi, with increased drought, extreme weather events, and pests observed, especially over the past 10 years (since 2002). These conditions were particularly severe during a prolonged drought in Yunnan for 5 consecutive years in 2010–2014. Climatic challenges create further burdens for farming communities, who now must deal with unstable water resources and harsher growing conditions, as well as out-migration and shrinking agricultural labour. The quantitative survey findings presented below support and further elaborate on these climatic trends.

Percentage Households reporting each climatic change

Climate change is having a growing impact on villagers' farming and daily lives. In our survey, we found that more than half the farmers reported changes in rainfall, temperature, drought, and insects/pests in recent years. One of the most important changes is the decline in rainfall, reported by over 90 per cent of households.

Perceived degree of climate-related change

Our surveys asked farmers the degree to which different climatic conditions have changed on a five point scale from very little to very much (Table 25). Over 50 per cent of households have observed 'much' change in sunshine, rainfall, temperature, drought, and insects/pests. These factors have a great impact on the agricultural production and life of farmers.

Changes in rainy season arrival and duration

Guangxi province has a subtropical monsoon climate that does not have a clear cut rainy season and dry season. In Yunnan province, compared to 20 years ago, the rainy season is now delayed from April to June, and ends in October instead of September – an overall reduction by 1 month. Nowadays, the peak rainy season months are June, July, and August. In the last 10 years, drought has occurred almost every year and lasts for 1–2 months, mainly in May and June. Drought shrivels maize crops, leaving farmers to wait for the July rainfall. Sometimes, farmers experience irregular floods in the same season. In September 2014, the non-stop rainfall destroyed a large area of nearly matured maize, devastating the harvest.

Table 24: Number and percentage of surveyed households reporting climate-related changes in Guangxi and Yunnan

	NUMBER OF HOUSEHOLDS	PERCENTAGE HOUSEHOLDS (AVERAGE FOR BOTH PROVINCES)
Rainfall	317	**92.15%**
Temperature (summer/winter)	241	**70.06%**
Wind strength	88	25.58%
Sun shine	101	29.36%
River water flow	136	39.53%
Drought	216	**62.79%**
Flood	124	36.05%
Insects/pests	230	**66.86%**
Diseases (animal and crop)	153	44.48%
Mud-rock flow, landslide	5	1.45%

Table 25: Degree of climatic changes observed by households (% households)

LEVEL OF CHANGE	1 = VERY LITTLE	2 = LITTLE	3 = NORMAL	4 = MUCH	5 = VERY MUCH
Rain fall	2.69%	16.92%	25.38%	50.77%	4.24%
Temperature (summer/winter)	0.97%	7.73%	30.43%	57.97%	2.90%
Wind strength	8.16%	12.24%	51.02%	26.53%	2.05%
Sunshine	1.82%	5.45%	29.09%	61.82%	1.82%
River water flow	3.16%	10.53%	31.58%	38.95%	15.78%
Drought	0	3.90%	34.63%	52.68%	8.79%
Flooding	5.49%	13.19%	43.96%	34.06%	3.30%
Insects/Pests	2.06%	10.82%	27.84%	54.12%	5.16%
Diseases (animal and crop)	2.70%	13.51%	37.84%	39.64%	6.31%
Mud-rock flow, landslide	0	0	66.67%	33.33%	0

Extreme events

The table below compares the percentage household that have observed extreme events in the last 10 years (2002–2012) and before the last 10 years (2002) in each province. In the past 10 years, up to 70.7 per cent of households in Yunnan have observed drought, this percentage is higher than in Guangxi (57.9%), and much higher than the percentage reporting drought before the last 10 years in Yunnan (24.4%). In Guangxi, a higher percentage of farmers have observed flood and cloud burst than in Yunnan. A decade ago, drought, flood and cloud burst were higher in Guangxi than in Yunnan. On the whole, Yunnan's extreme climate events in the last 10 years have been increasing, particularly drought, and in Guangxi cloud burst has been increasing, but drought and flooding have decreased.

Climate change adaptation strategies

When we asked about farmers' adaptation strategies to climate change, they generally replied "I do not know". But we also found that a small number of farmers have applied some adaptive strategies, such as strengthening farmland management, adjusting sowing times to half a month earlier to avoid drought, planting more drought resistant varieties, avoiding planting the same varieties in consecutive years, switching and rotating varieties, applying more pesticides, and so on. The also study identified a number of technological (farming), market and institutional innovations developed by farmers to address climatic challenges, such as increased drought and pests. These are discussed in Sections 7 and 8.

Table 26: Extreme events observed by households (% of households surveyed)

	YUNNAN		GUANGXI	
	Households that observed the phenomena in last 10 years	Households that observed the phenomena before last 10 years	Households that observed the phenomena in last 10 years	Households that observed the phenomena before last 10 years
Drought	70.7%	24.4%	57.9%	63.3%
Floods	15.5%	5.7%	45.7%	57.9%
Cloud burst	10.6%	5.7%	68.8%	65.2%
Other	26.0%	15.5%	4.1%	1.8%

Social Capital and Indigenous Knowledge

6

Households speaking and writing the native language

Surveys in Guangxi and Yunnan found that 97.7 per cent of interviewees speak the native language—only a slight decrease in the last 30 years. Naxi is still spoken in everyday life in the Yunnan villages and is in little danger of dying out soon. In the Stone Village area, most of the women aged over 50 speak no mandarin Chinese, but only the Naxi language. However, whether in Guangxi or Yunnan, no primary school teaches in the native language. Before the year 2000, there were 10 communities where children were taught in native languages. Nowadays, most of primary schools promote and teach in mandarin Chinese.

Only 2.3 percent of interviewees write in native language. One reason is that some ethnic groups do not have their own script, and/or the script is rarely used in everyday life and few people are able to read it. For example, the Naxi language may be written in the syllabic geba script. There is also a Naxi tradition of pictographic symbols called dongba; this may sometimes be annotated with geba for clarification, since a dongba text may only be intelligible to its author. Secondly, the nation-wide promotion of Han script and mandarin Chinese replaces the use of native scripts and dialects.

Households with traditional houses

The percentage of households keeping the traditional house type/style is high in Yunnan; almost all villagers keep the traditional housing style. For example, in the Stone Villages of Yunnan, houses are kept in traditional wood structure, one reason being the enforcement of customary laws. When building/renovating a house, the traditional architecture style has to be kept and no modern construction materials can be used. Another reason is out of economic concern, villagers live in remote areas and their income level is rather low. It is cost-effective for villagers to accumulate wood materials over time to build/renovate wooden houses: that way they can avoid a lump-sum payment on house construction/renovation.

In Guangxi, only 20 per cent of households keep the traditional house type/style. The main reasons are that the surveyed villages have access to decent roads conditions and to higher incomes. Therefore, villagers in Guangxi construct/renovate their houses based on the city style, which is thought more desirable.

Households participating in traditional rituals and festivals

Table 29 shows many more people participate in traditional festivals than in traditional rituals. There is little variation in gender; although male participation is slightly higher than female participation. Out of all traditional activities, male participation is highest in rituals. The average age of participants in all traditional activities is over 40 years old.

Our community surveys found gender participation varies significantly in different communities since every community organizes different kinds of traditional activities. However, most communities reflect a similar general trend of higher female participation in entertainment-related festivals and celebrations, and higher male participation in traditional rituals.

Table 27: Percentage of surveyed households speaking the native language

	SPEAK NATIVE LANGUAGE 30 YEARS AGO	SPEAK NATIVE LANGUAGE NOW
Yunnan	100%	100%
Guangxi	97%	95.5%

Table 28: Percentage of households keeping traditional house type/style

	HOUSEHOLDS BUILT IN THE TRADITIONAL STYLE
Yunnan	98.4%
Guangxi	20.4%
Total	48.3%

Table 29: People participating in traditional rituals and festivals

	TOTAL NUMBER OF PEOPLE	AVERAGE NUMBER OF PARTICIPANTS PER HOUSEHOLD	PERCENTAGE OF PARTICIPANTS THAT ARE MALE	AVERAGE AGE
Participate in traditional rituals	484	1.41	54.2%	47.2
Participate in traditional festival	985	2.86	53.1%	40.6
Participate in traditional celebrations	780	2.27	51.5%	41.4

Households wearing traditional clothing

The survey results indicate that in Yunnan most female elders wear traditional clothing. Out of 344 households surveyed, 106 people wear traditional clothing: 23 in Guangxi and 83 in Yunnan. Of these, 83 per cent are female, and 17 per cent are male. The average age of people in traditional dress was 55.2 years but ranged from 8 to 92 years old.

A lot of elderly women in Yunnan still wear traditional clothing mainly because of their remote location and difficulty in travelling, and little contact to the outside world. Since the youth and men have more contact with the outside world, their dress style is gradually moving away from traditional clothing.

Household participation in collective activities

Out of the 344 households surveyed, 506 people participate in colletive activities in the communities, and 55.1 per cent of participants are male. Most people who participate in collective activities are 40–59 years old but nearly a third are 60 years old or more.

Traditional farming technologies and practices

In Yunnan, the use of cattle for cultivation has not changed significantly; but in Guangxi it has reduced by half, and has been partly replaced by mechanical tillage and partly by no tillage technology. Intercropping

Table 30: Participation in collective activities across 344 households surveyed in Yunnan and Guangxi.

AGE	NUMBER OF PEOPLE	PERCENTAGE
0–19	9	1.8%
20–39	91	18%
40–59	**245**	**48.4%**
>=60	**161**	**31.8%**

farming continues to be used, but the planting area and the number of households using intercropping are both reduced. Farmers still use manure as organic fertiliser, but now they mostly combine its use withchemical fertilisers. In the Community Supported Agriculture (CSA) organic farming communities, the use of manure is now gradually increasing.

Networking outside the community

Relatives from both sides of the family are the most frequent contacts outside the communities; the main purpose of this contact is for festivals, work-related issues, weddings and funerals etc. In the city, relatives from both sides of the family are also the most frequent contacts.

Table 31: Household responses to the survey question 'Who do you normally contact in other communities?'

	NUMBER OF HOUSEHOLDS
Relatives	145
Village cadres	12
Classmates and friends	68
Person with working relationships	11

Table 32: Household responses to the survey question 'What's the reason for your contact with others?'

	NUMBER OF HOUSEHOLDS
Wedding, bereavement	48
Visit relatives in festival	75
Daily chat (face-to-face or by phone)	47
Work	59
The village's work	5

Table 33: Household responses to the survey question 'Who do you contact in cities?'

	NUMBER OF HOUSEHOLDS
Relatives	235
Government workers	9
Classmates and friends	23
Person with working relationships	11

Biocultural Innovations

This section outlines the study's findings on types of biocultural innovations for adaptation to climatic and socio-economic changes, who are the innovators, the reasons for innovation and the importance of innovation. The next section explores key innovations identified in more depth.

7

Types of innovation

Based on discussions and exploration with communities (through the qualitative study), the types of innovation were grouped as: technical, institutional and market innovations; internally or externally initiated innovations; and individual or collective innovations. Among the internal (or 'endogenous') innovations, more technological innovations were identified than institutional and market innovations – eg. innovations in crop management, crop varieties, traditional knowledge and architecture. These include using drought tolerant landraces, water saving technologies, and labour saving innovations (the latter are more in response to economic changes that have led to labour shortages). Some informal institutional and market innovations have also emerged in the adaptation process, e.g. formation of vegetable groups, folk music and dancing groups, and revival of traditional community organisations and seed exchanges. Collective innovation has increased in recent years in both 'old' and 'new' project villages.

Among the externally initiated innovations, the communities identified Participatory Plant Breeding (PBB) and Community Supported Agriculture (CSA) in Guangxi, and the IPCCA (Indigenous Peoples' Climate Change Assessment) in Yunnan. PPB enables joint technical innovation by creating a collaborative research platform linking farmers and scientists, and has also led to more 'internal' innovation by communities. PPB and CSA are both systematic joint innovation processes, which begin with technical and market innovation, and then become established as institutional innovations which provide platforms and processes for collective action for local communities, scientific institutions and NGOs. Market innovations for value addition and institutional innovations for a fair access and benefit-sharing are crucial for incentivising and maintaining the innovation process.

The household level survey identified a total of 542 innovations (Table 34): mainly . farming technologies/ practices and market/livelihood innovations, but also some institutional innovations.

Table 34: Types of innovation

TYPES	NUMBER
Market/livelihood	210
Farming technology/practice	233
Institutional/social	99

The market/livelihood innovations mainly focused on 'go to work in city/town', 'micro-finance or banking service', 'labour exchange', 'distribution/sale of crops/ products nationally ', and 'loan money from relatives'. These are not strictly speaking 'biocultural', with the exception of labour exchange which may be a revived traditional practice.

The technology or practice innovations mainly concentrated on 'identification of resilient cultivars', 'growth of modern hybrids', 'improved/more resilient crop', 're-introduction of traditional crops', 're-introduction of traditional farming methods', 'cropping practice'. These are largely biocultural innovations

The institutional/social innovations mainly involved community organisations/groups for market access, community crop technician groups and community seed fairs.

Respondents' reasons for developing innovations — and supporting factors

There are many factors driving innovations (Table 35). In the household level survey, we found the driving forces for innovation can be divided into three aspects: economic and market needs, social and cultural needs, and labour shortage/saving needs. Likewise, in the community level survey, over 60 per cent of communities mentioned the factors driving innovation came from economic and market needs. Collaboration with scientists and experimentation are not so much drivers of innovation, but rather factors that support innovation.

Table 35: Households' reasons for developing innovation (Yunnan and Guangxi households combined)

THE REASON	NUMBER OF HOUSEHOLDS GIVING THIS REASON
Ecological risks/changes	1
Major climatic event that led to crop failure/scarcity	4
Economic and market needs	356
Social and cultural needs	74
Labour saving	73
Repatriation/collaboration with scientists (= supporting factor)	38
Experiment and exploration (= supporting factor)	29
Other (health, hobbies, etc.)	56

Table 36: Innovators' education levels

EDUCATION	PROPORTION OF INNOVATORS
Illiterate	7.99%
Primary school	32.38%
Junior high school	43.65%
Senior high school	12.09%
Special [technical secondary] school	1.23%
Junior college	1.64%
Undergraduate student	0.61%
Graduated from university or above	0.41%

The qualitative baseline study found that traditional basic values and beliefs – such as balance and harmony, sharing and exchange – are the core factors for the continuity of local innovation and adaptation processes, for both internal and joint innovations. The four main innovation factors (people, institutions, networking and community level factors) were not explored in detail, partly due to limited time and partly because the communities thought it made more sense in their context to start by exploring individual and collective actions and internal and external factors more generally.

Innovators

The innovators identified through the qualitative survey are mainly knowledgeable elders, middle-aged men and women with higher education and more external experience, information and networking, and active women who are especially innovative on seeds and marketing and are normally capable persons or leaders in the villages. The existence of a capable leader is the most important factor needed to start the collective action and institutional innovation process.

The quantitative survey found that male innovators out-numbered women innovators by a little (men accounted for 54 per cent of innovators). In terms of the education level of all the innovators identified, it found that most of the innovators only finished junior high school. The majority of Chinese farmers did not pursue higher education, and many of those who completed high school and above have gone into cities to work.

Importance of innovation and areas where innovations are most needed

Both farmers and farming communities as a whole have recognized the importance of innovation. Sixty per cent of the community heads believed that innovation is "very important" and the remaining 40 per cent believed that innovation is "important". We tried to find out the main aspects in which communities need innovation, in order to guide future projects and better respond to farmers' needs. In the community level survey, we found that 95 per cent of the communities need innovations to improve economic growth, and over half the communities need innovations for: maximization of agricultural production, linkage to marketing and increasing product sales, a more convenient life, household food security, and labour-saving. In the household level survey (Table 37) the areas that most required innovations are economic growth and maximising agricultural production.

Table 37: Responses to the survey question 'In what areas are innovations most necessary for the well-being of your household?'

AREAS	NUMBER OF HOUSEHOLDS REPORTING THEY NEED INNOVATIONS
1. Maximization of agricultural production	203
2. Economic growth	270
3. Confronting climate change	16
4. Marketing/product sales	112
5. Models of community participation	34
6. Integration with national and international economies	7
7. Reduced cost of living	139
8. Other	16
9. More convenient life	87
10. Labour-saving	141
11. Household food security	130

Exploring key innovations

This section explores key technical, institutional and market biocultural innovations for climatic and socio-economic resilience in more depth, based on the qualitative survey findings. These include innovations developed by farmers alone (internal or endogenous innovations), and those developed jointly with external partners such as PPB and CSA.

8

Technical Innovation

Farmers in the study villages were found to be developing a range of technical innovations to improve soil quality and combat drought and pests.

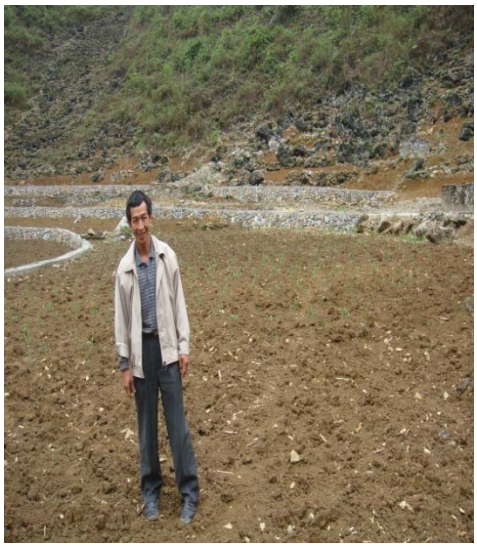
Drought Tolerance

Communities conserve and continually improve drought-tolerant landraces of maize, wheat and rice through field and post-harvest selection. One of the main properties they emphasize in the landraces of all these grains is their drought tolerance. In general, landraces are more drought tolerant than introduced varieties, therefore, even when farmers are primarily growing hybrid or other varieties of these grains, they still maintain some landraces and turn to them in times of drought. We found that all the communities in Yunnan and Guangxi maintain at least one maize landrace explicitly for drought tolerant properties, and will plant them when rainfall is low. In Yunnan, all wheat being grown in the villages are drought tolerant landraces. Wheat landraces will grow well during the dry winters when nothing else will, so villagers rely on it both seasonally and as a drought crop. In the Stone Villages, for example, they have five local wheat varieties that they have maintained and improved continually. Villagers were able to continue growing these even during the extreme drought of 2010–14. Similarly, in Guangxi, most farmer-improved maize landraces survived the severe spring drought of 2010, while most of the hybrid maize varieties did not.

In addition to conserving landraces for overall drought tolerance, communities also **select for variation of planting times**. Certain landraces are appropriate for planting later than others. For example, maize and rice usually need to be planted in early spring, but the Stone and Meiquan Villages in Yunnan have conserved several landraces that can be planted later. They had conserved them but were not using them. With the recent drought events, rains have come later in the year, so villages have brought these varieties back and have also introduced some landraces from neighbouring villages. These re-introduced traditional landraces allow them to plant later in the season, thereby remaining resilient to the drought conditions.

Some farmers have **switched to less water-intensive crops and changed cropping patterns** to remain resilient in the face of drought. For example, in the Yunnan Stone Villages, they used to grow walnuts for the nuts and oil but had shifted away from this during reforms in the 1970s and 80s, in favour of water intensive rice production. In recent years farmers have begun replacing rice with less water-intensive traditional crops such as maize and walnut production. They are also introducing a new cash crop, pelargonium citrosa (天竺葵), a fragrant herb used in perfumes, medicine and incense. This innovation is based on traditional knowledge and new technologies introduced through CSA.

Communities in Guangxi have also developed a number of new maize varieties through **Participatory Plant Breeding** (PPB), which uses local landraces and traditional knowledge, as well as external varieties and knowledge for a joint innovation process. After 10 years of experimentation on farm and on station, five new PPB varieties (4 open-pollinated varieties and 1 hybrid) have been developed and released in the research villages and have spread beyond these villages. In addition, five varieties from the International Maize and Wheat Improvement Centre that were showing increasingly



Left: Farmer-improved maize landraces (back) survived the severe spring drought of 2010 in Guangxi, but hybrid maize varieties did not (front). Right: Farmer-improved maize landrace. Photos by Cheng Weidong, March 2010.

poor results have been adapted locally, and five local landraces have been improved. All of these new and improved maize varieties have satisfactory yield, agronomic traits and palatability and are better adapted to the local conditions such as drought and pests than modern hybrids.

Integrated pest management

Spurred by market demand for healthier chemical-free food production, farmers are **reintroducing previously-abandoned traditional farming techniques** through joint innovations developed with CSA partners**.** For example, in Guangxi, farmers are bringing back traditional techniques of combining rice production with duck and fish production. They are taking conserved landraces and selecting them for characteristics that allow for this kind of mixed production. Specifically, the plant shape needs to be suitable for ducks to swim through without getting tangled up, and the ripening timing of different varieties needs to coincide in order to avoid plants being eaten by the ducks prior to harvest. The incentive to reintroduce these techniques comes from requirements by a local Community Supported Agriculture (CSA) scheme for greener rice, as the fish and ducks replace the need for pesticides and chemical fertilisers. This scheme is discussed in more detail in the Market Innovations section below.

Duck in rice farming in Nonlv village.Photo by Simon Lin, June 2013

In Yunnan, the farmers are also bringing back traditional farming techniques for pest control in rice fields, on their own initiative, in response to increased drought and pests. Pests such as snout moth's larva, have been increasing in recent years due to the droughts. Villages are experimenting with re-introducing the traditional approaches of using fire and smoke to control pests. They have started growing a traditional fragrant herb called Chinese mugwort, the smoke of which can be used to repel pests from the fields. Similarly, in Guangxi, villages are re-introducing traditional bio-pesticides using wild-crafted herbs and chilli pepper.

Farmers are also **experimenting with new crops for natural pest control**. As mentioned above, in Yunnan, farmers are growing the newly-introduced cash crop pelargonium citrosa. Though they primarily sell its oil directly to Japan, farmers have also discovered that it has useful pest control properties. They have begun deliberately growing it next to the rice and wheat fields so that its potent citronella-like smell deters pests from entering the fields.

Soil conservation

Erratic weather and low water availability have exacerbated soil erosion in some areas. Villages have begun **reintroducing traditional farming techniques and crops for soil management** purposes. In Guangxi, for example, formerly-abandoned traditional maize-soybean-pumpkin-sweet potato intercropping practices are being brought back in most villages. Similarly, traditional composting approaches and previously-abandoned methods of applying fish waste as fertiliser on fields are being re-introduced. These efforts are spurred by soil erosion problems as well as CSA demands for chemical-free food production. PPB has also played a role in revitalising traditional farming practices because it fosters recognition of the value of traditional knowledge and landraces among scientists and establishes a platform and network for interaction between farmers and scientists, and hence for enabling joint innovation.

Organic vegetable intercropping with pumpkins and maize in Guzhai village. Photo by Simon Lin, June 2013

As mentioned above, the Yunnan Stone Villages have re-introduced traditional walnut production. Facing drought, low labour availability (because of outmigration to the cities) and soil erosion problems, they have begun reintroducing walnut trees because of their lowlabour and water requirements, as well as their value as a cash crop.

Institutional innovation

An important institutional innovation, which has also provided a supporting structure to many of the technical innovations discussed above, is **Participatory Plant Breeding (PPB).** PPB is a mechanism that has been developed since 2000 in Guangxi for farmer-breeder collaboration on landrace conservation, seed selection and improvement and breeding. From late 2012 it has also started in Yunnan. Rather than working only on research stations, scientists from the formal breeding institutes work together with farmers in villages to identify farmers' interests and needs and desired characteristics of landraces (e.g. drought tolerance). Together, they develop community registers of existing traditional landraces. This also promotes formal recognition of farmers' rights to traditional varieties and knowledge. They then identify target landraces as well as varieties from other geographic regions and from the formal sector, and evaluate them for desired characteristics. After jointly selecting parent lines, famers and scientists collaborate in growing and breeding experiments in the research station and farmers' fields, together developing improvements to existing varieties as well as growing techniques. In general, traditional landraces are somewhat degenerated. Breeders work with farmers through the PPB mechanism to revitalise these landraces. For example, plant breeders taught farmers to cultivate plants in a way that avoids cross-fertilising in the field, and allows the uncontaminated seeds to be harvested and saved. This approach, known as 'purification and rejuvenation' (提纯复壮), has come out of this collaboration. The PPB process leads to the establishment of new collaborative ways of working between breeders and farmers, which can become institutionalised over time.

PPB experiment for landrace improvement led by farmers in Guzhai village. Photo by Yiching Song, May 2012

PPB variety, Zhongmo no 1 in a farmer's field in Wentang village, July 2012. Photo by Yiching Song

Ultimately, the goal will be to secure formal recognition and protection of farmers' field-based variety rights, as well as the collective rights of farming communities for those varieties developed in the PPB process. As farmers cannot currently register new PPB varieties jointly developed with breeders under China's seed law, SIFOR is exploring and experimenting with institutional innovations and tools for access and benefits sharing (ABS) in the PPB process both at the level of breeder to farmer and village to village interactions. These include pilot ABS agreements between breeders and PPB villages, revision of the seed law to allow formal seed registration by farmers, and clarifying the source/origin of parent lines.

Alongside PPB, farmers in Guangxi have also started a **platform for farmer seed and traditional knowledge exchange** involving different villages. Farmers take their improved and existing landraces to an annual seed fair, where they introduce the qualities of these varieties to each other, exchange growing techniques and the seeds themselves. These platforms were initiated as womens' seed fairs with support from the PPB project, and the PPB villages continued to organise them on their own initiative. Now, through SIFOR, farmers from Yunnan are beginning to participate in these exchanges in Guangxi and to organise their own seed fairs.

Biodiversity and traditional culture fair in Stone village, Yunnan. Photo by Yanyan Zhang, Dec 2013

Market Innovation

The above technical and institutional innovations are further supported by innovations in how the farmers are interacting with the market for their goods. Such market innovations provide crucial incentives for maintaining the joint innovation process (PPB), and have also led to a number of internal biocultural innovations by the communities in response to market demand. In Guangxi in particular, but also more recently and to a lesser degree in Yunnan, farmers are finding new market channels for their goods through community supported agriculture, notably urban 'farm-direct' restaurants and farmers' markets.

These efforts began in 2005, with the support of a local NGO in Guangxi, Farmers Friend (爱农会). To date, the project has established nine restaurants in Guangxi (four in Nanning and five in Liuzhou) and one in Yunnan (Kunming), as well as several farmers' markets in Liuzhou and Nanning (and one is planned in Kunming), for direct sale of the farm goods. At the beginning, the NGO identified target villages in the Nanning and Liuzhou area, and held discussions on possible products (pork, vegetables, alcohol, rice, chicken, maize, etc) and requirements for healthy and ecological production (eg. no pesticides or chemical fertilisers, no processed feed). The NGO then placed orders from the villages, relying on interns to provide direct technical support on growing methods, logistics and market links. These interns were recent college graduates specialising in sustainable agriculture. This process provided capacity building for the villages while also ensuring that the restaurant had a field-based understanding of the realities in the villages.

As a result of this new, high-value, stable market channel, farmers in participating villages have re-introduced traditional varieties of vegetables and animals that had gone locally extinct (heritage varieties of pigs, chickens, ducks, fish, vegetables and grains). For example, they have increased varieties of rice from three or four to 20 different landraces that are currently being tested. They are also re-introducing traditional planting techniques such as duck-fish-rice co-production, intercropping soy-maize-sweet-potato and applying bio-pesticides. Furthermore, they are using biogas technology to process animal waste for fertiliser and produce gas for cooking and preparing animal feed, thus reducing household energy consumption and contributing to climate change mitigation. Biogas was initially introduced to the area in the 1990s, and the CSA has spurred further improvements to the approach, allowing for a more comprehensive circular farming system.

Similar innovations spurred by new access to urban markets since late 2012 are taking place in Yunnan. The Kunming Farmers' Friend restaurant has started to order traditional walnuts, ham, wheat noodles, and wheat alcohol, encouraging re-discovery and further development of traditional crops like walnuts as well as traditional processing techniques such as ham-curing and walnut oil production that had nearly disappeared entirely.

Organic farming is forming circular links to organic restaurants in Guangxi. Photos by Yiching Song, Feb, 2011

Impact of the innovations on livelihoods, agrobiodiversity, social capital

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The technical, institutional and market innovations discussed above, both internally and externally initiated, have contributed to strengthened livelihoods, agrobiodiversity and social capital, thereby enhancing resilience to climate change and socio-economic change, and strengthening capacity for further innovation. The joint market and institutional innovations (CSA and PPB) have spurred a number of internal innovations by communities.

Agrobiodiversity has been directly impacted through these innovations, with landrace conservation and continual improvement ensuring high crop diversity, particularly in the PPB villages. The need for drought resistance, flexible planting time, better pest control and soil management all lead farmers to technical innovations that sustain and enhance crop biodiversity, because the farmers recognise that this leads to greater resilience and **food security**. The institutional and market innovations in PPB, CSA and farmers' markets further support this innovation process through formal, outside recognition of traditional knowledge and landraces, support and improvement of landraces, and market demand for traditional crops and farming practices.

In Guangxi, PPB has provided an enabling environment for many of the technical innovations to take place. Re-introduction of locally-extinct landraces, as well as the introduction of new varieties for cash crops or through the PPB and seed sharing process, has significantly improved the agrobiodiversity of the villages. As farmer Lu Rongyan said, "PPB and community-based seed production have provided us more options and more independence because our community has more landraces and other local varieties now." Efforts to conserve soil and produce pesticide-free foods also improve the local biodiversity. This agrobiodiversity in turn supports greater climate resilience in the region, as farmers are able to maintain productive fields through unstable weather patterns.

These improvements have had a direct **livelihood** impact because farmers have been able to maintain, and in some cases even improve, productivity despite drought conditions, allowing them to maintain good food security and income. The livelihood impacts of the market and institutional innovations can be seen in contrasting villages in Guangxi and Yunnan. In Guangxi, there is more focus on increasing income through CSA efforts as CSA has been underway for several years. As farmer Weiyugui explained, "Our CSA-supported organic rice has a price of 3–4 times higher than regular rice. This has allowed us to triple our farm income." These efforts are supported through a strong focus on developing the agrobiodiversity of the region through PPB and seed sharing. By contrast, in Yunnan, the focus is largely on drought resistance and food security, as value-added activities are only now being explored.

These qualitative findings are supported by the quantitative survey results presented earlier that show improved crop diversity and income trends in PPB and CSA villages in Guangxi since 2007 compared to before, and compared to 'new' project villages in Yunnan. They also show improved yield trends for PPB varieties (maize and rice) compared to non-PPB varieties (eg. wheat in Yunnan) – with average rice yields increasing by 16% since 2002. Field trials conducted in Guangxi showed that yields from PPB varieties are 15–30% higher compared to landraces. It is also evident that PPB seeds have spread spontaneously to neighbouring villages.

Perhaps most inspiring to the farmers in this study are the improvements to the **social capital** of their villages. Through the CSA in Guangxi, village women have formed an informal women's group, supporting each other's efforts to conserve landraces and strengthening their communication and bonds. This process also enhances communication with the village elders, who they must rely on for information about traditional landraces and growing techniques. The CSA has supported stronger urban-rural links, spurring young college-educated interns to go back to rural areas and get directly involved in farming activities. This is in stark contrast to the dominant trend in China of youth moving to urban areas, highlighting an exciting change in rural labour dynamics. Within the communities, the CSA has spurred formal farmer cooperatives to organise themselves and manage these exchanges. In Guangxi, there are now five formally registered farmer cooperatives, which allow formal recognition and connection to greater market channels and supporting institutions. As the Chengtang village farmer cooperative leader explained, "the most important aspect of PPB and CSA is providing a platform for us to work together with breeders, scientists, market people and more. This enhances our capacity and links us to a larger world with more information and opportunities".

Traditional harvest dancing by women groups in Guzhai, Gunagxi, November 2011. Photo by Rongyan Lu

Conclusion

Climatic challenges such as drought are adding to socio-economic challenges of out-migration and shrinking labour force. In response, farmers have developed a number of traditional knowledge-based innovations. PPB and CSA have proved effective in enhancing resilience, incomes, yields and crop diversity – as evident from the qualitative survey findings, backed by the quantitative findings.

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The overall trend of increasing migration to cities for work, and increasingly feminised and ageing agricultural labour force, continued in Guangxi and Yunnan between 2002 and 2012. Although out-migration forms an important part of household income in both provinces, this trend was much more pronounced in Guangxi. Incomes are much higher in Guangxi than in the more remote Yunnan villages, but the difference between income and expenditure has grown consistently in both provinces since 2002. Income from crop production fell since 2002 in both provinces; however in Guangxi it increased slightly since 2007 in PPB and CSA villages, providing evidence of the impacts of CSA, which started in 2005. However, given the high living expenses in urban areas, crop production and sales are still the most important livelihood activities for income and food security. In fact, some households reported a tripling of farm income because of CSA and rising income from CSA has prompted some young people to return to Guangxi villages, as the qualitative findings show.

Food self-sufficiency has declined as access to food markets has become easier, but is notably higher in villages with organic farmer groups compared to neighbouring villages – this is also mainly due to CSA creating demand for organic food. The findings also show that, since 2002, yields for maize and rice landraces (which have been the focus on PPB) have increased, with a relative relatively rapid yield increase for rice (16%). Evidence from PPB trials shows that PPB maize varieties have 15–30% higher yields than landraces. This contrasts with yields of wheat landraces in Yunnan which have decreased since 2002 as they have not received enough efforts for improvement.

The findings show that farmers in Guangxi and Yunnan still conserve significant levels of crop diversity – in 2012 farmers surveyed in Guangxi planted a total of 1235 varieties while those in Yunnan planted 463; however in Yunnan there was a smaller sample size and the percentage of landraces planted was higher. But the overall trend is one of declining crop diversity and landraces. There has been a rapid decline in the area planted with maize landraces since 2002 overall; and an increase in the area planted with maize hybrids. However, the findings also suggest that crop diversity loss is being reversed in PPB and CSA villages in Guangxi - since 2007, the area planted with maize hybrids declined, and the area planted with rice landraces grew. Furthermore, several heritage varieties that were locally extinct have been revived, along with agroecological practices such as intercropping and integrated pest management. This reversal in trends coincides with a significant rise in income from improved market linkages (community supported agriculture) for organic rice landraces. This contrasts with Yunnan villages where there was a very small area still planted with maize landraces in 2012, and a decline in the area planted with wheat and rice landraces since 2002. However, the number of wheat and rice landraces planted in the Stone Village, Yunnan, has actually gone up in that time - in the case of wheat farmers are mainly conserving drought tolerant local varieties.

It is interesting to note that after the year 2000, a much higher number of crop varieties were lost each year in both Guangxi and Yunnan. The spikes in crop variety loss coincide with external policy signals: in 2000, when China joined the WTO, hybrid seeds were popularised and subsidies for intensive agriculture grew; while in Yunnan the highest number of varieties were lost in 2008 and 2010 due to the local agricultural policy. The yield of hybrid seeds is a distinct advantage, which, coupled with the limited scientific investment in improving local varieties, leads to the frequent replacement and disappearance of more resilient and diverse local varieties which are important for climate change adaptation. The area planted with staple foods has also declined, while cash crops have increased due to higher revenues and government promotion of sugar cane. However, farmers still conserve a few different varieties and landraces, mainly due to their good taste and high yield in the local environment (under less than optimal conditions), and also due to their cultural value. Despite a small decline since 2002, soybean landraces still account for nearly 90 per cent of the area of soya cultivation, providing an important genetic reservoir for enhancing resilience of China's soya industry. In terms of seed security, farmers rely mainly on saved seed to access landraces and improved varieties, and on markets for hybrid seed. The findings show that women play a major role in selecting and saving seed for all types of crops.

The survey suggests that, in general, culture and traditional knowledge are still quite intact in the surveyed villages, particularly in Yunnan. Native language – an important carrier of traditional knowledge – is still spoken by 100 per cent of households in Yunnan, and 95.5 per cent in Guangxi (compared to 97 per cent 30 years ago). However, the fact that native language is no longer taught in primary schools, coupled with youth out-migration, represent significant threats. Overall, traditional culture seems stronger in Yunnan where nearly 100% of houses are built in traditional style (due to customary laws), compared with only

20 per cent in Guangxi. Similarly, the number of people wearing traditional clothing was more than three times higher in Yunnan. However, these differences are also due to the more remote location and lower income of Yunnan villages.

Overall, the findings on climatic changes observed by farmers show a marked decrease in rainfall and increase in drought in the 10 years from 2002–2012, with 92 per cent of farmers reporting changes in rainfall, and over 50 per cent reporting a high degree of change. Over half the farmers also reported much change in temperature and insects/pests. In Yunnan, 70 per cent of households observed drought since 2002, compared with 24 per cent who recalled earlier droughts. Over the last decade, spring drought has occurred almost every year and lasts 1–2 months, mainly in May and June. The planting time at the start of the rainy season has shifted by about 2 months over the past 20 years – from April to July. However, in September 2014, non-stop rain destroyed the maize harvest. In Guangxi, nearly 60% of households observed drought in the last 10 years, a slight decrease from previously, but more households observed cloud burst in the last 10 years than previously.

Despite a shrinking agricultural labour and considerable climatic challenges, farming communities are finding coping strategies through traditional knowledge based innovations. The survey identified a total of 542 innovations – 233 technical, 210 market and 99 institutional innovations – however some of these are not strictly speaking TK-based or 'biocultural' particularly amongst the market innovations. Internal technological innovations include development and improvement of drought tolerant landraces, water saving technologies, innovations in crop management and labour saving innovations. Some informal institutional and market innovations have also emerged, e.g. vegetable groups, folk music and dancing groups, and revival of traditional community organisations and seed exchanges. Collective innovation is increasing in recent years in both 'old' and 'new' project villages.

By far the greatest reason for developing innovations was for 'economic and market needs', followed by social and cultural needs and labour saving, with ecological risk/change and major climatic events being the least cited reasons. Similarly, when asked in which area is innovation most needed for wellbeing, the highest response was for economic growth and the second highest was to maximise agricultural production. Clearly economic concerns are a major driver of innovation, but it is clear from the qualitative survey that farmers are also developing specific TK-based innovations to cope with drought, pests and soil erosion on their own initiative. Often the innovations adopted meet both resilience and market needs.

Key biocultural innovations for climate resilience and adaptation include conserving and continually improving drought-tolerant landraces of maize, wheat and rice, and selecting varieties for a diversity of planting times. Farmers have switched crops and changed cropping patterns to remain resilient in the face of drought. Spurred by market demand for healthier chemical-free food (CSA), farmers are reintroducing previously-abandoned traditional agroecological farming techniques for soil conservation and natural pest control. An important supporting structure for these technical innovations is the participatory plant breeding (PPB) mechanism for farmer-breeder collaboration on landrace conservation, seed selection and improvement and breeding. The findings show that landrace improvement through PPB also prevents loss of landraces. Farmer seed and traditional knowledge exchanges are also important to support innovation and landrace conservation. Farmers are also linking with urban areas in news ways, finding new market channels for their goods through community supported agriculture, notably urban 'farm-direct' restaurants and farmers' markets.

It is clear that PPB and CSA innovations have stimulated biocultural innovation in Guangxi, however farmers in Yunnan have also developed a number of innovations without these, supported by their stronger traditional knowledge and landrace cultivation. Traditional basic values and beliefs - such as balance and harmony, sharing and exchange - are the core factors supporting the local innovation and adaptation process, for both internal and joint innovations. It is also clear that local landraces can be far more resilient than modern varieties – maize landraces survived the 2010 drought in Guangxi, but hybrids did not. Therefore, efforts to support climatic and socio-economic resilience in these communities should prioritise strengthening their biocultural heritage. About 20 per cent of households also said collaboration with scientists or experimentation were factors that support innovation. The individual innovators identified are mainly knowledgeable elders, middle-aged men and women who are especially innovative on seeds and marketing, and are normally capable persons or leaders in the villages (54 percent of the innovators were men). A capable leader is the most important factor needed to start the collective action and institutional innovation process.

The findings show that PPB and CSA are effective tools for achieving multiple goals of climate adaptation, food security, poverty eradication, biodiversity conservation, sustainable agriculture and transformational change. PPB has bred new maize varieties that are better adapted to local conditions such as drought and pests than modern hybrids, and that have 15–30 per cent higher yields than landraces. One Guangxi farmer noted incomes from rice have increased 3–4 fold due to market linkages, tripling farm income. PPB and CSA are reversing the loss of crop diversity, thereby sustaining options for future adaptation, and revitalising traditional agroecological farming practices that conserve ecosystem services. These impacts are particularly notable in Guangxi but are also beginning to emerge in Yunnan after just three years of support for PPB and CSA. PPB and CSA have also had notable impacts on social capital, stimulating the formation of farmers' cooperatives and womens' empowerment. By linking leading scientists directly with farmers, CCAP's PPB program in Guangxi has also started to change formal agricultural institutions and policies in China, leading to the introduction of a budget for PPB by the Guangxi Maize Research Institute (for GMRI costs, not field costs), and the revision of the national seed law to support farmers' rights to save, exchange and sell seed at local level.

Looking ahead

While communities have developed a number of internal technical innovations, more support is needed for institutional and market innovations , ultimately working towards a community-led process of systematic collective innovation. Likewise, for the joint innovation process, the existing PPB and CSA activities need to continue improving, working towards a fair, mutually supportive, complementary and sustainable innovation process. The ultimate aim will be to scale up activities like PPB and CSA and ensure they are a mainstream part of farming approaches in southwest China.

External support and enabling policies are crucial for enhancing biocultural innovation. Clear policy support and incentives are needed for promoting PPB within formal agricultural systems at provincial and national level, for combining traditional knowledge with scientific knowledge, and for strengthening market linkages. Recognition of the community biocultural innovation system, its role in complementing science, and its collective spirit, is critical if the innovation process is to continue.

The new National Farmer Seed Network in China needs to be further strengthened so that it can play several important roles: to support scaling up of PPB, CSA and farmer innovations; to provide a 'living seed lab' for legal and policy pilot studies; and to boost information-sharing between different stakeholders. All these activities to support biocultural innovation systems in China are important to enhance food security and resilience to climate change, not only in smallholder farming communities in southwest provinces, but also within the national agricultural system by providing a wide, resilient and evolving gene pool.

China's successful and multiple impact PPB and CSA approaches provide important models and tools for climate-resilient sustainable development in other Southern countries. Experience in China suggests that the time-frame for PPB is actually shorter than conventional breeding (2–4 years for PPB maize) due to parallel on-farm research and high adoption rates, and that the cost of PPB is lower than conventional breeding (as farmers give their time for free). China's experience also shows that PPB needs to be accompanied by market incentives to sustain farmers' active involvement – hence the importance of CSA. The success of CSA in China has been down to a number of factors. A growing urban middle class in provincial cities, strong dining-out culture, rising demand for healthy ecologically-produced food, and the facilitation role of the NGO 'Farmers' Friend', which has established a number of restaurants linking farmers directly with urban consumers.

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All over the world, we are rapidly losing a diversity of locally adapted crops and traditional knowledge, which provide resources for resilience and adaptation to climate change. The SIFOR project (Smallholder Innovation for Resilience) aims to strengthen traditional knowledge-based innovation systems for food security in the face of climate change. This report presents findings from a baseline study conducted in 18 communities in Southwest China, which explored trends in livelihoods, crop diversity, social capital and climate, and traditional knowledge-based innovations. These include innovations developed jointly by ethnic communities and external partners, notably Participatory Plant Breeding and Community Supported Agriculture, which have strengthened resilience by enhancing food security, incomes and crop diversity.

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