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# Emerging Biocultural Innovations for Climate Resilience in Southwest China

## SIFOR Qualitative Baseline Study

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# Acronyms

| | |
|---|---|
| ABS | access and benefit sharing |
| CAS | Chinese Academy of Science |
| CCAP | Centre for Chinese Agricultural Policy |
| CSA | community supported agriculture |
| FAO | Food and Agriculture Organization of the United Nations |
| GEF | Global Environment Facility |
| IGNRR | Institute of Geographic and Natural Resources Research |
| IPCCA | Indigenous Peoples' Climate Change Assessment |
| M&E | monitoring and evaluation |
| MOA | Ministry of Agriculture |
| NGO | non-governmental organisation |
| PAR | Participatory Action-Research |
| PPB | participatory plant breeding |
| SIFOR | Smallholder Innovation for Resilience |
| TK | traditional knowledge |

# Summary

This report presents the findings of a qualitative baseline study conducted in 18 smallholder farming villages in Yunnan and Guangxi provinces, southwest China, from January to July 2013. The study was conducted as part of the SIFOR project – Smallholder Innovation for Resilience. It explored the innovations developed by farmers to strengthen resilience, food security and income in response to socioeconomic and climatic challenges. It focused on internal innovations based on traditional knowledge (TK) and biocultural heritage, as well as those developed jointly with scientists and NGOs (non-governmental organisations), using both TK and external knowledge – notably participatory plant breeding (PPB) and community-supported agriculture (CSA). PPB and CSA have been supported by the Chinese Centre for Agricultural Policy (CCAP) since 2000 and 2005 respectively in Guangxi, and since 2012 in Yunnan.

About two thirds of farmer households had one or more family members working in cities, and on average, more than half their income is derived from off-farm activities. Levels of out-migration and non-farm income have increased, particularly in Yunnan. As off-farm incomes have increased, the income gap has increased between villages and within villages, with young men better able to take advantage of urban incomes. This has resulted in decreasing interest in small-scale village farming. In most villages, agriculture has become the work of women and elders. As a result, about 30 per cent of households surveyed in Guangxi and 20 per cent in Yunnan, have given up traditional intensive farming in favour of labour-saving chemical intensive monocropping. This has led to degradation and loss of agrobiodiversity, traditional knowledge, culture and community cohesion

Villages which have been involved in PPB and CSA for over a decade and 'new' project villages (mainly in Yunnan but also in Guangxi) show some marked differences.

- In new project villages, the main source of income is off-farm work, but in PPB and CSA villages, farming income has increased rapidly in the last 10 years.
- In all villages, the overall trend is for young people and men to migrate out and work in the non-farming sector, but more young people are going back to farming in PPB and CSA villages than in new project villages.
- Agrobiodiversity has decreased significantly in the new project villages with local varieties disappearing and some traditional crops like Tibetan barley lost altogether, along with their associated traditional farming and food knowledge. In PPB and CSA villages, traditional varieties and knowledge have been maintained or even increased.

Climate change has also affected both provinces, with increased drought, more extreme weather events and increasing pests observed over the past 10 years. These conditions were particularly severe during a recent prolonged regional drought in 2010–2012. Villages in Yunnan were especially affected due to their more mountainous and remote location.

In the face of these socioeconomic and environmental challenges, communities and farmers have developed a variety of technical innovations and coping strategies:

Communities **conserve and continually improve drought-tolerant landraces of maize, wheat and rice** through field and post-harvest selection. Even when farmers are primarily growing hybrid or other varieties of these grains, they will still maintain these landraces and turn to them in times of drought. All the communities in Yunnan and Guangxi maintain at least one maize landrace explicitly for their drought-tolerant properties. In Yunnan, all wheat being grown is from drought tolerant landraces. Some villages in Yunnan have conserved landraces of maize and rice that can be planted later in spring, thereby remaining resilient to the drought conditions. In the Yunnan stone villages, they have begun replacing rice with less water-intensive traditional crops such as maize and walnuts. They are also introducing a new cash crop, *Pelargonium citrosa*, a fragrant herb used in perfumes, medicine and incense.

Farmers are bringing back **traditional farming techniques for pest control.** In Yunnan rice farmers have started growing a traditional fragrant herb called Chinese mugwort, the smoke of which can be used to repel pests. Similarly, in Guangxi, villages are reintroducing traditional biopesticides using wild

herbs and chilli pepper. Farmers are also **experimenting with new crops for natural pest control**. They are growing the newly introduced *Pelargonium citrosa* next to rice and wheat fields so that its potent citronella-like smell deters pests.

Villages have begun **reintroducing traditional farming techniques and crops for soil management**. In Guangxi, most project villages are bringing back formerly abandoned traditional intercropping approaches, and have reintroduced traditional composting approaches and previously abandoned methods of applying fish waste as fertiliser. The Yunnan Stone Villages have begun reintroducing traditional walnut trees due to their usefulness for soil conservation, low requirements for labour and water, and cash crop value.

Communities in Guangxi have developed a number of new maize varieties through **participatory plant breeding** (PPB), which combines local landraces and traditional knowledge with external varieties and knowledge in a joint innovation process. Some farmer-preferred maize and rice landraces have also been improved by farmers with assistance from scientists. All of these varieties have satisfactory yield, agronomic traits and palatability, and are better adapted to the local conditions such as drought and pests than modern hybrids.

PPB has also introduced institutional innovation through new ways of working designed jointly by farmers and scientists to link these previously separate actors. It has led to pilot access and benefit-sharing agreements between breeders and PPB villages in Guangxi, while turning leading agricultural scientists into champions of *in situ* conservation and farmers' rights over seeds. Alongside PPB, farmers in Guangxi have also started a **platform for farmer seed and traditional knowledge exchange** involving different villages. These platforms were initiated as womens' seed fairs, which the villages have continued to organise themselves annually.

In Guangxi, farmers are finding new market channels for their goods through **community-supported agriculture**, notably urban farm-direct restaurants and farmers' markets, with support of the NGO Farmers' Friend. As a result of this new, high-value, stable market channel, farmers have reintroduced traditional varieties and breeds that had gone locally extinct as well as the traditional techniques discussed above. They are using biogas to process animal waste, thus reducing household energy consumption and contributing to climate-change mitigation. Farmers' Friend have also recently established a restaurant in Yunnan, spurring similar innovations such as the rediscovery and further development of traditional crops like walnuts and traditional techniques such as ham curing and walnut oil production that had nearly disappeared.

These innovations have had impacts on livelihoods: CSA-supported organic rice commands a price 3 to 4 times greater than regular rice, while for maize overall incomes are 30 per cent higher in PPB villages than non-PPB villages growing hybrid maize. They have also increased social capital: spurred by the CSA in Guangxi, women leaders established informal women's groups to support each other's efforts to conserve landraces and strengthen their communication and bonds. These groups have gradually expanded and grown into five registered farmer's co-operatives.

Traditional basic values and beliefs – such as balance and harmony, sharing and exchange – are the core factors behind the continuity of the local innovation and adaptation process, for both internal and joint innovations. Innovators 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. The existence of a capable and committed leader is the most important factor in starting collective action and institutional innovation processes.

The long-existing traditional farming and seed system in China is threatened or even disappearing due to some modern farming policies. For example, national policies on plant variety registration have only recognised breeders' rights over high-yielding hybrid seeds, and only provide subsidies for hybrid seed production and for inputs such as fertilisers and machinery. Agricultural research policies focusing only on hybrids of a few staple food crops have a direct influence on breeders' incentives and are leading to reduced diversity of crops and varieties for future plant breeding in China. However, in recent years, the state's new strategic goal of 'ecological civilisation' and some supportive policies on agriculture and farmer co-operatives are having some positive impact on farmer seed systems and innovation process. The new multi-stakeholder Farmer Seed Network in China provides a key opportunity for scaling up PPB, farmer networking and policy pilots to enhance support for biocultural innovation in remote farming communities for food security and resilience to climate change.

# Introduction

Smallholder Innovation for Resilience (SIFOR) is a five year project which aims to strengthen traditional knowledge-based or 'biocultural' innovation systems of smallholder farming communities for food security in the face of climate change.[1] It is co-ordinated by the International Institute for Environment and Development (IIED) and partners in four focal countries: China, India, Kenya and Peru. In China, the project is co-ordinated by the Participatory Action-Research Program (PAR) of the Centre for Chinese Agricultural Policy (CCAP), which forms part of the Institute of Geographic and Natural Resource Research (IGNRR) of the Chinese Academy of Science.

The project aims to strengthen the innovation systems of indigenous and traditional farming communities in remote and risk-prone environments which still sustain significant agrobiodiversity and traditional knowledge (TK) for adaptation to climate change. It is a participatory action-research project with four specific objectives: 1) to identify TK-based innovations that enhance productivity and the conditions that support innovation; 2) to develop tools to increase the resilience of innovation systems and improve rights security; 3) to strengthen the capacity of smallholders, including indigenous farmers and women, to sustain resilient innovation systems and agrobiodiversity; and 4) to enhance understanding and commitment of scientists and policy makers towards more supportive policies and institutions.

This report summarises the findings of the qualitative baseline study conducted in Yunnan and Guangxi provinces in China from January to July 2013, to address the first specific objective above and provide baseline data for monitoring and evaluation (M&E). A common research framework was developed collaboratively between all four country partners and subsequently adapted to each local context. It focused on two main areas: 1) trends in livelihoods, biodiversity, social capital and climate in the last 20-30 years; and 2) biocultural innovations developed in response to these trends, and the people, institutions, networking and community factors that supported/enabled the innovations. The qualitative baseline study will be accompanied by a forthcoming quantitative study exploring the same themes in the same regions and communities.

In China, the SIFOR baseline study focused on innovations developed by farmers alone (internal innovations), and those developed jointly by farmers and scientists or external partners, using both traditional knowledge and external knowledge/science. In particular, it looked at CCAP's participatory plant breeding (PPB) programme which was initiated in 2000 and supported by IDRC's Biodiversity programme for a decade, and a community-supported agriculture (CSA) programme led by the Chinese NGO Farmers' Friend, to enhance market linkages for ecological and traditional farming. PPB is a collaborative breeding process which is designed and implemented jointly by farmers and breeders. CSA is a partnership between farmers and the local community (consumers), providing mutual benefits such as more stable income for farmers and more fresh and healthy food for consumers.

1 For more information about SIFOR see the Biocultural Heritage website at www.bioculturalheritage.org

# Research framework and methods

Guangxi and Yunnan provinces are situated in southwest China (see Figure 1), a region that is home to most of China's rural poor ethnic minority communities. Eighteen farming villages were chosen for the baseline study: 11 in Guangxi and 7 in Yunnan province, spanning 9 counties. Most of the villages in Guangxi have been involved in CCAP's participatory plant breeding programme since 2000 and in community-supported agriculture since 2005, but a few are new project villages which joined in 2012. All the villages in Yunnan are 'new' project villages which joined the PPB and CSA programmes in 2012.

Figure 1: Map of China showing provinces studied

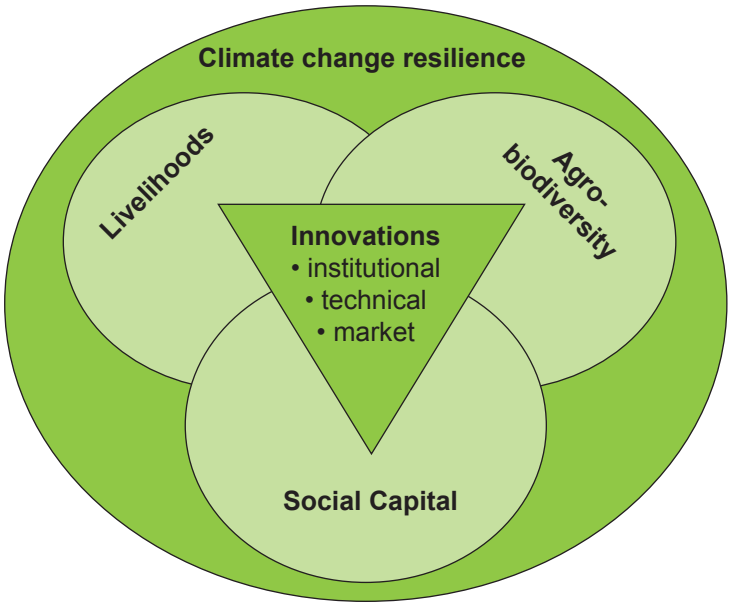

Research was conducted from January to July 2013, using individual and semi-structured interviews and focus-group discussion at both household and village levels. Individual 'innovators' were identified through individual interviews and focus groups were then given more in-depth semi-structured interviews. Table 1 below shows the primary characteristics of the villages studied, including the number of households, ethnic group and primary crops produced.

Table 1: Characteristics of villages studied

| County name | Village name | Total Households | Ethnic group | 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 | Guzhai Shanggula V | 65 | Yao, Zhuang | Maize, beans, sweet potato, vegetables |
| Mashan | Guzhai Zhonggula V | 50 | Yao, Zhuang, Han | Maize, beans, sweet potato, vegetables |
| Mashan | Guzhai Xiagula Village | 76 | Yao, Zhuang, Miao | Maize, beans, sweet potato, vegetables |
| Hengxian | Chengtang Village | 250 | Zhuang, Han | Rice, beans, vegetable, maize |
| Henxiang | Shancha 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 | Beidou Village | 100 | Zhuang, Han | Maize, vegetables, rice, fruits |
| Dahua | Xiahe 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, Pelargonium citrosa etc, |
| Yulong | Stone village Natural V2 | 51 | Naxi | Maize, rice, wheat, beans, Tibetan barley, millet, sougum, citrosa etc |
| Yulong | Stone village Natural V3 | 50 | Naxi | Maize, rice, wheat, beans, Tibetan barley, millet, sorghum Pelargonium citrosa etc |
| Yulong | Stone village Natural V4 | 39 | Naxi | Maize, rice, wheat, beans, Tibetan barley millet, sorghum Pelargonium citrosa etc |
| Yulong | Stone village Natural V5 | 52 | Naxi | Maize, rice, wheat, beans, Tibetan barley millet, sorghum, Pelargonium citrosa |
| Yulong | Stone village Natural V6 | 38 | Naxi | Maize, rice, wheat, beans, Tibetan barley millet, sorghum Pelargonium citrosa etc |
| **Total # counties** | **Total # villages** | **# households interviewed** | **Total ethnic groups** | **Primary crops in study** |
| 9 | 18 | 220 | 9 | Maize, rice, wheat, beans, potato, sweet potato, vegetables |

This research focused on identifying specific institutional, market and technical innovations and adaptations in the selected villages. These innovations are understood to impact three main aspects or components of the system: livelihoods, agrobiodiversity and social capital, with corresponding implications for strengthening the climate resilience of the villages. At the same time, these three aspects support innovation. Climatic challenges and changes as well as socioeconomic challenges have been an overarching driving force for biocultural innovation in these communities. This research framework is represented visually in Figure 2 below.

Figure 2: Research framework for biocultural innovation systems for resilience




An innovation can be simply defined as ‘a new way of doing things’, although strictly speaking an ‘innovation’ is something which has become established in the fabric of society. Hence, some of the ‘innovations’ that have been identified in this study could be termed adaptations or social changes. ‘Biocultural’ means derived from traditional knowledge and biocultural heritage. Biocultural heritage is composed of interconnected traditional knowledge, biodiversity, landscapes, cultural and spiritual values and customary laws. In this study, ‘biocultural innovations’ were taken to include innovations which are either wholly derived from traditional knowledge or biocultural heritage (‘internal innovations’), or which are at least 50 per cent based on these and 50 per cent based on science or external knowledge (‘joint innovations’).

# Current situation and trends in livelihoods, farming systems and biodiversity in Guangxi and Yunnan

Livelihood strategies are shifting in Guangxi and Yunnan provinces, with increasing diversification of income sources and out-migration to urban areas. About two thirds of farmer households in this study had one or more family members working in cities, and on average, more than half of farmer household income is derived from off-farm activities. Levels of out-migration and non-farm income have increased compared with 10 and 20 years ago in both Guangxi and Yunnan, with the greatest increase in Yunnan. As non-farm incomes have increased, the income gap has also increased both between and within villages. More remote, ethnic minority villages which are less able to access higher paying jobs in urban areas are seeing lower incomes. Income gaps are also increasing between women and men and between young and old in the same village, with young people and men better able to take advantage of urban incomes.

This increasing 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 emphasise investment in houses, children's education and starting small businesses, putting less capital and labour into agriculture as a result. In most of the communities, land-use rights are being transferred from households, with fewer farmers consolidating larger farms. At the village level, agriculture has become the work of women and elders, while men and youth are away in school and higher-paying jobs.

Stone Village, Yunnan, by Yiching Song, April 2013

As a result of these social trends and other factors such as agricultural modernisation, about 30 per cent of households surveyed in Guangxi, and 20 per cent of households surveyed in Yunnan, have given up traditional intensive farming methods such as intercropping, double cropping and rotational cropping, in favour of labour-saving chemical intensive monocropping techniques. This has led to degradation and loss of agrobiodiversity, traditional knowledge, culture and community cohesion.

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

Furthermore, climate change has affected both Yunnan and Guangxi, with increased drought, more extreme weather events and increasing problems with pests observed over the past 10 years. These conditions were particularly severe during a recent prolonged regional drought that lasted three consecutive years in 2010–2012. Villages in Yunnan were especially affected due to their more mountainous and remote location. These challenges create further burdens for farming communities, who now must also deal with unstable water resources and harsher growing conditions.

Stone Village in Yunnan, By Yiching Song, August 2013

In the face of the present socioeconomic and environmental challenges, the communities have developed a variety of adaptation and coping strategies. We found that despite tremendous difficulty, all communities were increasingly investing in developing creative solutions, farming techniques, market engagement and social organisations, both based on their traditional knowledge and biocultural heritage and in collaboration with scientists and NGOs (especially in Guangxi where CCAP's PPB project has been underway since 2000). All the communities are looking for market access and external support. Those with capable leaders have developed more and stronger collective actions and institutional innovations in response to these challenges, and are realising improvements economically, spiritually and ecologically. Farmers are also becoming increasingly interested in collective culture activities in all the communities involved in the CCAP programme, including the 'new' project villages in Yunnan and Guangxi, mainly due to exchanges with 'old' villages and project networking with other stakeholders (such as indigenous farmers from the Potato Park, Peru).

The study revealed some marked differences between the villages which have been involved in PPB and CSA for over a decade and the 'new' project villages (mainly in Yunnan but also in Guangxi):

- In the new project villages, the main source of income is off-farm work, but in PPB and CSA villages, farming income has increased rapidly in the last 10 years.
- In all the villages, the overall trend is for young people and men to migrate out and work in non-farming sector. However, more young people are going back to farming in PPB and CSA villages than in new project villages.
- Agrobiodiversity has decreased significantly in the last 10 years in the new project villages. For instance, in the 7 villages in Yunnan, 50 local food crop varieties disappeared, including 13 rice varieties, 10 maize varieties and 6 bean varieties. Some traditional food crops like Tibetan barley have been totally lost. At the same time, traditional knowledge in farming and food around those crops is also disappearing. Yet traditional varieties and knowledge have been maintained or even increased in PPB and CSA villages, where these activities have added value to biodiversity and contributed to its increase in the last 10 years.

# Biocultural innovation in Guangxi and Yunnan

## Types of innovation and innovation factors

This section outlines the biocultural innovations communities were using to adapt to climatic and socioeconomic changes. Based on discussions and exploration with communities (and building on earlier discussions with project partners),the following types of innovation were identified: technical, institutional and market innovations; internally or externally initiated and individually or collectively developed.

Among the internal (or 'endogenous') innovations, there were more technological innovations than institutional and market ones. These included innovations in crop management, crop varieties, TK and architecture. For example, drought-tolerant landraces, water-saving technologies and labour-saving innovations in response to labour shortages (due to migration). Some informal institutional and market innovations have also emerged in the adaptation process, including a vegetable marketing group, folk music and dancing groups, and the revival of traditional community organisations and seed exchanges. Collective innovation is increasing in recent years in both 'old' and 'new' project villages.

All the villages have observed and experienced climate changes, the most severe being drought, increased temperatures and pests, and all have developed their own adaptation strategies and innovations such as the adoption of more drought-tolerant crops or varieties. In the Stone Villages, some farmers have started cultivating maize or cash crops instead of rice. At same time, they have brought back customary laws and combined them with some new rules for water management and distribution in times of scarcity.

Among the externally initiated innovations, the communities identified PPB and CSA in Guangxi, and the IPCCA (Indigenous Peoples' Climate Change Assessment) in Yunnan, which was also initiated by CCAP. The main scientific partners for PPB are the national maize breeding programme in China and its leader Professor Zhang, the Guangxi Maize Research Institute and, more recently, the Yunnan Academy of Agricultural Science. PPB enables joint technical innovation by creating a collaborative research platform linking farmers and scientists, and has also led to more 'internal' innovations by communities. The NGO Farmers' Friend has supported CSA, creating market linkages by establishing organic restaurants and links to urban consumers. 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 innovation to add value to produce (e.g. CSA) and institutional innovation for fair access and benefit sharing (ABS) are crucial for incentivising and maintaining the PPB innovation process.

The project team is involved in IPCCA programme as a country case, using the IPCCA framework to do a climate change assessment in the stone villages in Yunnan. The IPCCA provides the institutional framework to pull together TK and link it with scientific assessments. It allows the use of TK to assess climatic changes and their impact and to develop responses based on TK. At same time, the team is collaborating with two groups of climate change scientists from the Chinese Academy of Science (CAS). One is the snow mountain research group based in Lijiang city near our project villages in Yunnan, the other is from the CCAP led by Dr. Linxiu Zhang, who has conducted a Global Environment Facility (GEF) Special Climate Change Fund Ecosystem Based Adaptation project since 2013. The CCAP project team is trying to link the IPCCA community assessment data with their macro-level scientific data to create a more complete picture to provide suggestions for climate change policy responses. This is a more recent and still emerging institutional innovation.

Traditional basic values and beliefs – such as sharing and exchange, balance and harmony – are the core factors behind the continuity of the local innovation and adaptation process, for both internal and joint innovations. These values ensure interaction, collaboration and sharing of knowledge, seeds and labour, as well as interaction with and maintenance of ecosystems and biodiversity, without which there would be little innovation. The individual innovators identified 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 and committed leader is the most important factor in starting the collective action and institutional innovation process.

## Technical innovations and coping strategies

Farmers in the study villages were found to have developed a range of technical innovations and coping strategies to combat drought and pests and improve soil quality, based on traditional knowledge and crop varieties.

### Enhanced drought tolerance through landraces, switching crops and PPB

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 value in the landraces of all these grains is their drought tolerance. In general, these landraces are more drought tolerant than introduced varieties, therefore, even when farmers are primarily growing hybrid or other varieties of these grains, they will still maintain the 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 their 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 will grow well during the dry winters when nothing else will, so they 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. They were able to continue growing them even during the extreme drought of 2010–12. Similarly, in Guangxi, most farmer-improved maize landraces survived the severe spring drought of 2010, while most of the hybrid maize varieties did not (see photo below).

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.

In addition to conserving landraces for overall drought tolerance, communities also select to provide a variety 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 and will still sprout and provide a good harvest. 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 reintroduced 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 they 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, with new technology introduced by CSA.

Communities in Guangxi have also developed a number of new maize varieties through participatory plant breeding (PPB), which combines local landraces and traditional knowledge with external varieties and knowledge in a joint innovation process with scientific partners. PPB is discussed in the section below on institutional innovations.

**Reintroduction of traditional practices for integrated pest management**

Spurred by market demand for healthier chemical-free food production, farmers are reintroducing previously-abandoned traditional farming techniques as a result of joint market innovations developed with CSA partners. For example, in Guangxi, farmers are bringing back traditional techniques of combining organic rice production with duck and fish production for natural pest control. This innovation process was started and led by a woman, Wei Yugui, who is a capable leader with urban working experience, giving her a perspective on the value of her traditional knowledge as well as networking links beyond the village. She leads a small women's group who are interested in organic rice farming and joined the project in 2006. When she heard about organic rice farming cases in Chengtang and Sancha villages through the PPB project, she immediately visited the two villages and brought back the technologies and tried organic rice herself the same year. The following year, in order to control insect pests, she discussed with the elders in the village and decided to bring back the traditional practice of duck-in-rice. Starting from the second year more and more women farmers followed her example. Now more than 65 households are growing organic rice in her village and all villagers have ducks for controlling insects and pests. This technology has even spread to the six neighbouring villages.

The reintroduction of traditional duck-in-rice farming is an internal innovation spurred by the farmers themselves. They are taking conserved rice 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 different varieties need to ripen at the same time 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, by Simon Lim, 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 the snout moth larva, have been increasing in recent years due to drought. Villages are experimenting with reintroducing 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 reintroducing traditional bio-pesticides using wild herbs and chilli pepper.

Farmers are also experimenting with new crops for natural pest control. As mentioned above, in Guangxi, 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.

**Reintroduction of traditional practices for 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, most project villages are bringing back formerly-abandoned traditional intercropping approaches of maize-soybean-pumpkin-sweet-potato production. This increases soil fertility through nitrogen fixation by the soybean, while also improving soil composition and integrity, which decreases erosion. Similarly, they have reintroduced traditional composting approaches and previously abandoned methods of applying fish waste as fertiliser on fields. These are spurred by soil erosion problems as well as CSA demands for chemical-free food production. PPB has also played a role in the revitalisation of traditional farming practices due to recognition of the value of traditional knowledge and landraces by scientists and the establishment of a platform and network for interaction with scientists and joint innovation.

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

As mentioned above, the Yunnan stone villages have reintroduced traditional walnut production for resilience to drought, and this is also partially for soil conservation. Facing drought, low labour availability due to out-migration to the cities and soil erosion problems, they have begun reintroducing walnut trees due to their usefulness for soil conservation, and their low-labour and low-water requirements. They are also a valuable cash crop.

## Institutional innovations

**Participatory plant breeding for enhanced resilience**

Participatory plant breeding (PPB) is an important institutional innovation, which has provided a supporting structure to all of the technical innovations discussed above. The PPB programme was initiated in 2000 to help poor farmers increase productivity in the harsh karst mountain areas with limited arable land, and to link the previously separate formal and informal seed systems for mutual benefit. This mechanism has been developed over the past 15 years in Guangxi for farmer-breeder collaboration on landrace conservation, seed selection and improvement, and crop breeding, and was then initiated in Yunnan in late 2012. Rather than working only on station, scientists from the formal breeding institutes work together with farmers in villages to identify farmers' interests and needs and the desired characteristics for breeding improved crops (such as drought tolerance). The CCAP facilitated the interaction between the scientists and farmers and the most important factor in starting the process was its capacity to create synergies. For example, allowing breeders to conduct experiments on station ensured buy in from them, while the farmers also learnt from it.

After 15 years of experimentation on farm and on station, 8 new maize PPB varieties (7 open-pollinated varieties and 1 hybrid) have been developed and released in the research villages and have spread very quickly beyond these villages. In addition, 20 farmer-preferred maize landraces and 15 rice landraces have been selected and improved by farmers in the villages with assistance from scientists. 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 developed by breeders alone.

Each step in the breeding process is designed jointly by farmers and breeders, using both traditional knowledge and science. Together, they develop community registers of local landraces, which also enhances formal recognition of farmers' rights to traditional varieties and knowledge. They then identify target landraces as well as other varieties from other geographic regions and the formal sector, and evaluate them for the desired characteristics for plant breeding. After jointly selecting the parent lines, they then collaborate in growing and breeding experiments in the research station and in farmers' fields, together developing improvements to existing varieties and growing techniques. Gradually more and more farmers have become involved in PPB – for example, in Guzhai community the work started with only 9 elderly women farmers and has now expanded to 63 people, mainly women (for further information about the PPB process see Song and Vernooy, 2010; Li *et al.*, 2012)

In general, maize landraces have become somewhat degenerated due to mixing between lines, as maize is open pollinated. Breeders work with farmers through the PPB mechanism to revitalise these landraces. For example, plant breeders taught the 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 been adopted by the project villages as a result of this collaboration.

The PPB collaboration process between breeders and farmers has led to the establishment of new collaborative ways of working for both scientists and farmers, which have become institutionalised in their working practices over time in Guangxi province. Plant breeders have benefited from PPB by gaining access to diverse landraces for plant breeding. Through the PPB process, they have gained new understanding of the importance of conserving genetic resources in the field and not only in gene banks, for evolution and co-evolution with farmers, and of the critical role of smallholder farmers in *in situ* conservation. The practice of PPB has become further institutionalised in Guangxi through the introduction of a provincial government budget for PPB which provides some funding for scientists (but not for community-level work).

Maize PPB experiment for landraces improvement led by farmers in Guzhai village, Guangxi, by Yiching Song, May 2012

Maize PPB variety, Zhong mo no 1 in a farmer's field in Wentang village, Guangxi, July 2012, by Yiching Song

**Access and benefit sharing for enhanced farmer income from PPB and landrace conservation**
Ultimately, the PPB programme aims to secure the formal recognition and protection of farmers' plant variety rights, including the collective rights of farming communities over varieties developed through the PPB process. As only formal breeders and not farmers can currently register new PPB varieties under China's seed law, SIFOR is exploring and experimenting with institutional innovations and tools for access to genetic resources and benefits sharing (ABS) both at the level of breeder-to-farmer and village-to-village interactions, to ensure that farmers are rewarded for the local landraces and traditional knowledge they contribute for developing new PPB varieties.

These ABS innovations include pilot ABS agreements between breeders and PPB villages, the revision of the national seed law to allow formal seed registration by farmers, and clarifying the origin of parent lines. The ABS agreements allow farmers to retain 100 per cent of revenues from the sale of PPB hybrid seed in local markets, in return for their contribution of local landraces and traditional knowledge for plant breeding. As a result of awareness gained through participation in the PPB process, the head of China's maize breeding programme recently proposed the revision to China's seed law to include protection of farmers' rights and seed systems, and this proposal has been accepted. These ABS-related innovations are contributing to the implementation of the Food and Agriculture Organization (FAO) Treaty on Plant Genetic Resources, which entered into force in 2004, although China has not yet signed it. The treaty requires benefit sharing in return for access to genetic resources and the protection of farmers' rights.

**Platforms for traditional seed and knowledge exchange for crop diversity, resilience and adaptation**

Alongside PPB, farmers in Guangxi have also started a platform for 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 women's seed fairs with the support of 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. As a result, the villages and farmers are able to increase their crop diversity and access 'new' varieties for resilience and adaptation.

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

**Women's groups and farmer co-operatives for landrace conservation and marketing**

Spurred by the CSA in Guangxi, village women have formed informal women's groups, supporting each other's efforts to conserve landraces and strengthening their communication and bonds. Gradually the groups have expanded to involve more people in each village and do more activities, and have grown into more organised and registered farmer co-operatives. This is a typical women's empowerment process for our working villages. It normally starts with a capable and committed woman leader in a village. Two concrete examples are Lu Rongyan from Guzhai Village and Wei Yugui from Nonlv Village, who reintroduced duck-in-rice farming as outlined in the previous section. Both are women leaders who have experienced the empowerment process, and as a result they have become more actively involved in village decision making and innovation.

## Market innovations

**Community-supported agriculture (CSA) to create market incentives for ecological and traditional farming**

Technical and institutional innovations are further supported by innovations in how the farmers interact with the market for their farm goods. In Guangxi in particular, but also more recently in Yunnan, farmers are finding new market channels for their goods through community-supported agriculture, notably urban farm-direct restaurants and farmers' markets. These market innovations were externally initiated but have been developed in collaboration with farmers. They provide crucial incentives for maintaining the PPB and CSA innovation processes, and have also led to a number of internal biocultural

innovations by the communities to reintroduce traditional ecological farming practices in response to market demand.

These efforts began in 2005, with the support of a local NGO in Guangxi, Farmers' Friend (爱农会). To date, they have 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 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 (e.g. no pesticides or chemical fertilisers, no processed feed). The NGO then placed orders with 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.


Organic circular farming linking to organic restaurants in Guangxi by Yiching Song, Feb, 2011

As a result of this new, high-value, stable market channel, farmers in participating villages have reintroduced traditional varieties of vegetables and breeds of animal that had gone locally extinct (heritage varieties of pigs, chickens, ducks, fish, vegetables and grains). For example, they have increased varieties of rice from 3 or 4 to 20 different landraces that are currently being tested. They are also reintroducing traditional planting techniques such as duck-fish-rice co-production, intercropping soy-maize-sweet-potato and applying bio-pesticides. Furthermore, they are using biogas 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 this new access to urban markets since late 2012 are taking place in Yunnan. The Kunming Farmers' Friend restaurant, which was established in 2011 and started working with CCAP in November, 2012, has started to order traditional walnuts, ham, wheat noodles and wheat alcohol. This has encouraged the rediscovery and further development of traditional crops like walnuts as well as traditional processing techniques such as ham curing and walnut oil production that have nearly disappeared entirely.

# Impact of the innovations on livelihoods, agrobiodiversity, social capital and innovation

The technical, institutional and market innovations discussed above, whether internally and externally initiated, have contributed to strengthened livelihoods, agrobiodiversity and social capital, thereby enhancing resilience to climate and socioeconomic change, and strengthening capacity for further innovation. The joint market and institutional innovations have spurred a number of internal TK-based innovations by communities.

**Agrobiodiversity** has been directly impacted through the externally initiated PPB and CSA innovations, with landrace conservation and continual improvement ensuring high agrobiodiversity, particularly in the PPB villages. The need for drought resistance, flexible planting times, and better pest control and soil management have all led farmers towards 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 of PPB, CSA and farmers' markets further support this internal innovation process by providing formal, outside recognition of traditional knowledge and landraces, support for conservation 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. The reintroduction of locally-extinct landraces, as well as new varieties to serve as cash crops or through the PPB and seed-sharing process, has significantly improved the agrobiodiversity of the villages. As farmer Lu Rongyan said during her interview, "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 local agrobiodiversity. This in turn supports greater climate resilience in the region, since the wider variety of crops allow farmers to maintain productive fields through unstable weather patterns.

These biocultural innovations have also had a direct **livelihood** impact because farmers were able to maintain, and in some cases even improve, productivity despite drought conditions (e.g. by using the diversity of varieties and crops in nearby fields for pest control), 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 Wei Yugui explained, "Our CSA-supported organic rice has a price of 3 to 4 times higher than regular rice. This has allowed us to triple our farm income." In maize production, incomes in PPB villages are 30 per cent higher than for non-PPB villages growing hybrid maize. 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-adding activities are only now being explored.

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 rely on for information about traditional landraces and growing techniques. The CSA has also supported stronger urban-rural links, spurring young college-educated interns to return 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 co-operatives to organise themselves and manage exchanges between rural and urban communities. In Guangxi, there are now five formally registered farmer co-operatives, which allow formal recognition and connection to greater market channels and supporting institutions. As the

Chengtang Village farmer co-operative 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, Guangxi, November 2011. By Rongyan Lu

# Policy environment and impacts on biocultural innovation processes

China has a long farming history and civilisation. Its agriculture is 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 adaption, evaluation and innovation, and has accumulated a very rich agricultural biodiversity and resilient bio-cultural 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 programs and projects and agricultural science and technology policies and programs. 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 on plant variety registration only recognise breeders' rights over high-yielding hybrid seeds, provide subsidies for the production and distribution of only hybrid seeds, and subsidises inputs such as fertilisers and machinery. These policies do not protect the rights of smallholder farmers over the landraces they have domesticated, improved and conserved, or support their local seed systems, and have negative impacts on farmers' informal seed systems. On the other end, 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 crops and varieties. As a result the genetic basis for future plant breeding in China is becoming increasingly narrow.

However, in recent years, the state had developed an overall new strategic goal of 'ecological civilisation'. Under this, some supportive policies and programmes supporting circular farming and ecological agriculture 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 their innovation processes. The public in China are 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 formal 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 Farmer Seed Network in China, a multi-stakeholder platform which also involves the MOA and the Ministry of Environment.

# Conclusion

Despite considerable socioeconomic challenges in southwest China, and despite climate change further exacerbating these challenges, farming communities are finding coping strategies through the technical, institutional and market innovations discussed in this study, notably PPB and CSA.

Communities are conserving and continually improving drought-tolerant landraces of maize, wheat and rice, and selecting varieties for a diversity of planting times. We have observed how farmers switch crops and change cropping patterns to remain resilient in the face of drought. Spurred by market demand for healthier chemical-free food production, farmers are reintroducing previously abandoned traditional farming techniques and crops, as well as experimenting with new crops, for soil conservation and natural pest control. An important supporting mechanism for these technical innovations is the participatory plant breeding (PPB) mechanism for farmer-breeder collaboration on landrace conservation, seed selection, and improvement and breeding, as well as the farmer seed and traditional knowledge exchanges. Finally, farmers are connecting with urban areas in news ways, finding new market channels for their goods through community-supported agriculture (CSA), notably urban farm-direct restaurants and farmers' markets.

These innovations all contribute to greater climate resilience for the individuals and communities in this study. This greater resilience stems from strengthened livelihoods, agrobiodiversity and social capital. Our research suggests that innovations starting within the villages – internal innovations based on traditional knowledge and biocultural heritage – are the basis for climate resilience. These are then strengthened through external recognition and support, through for example, PPB or CSA. These spur further external or joint innovations and further internal innovations. Therefore, we argue that efforts to support climate resilience in these communities should prioritise strengthening their biocultural heritage, as well as partnerships for PPB and CSA.

The SIFOR project is working on all levels to support these efforts. At the village level, we are documenting traditional landraces as well as traditional processing methods. For example, in Yunnan, 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 the chemical salts now routinely used and traditional alcohol fermentation processes which rely on herbal fermentation techniques. SIFOR is documenting these and plans to conduct training for households wishing to revitalise these traditional processing approaches. Externally, we are also supporting research into market channels for some traditional crops, and planning training for farmers in certain value-adding processes. These include 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 (Yunnan).

The SIFOR team is also directly involved in the National Farmer Seed Network and advocating for a strong, clear policy environment supporting internal and joint biocultural innovations for climate resilience, including reform of the national seed law to protect farmers' rights and seed systems. The Farmer Seed Network submitted suggestions to protect farmers' interests and biodiversity in 2014, but these were not taken up as the network is not a formal policy actor. However, one of its suggestions was formally accepted when a leading maize scientist in China, a key PPB partner, proposed them a second time. As a result, a key provision to allow farmers to save, exchange and sell their own seed, which had been removed from the seed law during its revision, has been re-inserted.

The communities' internal innovation process tends to stop at technical innovations. More support is needed to enhance the internal institutional and market innovations of the communities, ultimately working towards a community-led systematic collective innovation process. Likewise, for the joint innovation processes, the existing PPB and CSA activities need to be continually improved towards a fair, mutually supportive, complementary and self-sustaining innovation process, and ultimately for these activities to be scaled up and brought into the mainstream, which will require further funding.

Finally, external support and enabling policies for combining traditional knowledge with the formal scientific knowledge bodies and market linkages are crucial for enhancing internal innovation for a joint innovation process. Recognition of the community biocultural innovation system and its complementary role to science, and a collective spirit, are critical for the continuity of the innovation process. Market innovation for adding value and institutional innovation to link communities with enterprises and public research institutes for a fair system of access and benefit sharing, provide important incentives to maintain the innovation process. Traditional cultural values and beliefs that promote the use of traditional knowledge and crops are also critical for the continuity of internal and joint innovation processes. The new National Farmer Seed Network in China – which brings together farmers from several provinces, north and south, to exchange knowledge and seeds and dialogue with policy makers and scientists each year – needs to be further strengthened to support the scaling up of PPB and enhance farmer networking. It can provide a 'living seed lab' for legal and policy pilot studies and information-sharing between different stakeholders to enhance support for biocultural innovation systems of remote communities in Southwest China for food security and resilience to climate change.

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SIFOR (Smallholder Innovation for Resilience) is an action-research project working with indigenous and local communities in China, India, Kenya and Peru, coordinated by the International Institute for Environment and Development (IIED). It aims to revitalise traditional knowledge, crops and innovation systems for food security in the face of climate change.

This report presents the findings of a qualitative baseline study conducted in 18 ethnic minority villages in Guangxi and Yunnan provinces, southwest China. The study explored the farming systems and changes that have occurred in the last 30 years, the innovations developed in response to these changes by farmers alone and jointly with scientists, and the social factors that support traditional knowledge-based innovation.

Project materials

**Food and Agriculture**

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