

SEEDS AND SYNERGIES

Innovating Rural Development in China

Edited by Song Yiching and Ronnie Verwooy



Seeds and Synergies

Praise for this book...

'The challenge of improving food security and reducing poverty by exploiting crop genetic potential is more complex than entailed in Green Revolution strategies of developing and distributing 'improved' varieties. This book explores the potentials of existing varieties and the operational context of local farmer participation, farmer interactions with state-sponsored research and extension, and achieving rural empowerment for broader transformations. The many connections that 'seeds' have or can lead to for improving rural livelihoods and quality of life are fascinating and worth in-depth examination.'

Norman Uphoff, former director of the Cornell International Institute for Food, Agriculture, and Development, Cornell University

'*Seeds and Synergies* presents inspiring evidence of change in practice and policy in the governance of seed systems and the conservation of agrobiodiversity. Policy makers and plant breeders should read this!'

Janice Jiggins, Professor and guest researcher, Communication and Innovation Studies, Wageningen University Research Centre, Netherlands

Seeds and Synergies

Innovation in rural development in China

Edited by Song Yiching and Ronnie Verwooy



International Development Research Centre
Ottawa • Cairo • Dakar • Montevideo • Nairobi • New Delhi • Singapore

Practical Action Publishing Ltd
Schumacher Centre for Technology and Development
Bourton on Dunsmore, Rugby,
Warwickshire CV23 9QZ, UK
www.practicalactionpublishing.org
ISBN 978 1 85339 705 9

and the International Development Research Centre
P.O. Box 8500, Ottawa, ON, Canada K1G 3H9
www.idrc.ca/info@idrc.ca
ISBN (e-book) 978 1 55250 485 7

© International Development Research Centre, 2010

All rights reserved. No part of this publication may be reprinted or reproduced or utilized in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without the written permission of the publishers.

A catalogue record for this book is available from the British Library.

The contributors have asserted their rights under the Copyright Designs and Patents Act 1988 to be identified as authors of their respective contributions.

Since 1974, Practical Action Publishing (formerly Intermediate Technology Publications and ITDG Publishing) has published and disseminated books and information in support of international development work throughout the world. Practical Action Publishing is a trading name of Practical Action Publishing Ltd (Company Reg. No. 1159018), the wholly owned publishing company of Practical Action. Practical Action Publishing trades only in support of its parent charity objectives and any profits are covenanted back to Practical Action (Charity Reg. No. 247257, Group VAT Registration No. 880 9924 76).

Cover photo: Farmers and formal sector breeders learn from each other.

Credit: IDRC, Ronnie Vernooy

Cover design by Practical Action Publishing

Indexed by Andrea Palmer

Typeset by S.J.I. Services, New Delhi

Printed by Replika Press Pvt. Ltd.

Contents

Figures	vii
Tables	vii
Boxes	viii
Foreword	ix
<i>Huang Jikun</i>	
Preface	xiii
<i>Ronnie Vernooy and Song Yiching</i>	
Acknowledgements	xvii
1. Searching for synergy	1
<i>Song Yiching and Ronnie Vernooy</i>	
2. Maize and the formal agricultural research and development system: evolution, challenges and alternatives	13
<i>Zhang Shihuang, Huang Kaijian and Song Yiching</i>	
3. Farmers' changing livelihood strategies in rural Guangxi	29
<i>Song Yiching, Wang Xiufen, Li Jingsong and Ronnie Vernooy</i>	
4. Seeds of inspiration: breathing new life into the formal agricultural research and development system	47
<i>Song Yiching, Zhang Shihuang, Huang Kaijian, Qin Lanqiu, Li Jingsong and Ronnie Vernooy, with the collaboration of farmer plant breeders from Wentan, Guzhai and Gushang villages and Dujie township</i>	
5. Farmer cooperation and organization: new challenges, new networks, new identities	65
<i>Yang Huan, with Gao Xiaowei and Li Jingsong</i>	
6. Opening our eyes: renewing the Chinese public extension system	85
<i>Zhang Li, with Luo Haichun, Huang Bailing and Pan Qunying</i>	
7. Changing rural development in China	113
<i>Ronnie Vernooy and Song Yiching</i>	
References	123
Index	131

This page intentionally left blank

Figures

1. The two major maize-growing regions	14
2. Organizations involved in agricultural research at the national level	20
3. Organizations involved in agricultural research at the provincial level	20
4. Increases in maize yields in China, 1950–1995	23
5. Maize yields of hybrids only, 1995–2007	23
6. Breeding process for three open-pollinated (OPV) varieties	55
7. Breeding process for Guinuo, 2006	56
8. Mutual help network for sugar cane production in Wentan, 1987–1995	74
9. Participatory action research spiral	90

Tables

1. Number and extent of maize varieties grown in Guangxi by type and period	17
2. Dominant maize hybrid varieties and inbred lines used in China	18
3. Top five hybrid varieties and inbred lines used in Guangxi in 2007	18
4. Number of maize varieties developed (Dev) and disseminated (Diss) in China, 1954–2002	22
5. Number of maize varieties developed (Dev) and disseminated (Diss) and crop area in Guangxi, 1954–2002	22
6. Average per capita income (CNY) in selected villages in five counties in Guangxi , 1995–2007	36
7. Variation in household incomes in the study villages, 2007	36
8. Changes in source of income in the study villages, 1995–2007	37
9. Sex and age of de facto farmers in study villages	37
10. Distribution of land in Wentan village	39
11. Livelihood strategies of various household types in Wentan	41

12. Comparison of variety selection criteria used by women and men farmers in trial villages	54
13. Activities carried out by farmers' organizations at the project sites	71
14. Farmers' channels of access to rice varieties	73
15. Cooperation among farmers in the use of labour	73
16. Sources of Mashan farmers' income	95

Boxes

1. Some technical terms	15
2. The experience with Tuxpeño 1 in south-west China	25
3. The limitations of conventional plant breeding research	48
4. Challenges in China's extension system	86
5. Example of a PM&E visit	94
6. Main activities of the Guzhai Community Development Committee in 2006	99

Foreword

The re-emergence of China as an important global actor is one of the miracle growth stories of the last part of the 20th century and the early part of the 21st century. Since 1980, China's economy has been the fastest growing in the world. Poverty has decreased. In the past 30 years, more than 230 million Chinese rural residents have risen above the country's official poverty line. Moreover, the general welfare of most of the population has improved markedly. In fact, by the end of 2007, China had achieved many of its millennium development goals.

China's rapid economic growth would not have been possible without the successes achieved in the agricultural sector. Its growth of nearly 5 per cent a year has played a key role in the nation's transition from an economy dominated by the agriculture sector to one in which the industrial and service sectors have achieved dominance. The growth in agricultural productivity enabled China to 'release' its large pool of abundant rural labour, providing cheap labour for industrialization.

However, although past accomplishments in both agriculture and the rest of the economy are impressive, great challenges still lie ahead for China's rural development. Income disparity, for example, rose with economic growth. There are significant differences in income among regions, between urban and rural zones and among households at the same location. Despite the significant decline in poverty, the World Bank estimated that in 2004 about 27 per cent of China's population (or 350 million people) were still living at or below the 1.25 US\$/day level (in terms of purchasing power parity). Of these, 99 per cent live in rural areas. Poverty remains persistent in many western and south-western provinces (such as Guangxi) and particularly in remote rural areas.

Technology change has been a major engine driving China's agricultural growth. However, new challenges have recently emerged. China's agricultural research, dominated by a public research and development system, is becoming less responsive to farmers' demands for novel technology. The agricultural extension system has been in crisis for some time. Farmers, mainly women and the elderly, in many remote areas are still facing difficulties in gaining access to information technology and markets. The achievements in agricultural growth have been made at a high cost to the environment and to agrarian biodiversity, which is being eroded all over the country. Farm incomes are now under pressure, in part because of degradation of the resource base.

Chinese leaders recognize that policy reform, especially agricultural and rural policy, has a vital role in the success of sustained agricultural and rural development. The national development goals articulated in 'Five Balanced

Development Strategies' are ambitious and a number of the proposed strategies and reforms are bold. However, national leaders also realize that many barriers prevent them from achieving these lofty goals. In some cases, factors that contributed to the success of China's economy in the past have become obstacles that hinder pursuit of the nation's future development goals. The goals are ambitious and the problems are complicated. So, the government has called for the development of new ideas and innovative policies to move China's economy toward rapid and harmonious change.

The Center for Chinese Agricultural Policy (CCAP) is dedicated to policy studies and aims to generate new ideas and innovative policies for China's agriculture and rural economy. It has four major policy research programmes: Agricultural Science and Technology, Natural Resources and Environmental, Integrated Rural and Urban Development and Poverty Alleviation and Agricultural Commodity Policy Analysis and Decision Support Systems.

CCAP's participatory plant breeding initiative in Guangxi, which is highlighted in this book, is one of the most innovative in its portfolio. Participatory plant breeding (PPB) is based on multiple disciplines and involves nearly all four of CCAP's research programmes. It has brought together a group of brave 'action researchers', including plant breeders, extensionists, farmers and policy researchers from the national level to the village level. Following the participatory action research approach, they have explored and experimented with ways and mechanisms to address the issues of poverty and biodiversity and overcome the institutional obstacles in public research and extension in five counties of Guangxi. They have now spent 10 years working and learning by doing, through action and experiments together with farmers and other related stakeholders, to bring innovation to rural development in China.

The Guangxi participatory action research initiative has brought many changes and new ideas to rural development. The Guangxi team's self-evaluation (in 2008) shows that it has greatly strengthened the capacity of farmers (women and men), significantly enhanced biodiversity and increased farmers' maize yield and income in the trial villages. More importantly, in collaboration with related policy institutions such as the Ministry of Agriculture, the Chinese Academy of Agricultural Sciences (CAAS) and the State Environmental Protection Agency, among others responsible for the implementation of the Convention on Biodiversity in China, the project has explored and experimented with a number of innovative institutional mechanisms and regulations. For example, some methods and mechanisms for PPB and participatory extension have been tested by the Guangxi team and other colleagues and are now being applied by the Ministry of Agriculture and CAAS in other provinces. Recently, the team also explored novel ways to improve farmers' livelihoods through innovative ways of organizing by, for example, taking collective action in marketing organic produce and improved seed varieties (see Chapter 5 for details).

This book addresses agricultural and rural development in several dimensions. It also deals with some under-researched, underestimated and neglected issues. For example, the authors argue that a cooperative and complementary

relationship between farmers (with their ways of organizing the key features of rural life) and the world of formal rural development policy making and the national agricultural research system is urgently needed to address the challenges in food security, livelihood well-being, sustainable natural resource management and biodiversity conservation facing China as a whole and Guangxi in particular. They also show that decentralization of the formal research and development system (including the seed system) and meaningful involvement of women and men farmers in the design, development and implementation of innovation processes are essential to stimulate collaboration and the creation of much-needed synergies.

I certainly hope that the information in this book will be fully used by scholars who are interested in rural development.

I thank Dr Ronnie Verwoerd and Dr Song Yiching, as well as their team, for the intensive research they have carried out. I would also like to express appreciation to the International Development Research Centre for funding this initiative.

Huang Jikun

Director

Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing

May 2009

This page intentionally left blank

Preface

Back in 1999, when we first talked (by email) about starting a participatory action research (PAR) process around ‘seeds’ in Guangxi province, we had no idea that 10 years later we would still be cooperating in this work. Life is indeed full of pleasant surprises.

In 1999, Ronnie visited China for the first time, not to meet with Yiching (we would not meet until 2001), but to visit International Development Research Centre (IDRC) research partners in Yunnan and Guizhou, both neighbouring provinces of Guangxi in China’s mountainous and beautiful south-west. Thus, this year, 2009, is special in several ways: 10 years of co-operation between the IDRC and the Center for Chinese Agricultural Policy (CCAP) (where Yiching is based) and its partners, and 10 years of fruitful working in and learning about China for Ronnie.

Sharing a common university background and influence – Wageningen University in the Netherlands with its strong emphasis on social-actor-oriented approaches to rural development studies, doing fieldwork, putting research results to good use – and sharing an interest in working closely with men and women farmers, focusing on issues such as crop improvement, farmer organization and rural development policies, it was not hard to find common ground. We did not have to convince each other, but there were many others who had to be convinced to try out a novel and, in many ways, transformative way of doing research.

Luckily, from early on, we found others interested in supporting our ideas. Among them, was Hein Mallee, who was then a programme officer at the Ford Foundation in Beijing. Now, Hein is working at IDRC’s regional office for South-east Asia in Singapore and continues to be supportive of the work we started together in Guangxi a decade ago.

We set out on our journey with only a few committed people, beginning with a number of valiant Guangxi farmers (most of them women) with whom Yiching had been working in the 1990s. A number of plant breeders at the Guangxi Maize Research Institute joined us as well, as did a few brave agents from extension stations at the township level. Together, we designed a way to introduce and test participatory plant breeding (PPB), a first in all of China.

Although enthusiasm in the field was strong, the same could not be said of the upper levels of some key organizations with whom we intended to cooperate; there, views about participatory action research (PAR) were mixed. We are forever grateful to CCAP’s senior management, for whom PAR was also new, as they gave us room to experiment with this new approach and the opportunity to demonstrate that it could work in China.

How many people does it take to bring about significant change in the Chinese agricultural research and development system, which is probably the biggest in the world? What kinds of people does it take? What are good entry points? What has been tried in the past? How long does it take? Are there certain conditions that make it easier? Does it require policy analysis and advocacy or will local-level field research suffice? We had many big questions and no examples from the field of Chinese crop improvement and agricultural biodiversity conservation to learn from. It was like jumping into cold water and learning to swim by doing, moving arms and legs at the same time. But we were not afraid. ‘Let us start,’ Yiching said, ‘then, things will move.’ How right she was! Things did move – beyond our imagination.

In 10 years, China has changed dramatically. We have been able to read about it in western newspapers almost daily. The Chinese government’s ‘opening up’ policy has stimulated an enormous amount of creativity. Not that opening up has meant total freedom, but it has encouraged change and opened the door to novel ways of doing things, including introducing PAR and PPB. Although changes have been most visible in cities and in the eastern, more developed part of the country, rural areas have been affected as well. Most notably, the social fabric of villages and townships has been dramatically altered. Men and young women have migrated to cities in large numbers. Many rural areas are now left to young children, the elderly and women. The meaning of family is changing: middle-aged wives live without their husbands, young children live on their own without their parents. These young people, their grandparents and women who are too old to migrate and find work in the cities or in the booming assembly plants are today’s Chinese farmers.

The government is building new roads into rural areas. Migrant workers send money back to rural communities and many new farmhouses are under construction. Small farmhouses are now becoming two-, three-, or even four-storey homes. But many construction projects are unfinished; more money is needed to install windows and doors, to paint walls, let alone to decorate the many new rooms being added. Dreams are colourful but realities are hard.

In this rapidly and dramatically changing context, we set out to revive maize production as an entry point to lead towards renewing the local, provincial and national agricultural research and development system. We hoped to be able to create synergies between the various actors involved in maize production, break down organizational and institutional barriers and overcome ingrained prejudices about farmers’ knowledge and skills, farmers’ capacities to learn and innovate and farmers’ voices and choices concerning their own future and that of China at large. We started with maize, but the PAR process steered us into addressing rural livelihood issues more broadly. Farmers face so many problems. Over time, we learned that solving maize problems alone is not sufficient. Thus, we allowed the research agenda to evolve, adding other key elements, such as the provision of credit, extension services, questions about access to and sharing the benefits of genetic resources and, above all, farmers’ organization.

It has been a long and arduous journey, with many obstacles and setbacks. Bringing about change is never easy, especially in a country so vast, with so many people and with a history such as China's. But we believe that we succeeded in changing something. In this book, we present our experiences to share them with others and to show that change is possible. Change *is* possible if there is a shared vision, a shared commitment to act and learn and enough time to build new relationships, try out new things, critically review them and adjust our actions along the way. Positive change is helped by an enabling policy and institutional environment, but such an environment by itself is not sufficient to bring about change. It takes courageous people with both feet on the ground to join forces and rebuild social relationships, both horizontally (e.g., between farmers and farmer communities) and vertically (between farmer communities and 'outsiders' from government, academia, non-governmental organizations and international donor agencies). In this book, we tell the story of 10 years of efforts to change things and the results.

We do not know what the future will look like 10 years from now. But we do know that change is possible. Ten years ago we were not quite sure. But now we are. The friendship that we have built along the way has been an unexpected outcome. We are convinced that without it, our results would have been less significant.

Ronnie Verhooy and Song Yiching
May 2009
Ottawa and Beijing

This page intentionally left blank

Acknowledgements

It takes many factors to make a maize seed grow and bear fruit. The soil and environment around the seed need to be fertile. The weather must be conducive. Other seeds and seedlings growing up nearby will allow for possible productive cross-fertilization. Attention and care during growth will have a nurturing effect. Experimentation could overcome constraints or explore new avenues.

Our action research efforts in Guangxi province in south-west China would not have been possible without all these factors giving us a helping hand. First, we would like to thank the unconditional commitment and cooperation of hundreds of women and men farmers who embarked with us on this long journey to improve maize and maize-based livelihoods. Their curiosity and courage, their arduous work in the field, and their melodious and often humorous singing and dancing showed us the way. Farmers are building and sustaining the new China, be it in the rural areas as agricultural producers, processors and vendors, or in the urban areas where they work part time as construction or factory workers or service providers. Or, in fact, as multi-faceted practitioners giving new shape to Chinese society everywhere.

We have been lucky to have encountered on our way several other brave travellers. They include the so-called grassroots extension agents who, tired of the old and moribund national extension system, decided to join forces with us and try out a number of new ways of working together with and serving poor and marginalized farmers. Numbering only a few in the beginning, they nonetheless served as examples to convince higher ranking officials in the national extension system to support a systematic attempt to reform China's agricultural extension system based on the day-to-day experiences of the grassroots reformers.

Other travellers are the maize breeders from the Guangxi Maize Research Institute in Nanning and the Institute of Crop Science of Chinese Academy of Agricultural Science in Beijing. Although sceptical at the beginning about farmers' capability to improve maize varieties and farmers' knowledge and skills more broadly, they opened their hearts and minds leading to a fruitful cooperation between professional breeders and farmer breeders. It is this story of cooperation and the creation of synergy that is at the centre of this book.

After several years of experimenting at the local level, we (farmers, grassroots extensionists, researchers) felt confident enough to communicate with key decision-makers in government and academia. It took courage and time to do so. In China, high-level decision-makers have a lot of prestige and also a very particular way of getting things done: top-down, with no or little voice

from 'down'. We thank colleagues at the Ministry of Agriculture, the National Agricultural Technology Extension Center, the Ministry of Environmental Protection, the Chinese Academy of Sciences and the Chinese Academy of Agricultural Sciences, and China Agricultural University for their trust in us and our efforts, and for their willingness to join us and see for themselves.

A number of PhD and Masters students joined the team for various periods of time to learn from the field. Wang Xiufen, Yang Huan, Zhang Li, Gao Xiaowei, and Jingsong Li joined us as contributors to this book, documenting and reflecting on their in-depth field work experiences in which they learned, for the first time, about the everyday lives and struggles of poor farmers.

The Center for Chinese Agricultural Policy (CCAP), as host of our efforts, has made our work possible and provided us continuous support throughout the years. We would like to express thanks to all CCAP staff and in particular to Dr Huang Jikun (Director) and Dr Zhang Linxiu (Deputy Director).

The Ford Foundation in Beijing and the International Development Research Center (IDRC) in Ottawa provided financial and technical support. IDRC continues to support our work in Guangxi, as well as our new efforts in neighbouring Guizhou and Yunnan provinces. IDRC also made this publication possible. We would like to thank Bill Carman for his dedication to publishing innovative work from around the world, including Guangxi Province.

Sandra Garland helped to make the whole text easily readable.

Song Yiching and Ronnie Verwooy

CHAPTER 1

Searching for synergy

Song Yiching and Ronnie Verwoerd

The many faces of Chinese development

CHINA IS UNDERGOING RAPID CHANGE – easily observed in many parts of the country, most spectacularly in the cities, which are growing rapidly. The country's economic growth has been and continues to be impressive, but poverty remains persistent in many rural areas including Guangxi province, the focus of attention in this book. The changes are not lived and felt in the same way by all people across the vast country. Some are making impressive gains and managing to improve their livelihoods rapidly. Others, those farther away from the centres of economic and political power and activity, are finding it difficult to keep up.

Divergence between those who have and prosper and those who do not have and do not gain seems to be increasing. The fancy skyscrapers, luxury cars and expensive restaurants of Beijing, Shanghai and, increasingly, of provincial capitals and other major urban centres, stand in sharp contrast to the poor dwellings, dirt roads and hungry mouths found in thousands of villages in the north, west and south-west of China. Contrasts are becoming more pronounced and, as a result, tensions are increasing all over the country. (Note: To read how a 13-year-old farm girl experiences the many hardships of rural life, speaking for many rural youngsters, see the gripping journal of Ma Yan from Ningxia province (Ma Yan and Haski, 2003).)

Many rural areas and communities, although not untouched by the pace of change, seem to be struggling to respond, adjust, or take advantage of the new dynamics. Millions of rural people continue to face poverty, often severe, and this poverty is profoundly differentiated socially. In many regions, women in particular endure hardships or are experiencing increased burdens, partly explained by the dramatic feminization of agriculture. Men leave to look for work elsewhere, leaving women to play an increasingly dominant role in food production and to take responsibility for post-harvest operations, seed selection and storage, as well as food processing. Traveling through rural Guangxi (and many other provinces), one observes women just about everywhere – in fields, along paths and roads, at the markets and in shops. After a while, the realization dawns that men are absent and one begins to wonder how women are experiencing, shaping and reshaping this new reality.

However, the fact of women's significant and increasing role in rural life is seldom noted among the key decision makers (mostly living in towns and

2 SEEDS AND SYNERGIES

cities) who deal with rural development issues, including health, education, service provision, market regulation (prices and subsidies) and wages. Women's specific needs, interests and expertise are also largely neglected in technology design, development and diffusion processes, e.g., the development of new varieties and alternative agronomic practices. Most policies are inadequate or do not address the important gender and social differences that exist in the countryside. Most research, including social science research, largely overlooks the question of how women and men, rich and poor, young and old, are dealing with the changes the country is undergoing. The politically charged questions of who gains, who loses and why are mostly overlooked or unanswered.

The Chinese government is trying hard, but rural realities seem to be running ahead constantly. Policy makers are finding it difficult to keep up, let alone design forward-looking policies.

This book

This book aims to address some of these under-researched, underestimated, or neglected issues. We argue that a cooperative and complementary relationship between poor farmers and *their ways* of organizing the key features of rural life – and the world of formal rural development policy making and the national agricultural research system – is urgently needed to address the challenges of food security, well-being, sustainable natural resource management and biodiversity conservation facing China as a whole and Guangxi in particular. Such a relationship would stand in sharp contrast with the current situation of either no connection or antagonism and conflict.

Decentralization of the formal system and meaningful involvement of women and men farmers in the design, development and implementation of processes for innovation are essential to stimulate collaboration and the creation of much-needed synergies between the two systems. Of course, this is easier said than done. It requires vision and courage, effort and time and persistence.

Concerning the world of seeds and agricultural production as a whole, the small-farmer sector needs to know more about modern plant breeding, while plant breeders need to learn about poor farmers' farming systems and their livelihoods. Farmers' knowledge of landraces and their understanding of the micro-variations in the environment are a sound basis for local-level plant breeding. Through participation with farmers, plant breeders and other scientists in the formal system gain new insights into criteria, objectives and evaluation techniques used by farmers, as well as the differences between regions. (For examples from around the world, see Vernooy, 2003; Almekinders and Hardon, 2006.)

In this book, we describe and reflect on the efforts of several groups of women farmers, a number of rural villages, township extension stations, two formal plant breeding organizations in the Chinese national agricultural research system and the Center of Chinese Agriculture Policy (CCAP) to change

things through a sustained, action-oriented, participatory research effort. This experience illustrates the successes and challenges of linking community-based action research with policy making processes by increasing efforts to engage key decision makers in the rural development policy arena at local, provincial and national levels. It shows that change can be achieved, but that it takes time and energy; in other words, the make-ability or changeability of society is not without constraints and limits.

The book highlights how field experiments (to improve maize and, later, other crops) have proved to be effective in strengthening interaction, communication and collaboration among stakeholders. These experiments have also strengthened the local-level organizational and decision-making capacity of farmers, far beyond the maize fields and varieties used for the experiments. Among the formal plant breeders involved in the research, there has been an impressive change in attitude – the needs and interests of farmers are now considered and included in the breeding plan and research priorities of the institutions. And farmers' efforts and knowledge of genetic biodiversity management are increasingly recognized by policy makers at both provincial and national levels. However, these changes did not come about overnight.

Many women are at the forefront of this work: farmers, extension agents and researchers. They were enthusiastic right from the beginning and have been active thinkers and doers during the whole process. Some men were initially surprised by the extent of women's involvement, but most came to accept it. The research process has served as a catalyst for change among most of those involved, especially the farmers and not only women farmers. The joint research efforts have strengthened the social fabric of local relations and those beyond the local. They have also created a framework for addressing issues and talking openly and face to face with policy makers and other decision makers. Farmers and extension agents have travelled to Nanning and Beijing to speak out to officials. They have started to ask the government to do things differently; they are no longer content to be the last 'bucket' into which government resources and orders are deposited.

Based on almost 10 years of participatory action research in China, this book also presents some reflections on the Chinese practice and theory of rural development. Although our work and thinking has been inspired by non-Chinese scholars, such as Norman Long and Niels Röling, our interest has always been to find ways to localize ideas, concepts, methods and practices. Just as we are trying to create synergies in the area of everyday rural life, we wish to create synergies at the level of academic performance.

Our approach

In most countries, most crop research and extension work continues to be guided by on-station experimentation. This is nearly always carried out under favourable environmental conditions and experiments are designed and executed by plant breeders or agronomists. Increased yield is the main and often

4 SEEDS AND SYNERGIES

single variable used to measure the value of a crop variety. Following a series of on-station testing cycles, improved varieties are then released to extension agents who channel them to farmers. The new, so-called ‘modern’ varieties are promoted in lieu of local varieties and often require the use of prescribed inputs, such as fertilizer and pesticides. Underlying this still-dominant research and extension practice, although at times more implicit than explicit, are a number of important notions about how science and society operate: positivism, centralization and reductionism.

Conventional crop research is strongly positivist in nature. A logical positivist or empiricist research paradigm seeks the accumulation of objective knowledge through the production of empirically testable hypotheses. This paradigm is mirrored in a so-called reproductive learning perspective (Van der Veen, 2000) that assumes that there is a body of objectively verifiable knowledge and that it can be taught by breaking down content into its essential elements. However, alternatives exist. A social constructionist paradigm opposes such a view and sees the role of science as the creation of concepts or theories that expand flexibility and choice (Röling, 2002). This view postulates that all social action is open to multiple interpretations, none of which is superior in any objective sense.

Thus, social constructionist learning assumes that important features of the external world are uncertain and disputed and that people actively construct their understanding of it. Rediscovery and innovation, not repetition, are essential parts of this construction process. During its practice, researchers and development workers often assume roles as facilitators, rather than instructors. They encourage work in groups and shared planning, action and reflection.

A social constructivist perspective can also be informed by transformative learning (Mezirow et al., 2000), in which learners together build a more integrated or inclusive perspective of the world. Through the learning process, they jointly transform some part of their worldview, for example, their understanding of social relations in their own community. Such transformation is often stimulated by communicative learning, but goes beyond it, in terms of internalization and transformation of understanding. Manifestations of transformative learning in natural resource management include, for example, new values or patterns of decision making that farmers generate and apply outside the immediate arena of the learning intervention (Vernooy and McDougall 2003).

In most countries, conventional crop research is largely centralized. Key research decisions are made at the top of the organizational hierarchy: which crops to focus on, which researchers to fund, which methods to use. Experiments take place at one or a few experimental stations. Variety release requires approval from a central body and regulations are defined centrally. This practice is characterized by top-down decision making and information flow. Farmers or others interested in crop development have no say in the process, nor are they able to provide meaningful feedback on the results. The research

process is very much inward oriented and disconnected from the diverse and often rapidly changing environment.

Reductionist thinking influences conventional crop improvement most notably in two ways. First, reductionist measurement fails to take into account the multiple and interrelated variables that farmers use to judge the value of a crop and cropping system. DeGrassi and Rosset (2003: 40–43) make the point that farmers' variables are often, if not always, site and season specific (embedded in particular genotype–environment variations), informed by social variables such as gender, class and ethnicity and influenced by socioeconomic factors, such as access to markets, credit, research and extension.

Second, conventional crop research disregards local biodiversity or, at best, considers it instrumentally – as inputs for breeding – and as best maintained *ex situ* in the proximity of the breeding station. It neglects the importance of biodiversity at the landscape and agro-ecological levels. As Scott (1998: 353) has argued, diversity has many advantages:

Old-growth forests, poly-cropping and agriculture with open-pollinated landraces *may* not be as productive, in the short run, as single-species forests and fields or identical hybrids. But they are demonstrably more stable, self-sufficient and less vulnerable to epidemics and environmental stress, needing far less in the way of external infusions to keep them on track.

Lessen agro-biodiversity and you weaken the resilience of the system and its capacity to deal with change. When this happens, communities face more limited options in managing their land and resources. The end result is that opportunities for the creation and re-creation of farmer knowledge and experimentation – the very processes that are essential for agro-biodiversity conservation, evolution and improvement – are lost. This relation between social and biological diversity is often overlooked.

We argue that a new approach to agricultural development research is needed to conserve agricultural diversity, improve crops and produce good-quality food for all (Verwooy and Song 2004). Such an approach should enable small farmers – women and men – on marginal lands to participate in research as equal partners alongside the agricultural scientists, sharing their know-how, expertise and seeds. This will require fundamental changes in agricultural and related policies as well as legislation (see, for example, Crucible Group, 1994, 2000a, 2000b; Halewood et al., 2007; Verwooy et al., 2009).

Such an approach focuses on practice, but is not theory-less or theory-poor, as we hope to demonstrate. Practising participation does not and should not take place in a void. In China, it is embedded in complex (and often complicated) socioeconomic and sociopolitical realities of long duration. We hope this book contributes to a better understanding of what participation means in practice, how it is informed by theory and how, in turn, it could usefully inform the further development of theory. This is another example of the challenging endeavour of creating synergies.

Through our case study, we illustrate how farmers and plant breeders are working together in diverse agro-ecological, socioeconomic and political contexts to put this new approach into practice. These innovators are contributing to the development of a research paradigm and practice that has as cornerstones social constructionism, decentralization, participation and a holistic perspective. We demonstrate that through strong collaborative and sound participatory methods involving researchers, farmers, extension agents and government staff *both* productivity and diversity can be enhanced while, at the same time, research management and organizational capacities are strengthened. Other examples of how this new research practice and paradigm is evolving around the world can be found in a number of recent related studies: Brush, 2000; Friis-Hansen and Sthapit, 2000; CIP-UPWARD, 2003; Vernooy, 2003; Almekinders and Hardon, 2006; Halewood et al., 2007; SEARICE, 2007; Vernooy et al., 2009.

The social nature of natural resource management

In most regions of the world, the sustainable management of natural resources, including biodiversity, requires the involvement of multiple social actors. This involvement means active and meaningful participation of women and men small farmers, large-scale farmers, entrepreneurs, local authorities, local groups, staff of nongovernmental organizations (NGOs) and policy makers in decisions about the use, management and conservation of natural resources. This includes the analysis of problems and opportunities, the definition of research and development initiatives and the monitoring and assessment of actions and plans. It often also includes working together to reconcile conflicting or diverging points of view and interests. In particular, the active involvement of NGOs, local governments, grassroots groups and farmer associations is now a feature in many participatory natural resource management initiatives.

With such an approach, it is imperative to address both the ecological and sociological aspects of natural resource management dynamics. This usually means looking at large landscape units, such as, for example, a watershed or micro-watershed, a community forest or rangeland. It requires dealing systematically with changing and often complex interactions among components of a natural resources or production system, e.g., farming, fishing, forestry, herding, collecting edibles, or combinations of these. It also requires considering the historical, socioeconomic and political forces that influence these interactions. These forces, in turn, are defined by such variables as class, gender, age and ethnicity.

Foremost, the approach involves learning from the women and men living in rugged mountainous areas, desert edges, stressed coastal basins and other marginal areas, who are struggling to make a living under very difficult conditions. The key questions to answer are: How do these women and men construct and perceive what is happening in their community, watershed, or region? How do they view what we call the management of natural resources?

What is their interest in participatory action research processes and do they see them as a way to create more room to manoeuvre? Are local women farmers and fishers interested in joining professional researchers in a collaborative effort to analyse their situation and to design, try out and assess new or adapted management practices?

These considerations lead to the exploration of such processes as the generation, distribution and use of knowledge. Of particular interest is the study of the social and gender relations and configurations that condition access, tenure, entitlements, claims and rights to natural resources, including the social and political dynamics of change, adaptation and resilience. Also important are the cultural and political nature of research methods and practices.

Research in Guangxi

The government of China has realized the need for sustainable use of biological resources to ensure that crop yields can keep pace with its increasing population in the face of environmental limitations. As the most populous country in the world with the least amount of arable land per capita, China has no choice but to keep food security high on its agenda. In the past decade, several initiatives have been taken to translate these crucial insights into practice. One is a participatory maize breeding programme coordinated by the CCAP, a leading agricultural policy research institution, which is part of the Chinese Academy of Sciences.

The CCAP-led initiative aims to identify technological and institutional options for developing more effective links and mutually beneficial partnerships between the formal and farmers' seed systems. The main hypothesis is that only such new institutional development can enhance sustainable crop development and in situ, on-farm management of genetic resources. It also aims to strengthen the capacity of women and men farmers to maintain agro-biodiversity in the specific Chinese context through research and management (CCAP, 1999; Song, 2003).

The CCAP-led research, which is being carried out in Guangxi province in south-west China, follows an impact study conducted by the International Maize and Wheat Improvement Centre (CIMMYT) from 1994 to 1998 to assess the impact of CIMMYT's maize germplasm on poor farmers in south-west China (Song, 1998). That study critically analysed the processes of technology development and diffusion. One of its key findings was a systematic gap between the formal and farmers' seeds systems, which resulted in inadequate variety development, poor adoption of formally bred modern varieties, an increasingly narrow genetic base for breeding and a decrease in genetic biodiversity in farmers' fields (Song, 1998).

The Guangxi research team supports farmers' groups through training, building links and networks and supporting interactions between farmers and those in the formal system. Policies are aimed at bringing about conceptual changes among those in the formal research and seed systems to ensure

better understanding of farmers' roles and enable farmers' participation. The research is being carried out by a team of men and women from various institutions and groups, from different disciplinary backgrounds and operating at different levels. Several groups of women farmers, various villages, township extension stations, two formal breeding institutes and CCAP have been directly involved in the project's design and implementation.

The team uses a participatory plant breeding (PPB) method adapted to the local context. PPB involves close collaboration among researchers and farmers and potentially other stakeholders, to bring about genetic improvements within a plant species. Collaboration occurs throughout the research and development cycle. Trials at the research station and in Guangxi villages include both PPB and participatory variety selection experiments. This allows for comparisons in terms of locality, approach, objectives and the varieties tested, which include landraces, open-pollinated varieties, so-called 'waxy' maize varieties and varieties introduced by CIMMYT (CCAP 1999). Some of the CIMMYT varieties have been locally improved through cross-breeding and selection.

The research site

The Chinese rural economy has experienced rapid growth since the adoption of a broad programme of rural economic reforms beginning in 1978 and China is widely recognized for its achievements in reducing absolute poverty since then. Nevertheless, about 60 million people still live below the poverty line and they constitute the majority of the food-insecure population. They are mainly subsistence farmers in resource-constrained remote upland areas in south-west and north-west China that are agro-ecologically diverse, resource poor and risk-prone. The average farm is less than 0.2 hectares. Although these poor farmers have land rights, in most cases the land is of such poor quality that it is not possible to achieve even subsistence levels of crop production. Consequently, most families must purchase grain and other subsistence foods and are negatively affected by price increases. Minority groups are disproportionately represented among the rural poor.

Guangxi is a risk-prone area. It is mostly mountainous and has an important ethnic population. Our study focuses on two contrasting environmental and economic conditions for maize farming in an agro-ecological region that also covers parts of Guizhou and Yunnan provinces. The first represents the poorest remote mountainous communities. Here, farmers plant maize in minute pockets of soil on steep mountain slopes and between rocks in flat fields. The topography makes irrigation water scarce, but rains can flood the land and wash away crops. There are no roads and access to markets is very limited. Maize is produced for consumption (we discuss the role and meaning of maize in chapter 3). It is a traditional staple crop in the area, where there is a diversity of maize landraces, including for example, waxy maize, which is thought to have originated here (Song, 1998).

The second area consists of relatively better-off communities in the valleys and flat areas. People here tend to be a bit better educated and their livelihood systems are more integrated with the market economy. Maize used to be a traditional staple food, but it is now used mainly as pig feed. Pig husbandry is the main source of income for most villagers.

Contents of this book

Chapter 2, 'Maize and the formal agricultural research and development system: evolution, challenges and alternatives', builds on the work of Professor Zhang Sihuang, one of China's foremost maize breeders. Plant breeders have much to contribute (seeds, knowledge, skills and access to other researchers and research organizations all over China and the world), but they need to challenge most if not all traditional plant science assumptions, such as the belief that farmers are less knowledgeable than breeders; that selection must be done under near-optimum conditions; that cultivars must be genetically uniform and widely adaptable over large geographic areas; and that landraces and open-pollinated varieties must be replaced. It is time to accept the fact that farmers are knowledgeable, have relevant expertise, have been doing plant breeding intentionally and are interested in learning more about the formal science of plant breeding; that local landraces respond to heterogeneous contexts better than high-yielding varieties; and that farmers are very interested in seed production and commercialization and have the capacity and expertise to produce high-quality seed.

Chapter 3, 'Farmers' changing livelihood strategies in rural Guangxi', illustrates the rapid agrarian and socioeconomic changes that have been occurring in Guangxi, as in other rural areas all over China. Farmers are responding to these changes by adopting different livelihood strategies. Male-dominated migration to cities to seek non-farming income and other opportunities is affecting most farm households, especially the poorer ones in remote villages. This has resulted in the increasing feminization and aging of agriculture and rural areas in general. Women and old people have become the main agricultural labour force in most if not all households and communities. Women have been playing key roles in local seed systems as well, although they continue to have limited control over key resources (land) and poor access to supporting services, such as credit, extension and education.

This chapter describes how PPB and related efforts assist women and their organized groups to obtain better access to and control over technologies, information and credit. Without appropriate, gender-sensitive policies and public support for farming, the status of these women will continue to deteriorate and they will become more marginalized in the globalization process. This, in turn, will have a negative affect on poverty reduction, food security and sustainable agricultural development in Guangxi and in China as a whole.

Chapter 4, 'Seeds of inspiration: breathing new life into the formal agricultural research and development system', is, in many ways, the heart of this book. A dynamic and viable seed production system is crucial to continue the process of crop improvement and to conserve diversity for future generations. Organized women have taken the initiative to become qualified seed producers and distributors. Their efforts are challenging existing intellectual property regimes, variety release policies and seed certification schemes. This chapter documents progress made in a variety of policy arenas: the integration of PPB into the research agendas of the Guangxi Maize Research Institute and the Crops Research Institute, broadening of the genetic base for maize policy in China with the Chinese Academy of Agricultural Sciences, the protection of farmers' indigenous knowledge and their access to and benefit from genetic resources by the State Environmental Protection Agency and the mainstreaming of social and gender analysis in research and policies at large.

Chapter 5, 'Farmer cooperation and organization: new challenges, new networks, new identities', focuses on collaboration among farmers to cope with the rapidly changing world and to create viable links to markets. The chapter demonstrates that farmer organizations can play a key role as representatives and speakers for individual farmers and link them with the 'external' world, including formal-sector service suppliers and markets. In the process of organizing, new networks emerge as well as new identities. Using three case studies, the authors analyse and answer the following questions: How does cooperation between farmers look these days? Where does cohesion in farmer organizations come from? What is the best way to support farmers' use of locally adaptable knowledge and link farmers with markets through a viable organizational process?

Chapter 6, 'Opening our eyes: renewing the Chinese public extension system', is about reform and renewal of the public extension system. Extension agents can bridge formal and informal systems and the worlds of knowing and doing. However, this requires motivated people, proper incentives and a new way of doing extension. Extension agents with a special interest in PPB and knowledge of its methods are of particular value. The government can make important contributions through general agricultural and rural development policies and through innovations in laws and regulations related to seed production and distribution, variety release committees and seed certification schemes.

Chapter 7, 'Changing rural development in China', makes the point that collaborative field experiments, biodiversity fairs and ongoing learning by doing and capacity building are not only resulting in a new way of doing research and extension, but also creating synergy, efficiency and a more dynamic and equitable process of rural development. We discuss the major policy challenges that have emerged from fieldwork at the local level and make some suggestions for

policy reform. We conclude with some reflections on the Chinese practice and theory of rural development sociology.

About the authors

Song Yiching is a social scientist with a special interest in rural development (especially working with women), farmer organizations and agricultural extension. She received a PhD in rural sociology and rural development studies from Wageningen University. Currently, she is a senior research scientist at the Center for Chinese Agricultural Policy, Chinese Academy of Science in Beijing, leading a long-term action research programme to create synergies between the seed systems of farmers and the Chinese government. She has led the research in Guangxi since 1999.

Ronnie Verwoerd is a senior programme specialist at the International Development Research Centre, Ottawa, Canada. He received a PhD in the sociology of rural development from Wageningen Agricultural University. He has conducted and directed a number of rural development research projects in Nicaragua and currently contributes actively to community-based natural resource management research in a number of countries in Asia, including China, Vietnam and Mongolia. He is also an adjunct professor at the College of Humanities and Development, China Agricultural University, Beijing.

This page intentionally left blank

CHAPTER 2

Maize and the formal agricultural research and development system: evolution, challenges and alternatives

Zhang Shihuang, Huang Kaijian and Song Yiching

WE START OUR JOURNEY to the mountains of Guangxi by looking at and talking about maize. Travelling through the narrow valleys and into the mountain ranges, it is maize that greets us during most of the year. For centuries, maize has meant life to the small farmers of rural Guangxi. However, it is no longer a certainty that maize will grow as it used to do, as many forces are disrupting traditional patterns. Some are related to weather – the region is becoming drier, but is also more prone to flooding; others to macro-level changes in markets and policies; still others to micro-level changes in ideas, values and interests. Because maize was the original entry point for Song Yiching's study and the starting point for the participatory action research process, we begin our story with maize and its links with the formal agricultural research and development (R&D) system.

Maize has always been and continues to be an important crop in China: it is now the number one feed and number three food crop nation wide. But maize is facing a very serious threat: genetic erosion. In a very short-time (40-50 years), the Chinese maize-breeding sector jumped from reliance on landraces to use of a limited number of mainly hybrid varieties, to double-cross hybrids, then single crosses. This has made the maize production system very vulnerable. Meanwhile, improvements in local landraces and germplasm, which provide a base for breeding, but take time and effort, have been neglected and overlooked by the national formal breeding system. In marginalized areas such as Guangxi, farmers' seed systems based on local varieties continue to play a major role in meeting the need for a supply of seed, while maintaining the diversity that is essential to sustain the livelihoods of all farmers. What is urgently needed is a cooperative and complementary relationship between the formal seed system and farmers' systems, rather than the current separate and conflicting situation, in order to address the challenges of achieving food security and maintaining biodiversity.

This chapter only offers a synthesis of maize in China. A detailed account is still to be written as far as we know. We can only hope that someone has the courage and energy to write it.

Cultivation of maize in China, past and present

Maize is now the most important feed crop and the third most important food crop in China. In the early 20th century, farmers cultivated about 10 million hectares of maize, covering 12–15 per cent of the nation's total sown area. Maize production increased from less than 17 per cent of total cereal production in 1970 to more than 26 per cent in 2000. Maize is the only grain crop whose area of cultivation has expanded continuously since the middle 1980s.

Although maize is grown in every province of China, regional variations in production are considerable. Given the climatic diversity of the nation, there are regional differences in the types of maize grown as well as in general cropping patterns. About two-thirds of all maize is grown in temperate climatic conditions, primarily in the northern and north-eastern provinces, China's so-called 'corn belt,' on mostly flat lands. The other third is grown in subtropical and tropical conditions in the mountainous areas of the west and south-west (Figure 1).

These two major maize production regions differ in terms of cropping methods, varieties and utilization due to various ecological and socioeconomic conditions. The northern and north-eastern areas are relatively better off, because of the higher quality of land, good irrigation conditions, the widespread use of hybrid varieties and the use of maize by the feed market. The south and south-west areas are much more diverse and growing conditions are harsh. Here, farmers continue to cultivate open-pollinated varieties



Figure 1. The two major maize-growing regions of China

Box 1. Some technical terms

A landrace or traditional variety refers to a domesticated plant, adapted to the natural and cultural environment in which it lives (or originated). A landrace often develops naturally with minimal assistance or guidance from humans. An inbred line is a genetic line of plants that has been self-pollinated for a sufficient number of generations (usually at least six) to produce individuals that are more or less similar in their genetic make-up. Heterosis is the hybrid vigour exhibited by the offspring of two inbred lines. This vigour, which is the basis for hybridization, persists for only one generation. A hybrid results from the purposeful cross of two cultivars of a single species. A single-cross hybrid results from crossing two pure-bred lines. The first generation offspring are called the F1 generation or Filial 1. Double-cross hybrids are the result of a cross between two different F1 hybrids. Open pollination is pollination by insects, birds, wind, or other natural means. It is usually uncontrolled, in contrast with controlled pollination, in which all seeds of a crop are descended from parents with known traits and are, therefore, more likely to have the desired traits.

Source: These definitions were adapted from the Open Plant Breeding Foundation Glossary (<http://www.opbf.org/glossary>) and Wikipedia (<http://www.wikipedia.org>) (both last accessed 26 October 2009).

(OPVs) and landraces (see list of technical terms above), mostly for their own consumption, but a small amount for marketing. In Guangxi, which is one of these south-western provinces, maize has played and continues to play a key role in rural livelihoods.

Formal-sector maize breeders have much to contribute to maize improvement – hybrid seeds, knowledge, skills and access to other researchers and research organizations all over China and the world. Maize research in China is well organized and has produced good results, but it has been carried out mainly in favourable production regions. The less favourable regions, including Guangxi, have not been served well in the past or present. This has been partly because of the dominance of traditional plant-breeding science assumptions among maize breeders, such as the belief that farmers are less knowledgeable than breeders, that selection must be done under optimum conditions, that cultivars must be genetically uniform and widely adaptable over large geographic areas and that landraces and open-pollinated varieties (such as those found in Guangxi) must be replaced by high-yielding varieties to ensure national food security. Such issues as biodiversity, farmers' diverse livelihoods and their contribution to crop improvement have been largely ignored.

There is no evidence of the exact beginning of maize cultivation in China. Some written records have been found in ancient annals of several regions in the south-west and north-west of China (AD 618–907) and in the *Annals of Shou Zhao* published in 1511. The oldest complete written record was found in Dian Nan Ben Cao, which was finished by Lan Mao in AD 1492. Maize was originally used in traditional medicine. The earliest planting records appeared in 1560. It was recorded as the fifth cereal crop in Pinliang Fu, Gansu Province in north-west China. The record indicated that maize was one of the goods that were sent to the emperor infrequently. Thus, it has been alleged that maize had been introduced to China or existed there before Columbus's

'discovery' of the 'New World' (Li Jiling, 1991; Zhang Shihuang, 1995), although the debate continues.

Based on historical and scientific analyses, Chinese scholars believe that there are two sources of maize cultivated in China, i.e., exotic maize (introduced from abroad) and indigenous or local landraces. The introduction or first arrival of exotic maize is thought to have occurred in the 16th century. There are two possible routes, both from the Americas via Europe to China (Zhang Shihuang, 1995). The first is the so-called Portuguese route, which brought maize to Java or the Philippines; from there it spread to the south-east coast of China, then inland. The second possible route was through India, Tibet and then into south-west China, the putative centre of maize cultivation in pre-Columbian times.

The origin of indigenous landraces, especially 'waxy' maize, is still not clear and no precise formal records have been found to adequately document an early presence. However, it is probable that landraces existed in south-west China long before the introduction of exotic varieties. Two facts support this claim (Zhang Shihuang, 1995). First, the annals of several local regions in Yunnan, Guangxi and Guizhou, under the Tang dynasty (AD 618–907), contain records of maize cultivation and the characteristics of local maize landraces, which are described in some detail, resemble today's waxy varieties. Second, the landraces described in these annals are identified as waxy varieties characterized by small grains and good-quality waxy endosperm, which suits the local taste.

Based on our own observations, there are connections between waxy maize and the traditional culture of the ethnic people dwelling in this area. These people like various kinds of waxy food, including maize. In ancient times, almost all their food crops – maize, rice, millet, etc. – were waxy in nature and, even though many of these varieties have been replaced by high-yielding strains, the people still try to grow waxy varieties in vegetable gardens as high-quality food for special cultural occasions, such as festivals and weddings (see the photo essay in Chapter 3).

Guangxi and south-west China: a centre of maize biodiversity

Some scholars accept the theory that waxy or sticky maize originated in south-west China (Li Jiling, 1991) and they argue that this area is not only the origin of maize cultivation in China, but also one of the first centres of maize cultivation in the world (Li Jiling, 1991; Zhang Shihuang, 1995).

In this area, the three south-western provinces, a wide variety of local germplasm is found; the genetic landrace records contain more than 15,961 entries (CAAS, 1994). In Guangxi alone, there are about 2,700 entries in the maize germplasm collection and more than 1,200 are landraces from the region. In Yunnan province, so far, 1,896 landraces have been collected and registered; of these, more than 300 are waxy maize varieties constituting about 38 per cent of all waxy maize in China.

Table 1. Number and extent of maize varieties grown in Guangxi by type and period

<i>Class of maize</i>	1960–1970 (no. and % crop area)	1970–1980 (no. and % crop area)	1980–1995 (no. and % crop area)	1996–2007 (no. and % crop area)
Hybrid	18 (16)	33 (28)	40 (18)	45 (80)
Improved OPV	30 (19)	20 (22)	10 (7)	7 (5)
Landrace	1200 (65)	1000 (50)	800 (37)	350 (15)
Total	1248	1053	850	402

Source: Data provided by the Guangxi Maize Research Institute and compiled by the CCAP team.

As illustrated in Table 1, landraces have been disappearing, in both number and coverage, especially in the last two decades, although some are still cultivated and a few have been used in breeding efforts. Most are kept in provincial and national gene banks. The common characteristics of the local varieties are small size, dent type, waxy grains and good quality for eating. These varieties are normally stress resistant, cold- and drought-tolerant and adaptable to infertile soils. In short, they are well suited to the area. Although their yield is rather low, their genetic base is broad and diversified.

Narrowing of the genetic base

Maize is currently experiencing genetic erosion. The genetic base for maize breeding has been dramatically reduced over the last few decades. Forty years ago, Chinese farmers grew at least 12,000 open-pollinated varieties on 11 million hectares. Today, maize is grown on more than 24 million hectares, but farmers in the main maize-growing areas have to rely on only about 200 hybrid varieties (Zhang Shihuang and Li Xinhai, 2000; Zhang Shihuang, 2003).

Although the national maize germplasm collection contains about 16,000 varieties, the use of much of this material in breeding programmes is very limited. In 1995, only five hybrid varieties were grown on 22.6 per cent of the total maize acreage and more than 38 per cent of maize crops by area were made up of five inbred lines: Huang Zao 4, Mo 17, Ye 478, Qi 319 and X 178 (Table 2).

Peng and Chen (1993) reported that nationwide most inbred lines were derived from only four dominant germplasm sources. Nearly 34 per cent of the hybrid maize crop area is dominated by Lancaster germplasm. Luda Red Cob, a local germplasm, shares 19 per cent of the acreage. Reid and Tangsipingtou occupy 14.4 per cent and 13.8 per cent, respectively. More than 52 per cent of the lines were recycled from single crosses, 10.4 per cent from three-way crosses and 10.4 per cent from synthetics (Peng and Chen, 1993).

In Guangxi province, with its rich diversity of local varieties, the genetic base for breeding and production is even narrower. Five dominant hybrids cover 65.9 per cent of the total maize acreage and about 71 per cent of the maize area relies heavily on five inbred lines (Table 3).

18 SEEDS AND SYNERGIES

Table 2. Dominant maize hybrid varieties and inbred lines used in China

Hybrids			Inbred lines		
Name	% of total maize crop area	Region	Name	% of total maize crop area	Heterosis group
CAU 108	11	N ¹ China NE ² China, Yellow River valley	Huang Zao 4	11	Dom ³
Yuyu 22	3.5	Yellow River valley	Mo 17	10	Lan ⁴
Ludan 50	2.7	Yellow River valley	Ye 478	9 PA ⁵	
CAU 3138	2.7	N China	Qi 319	5	PB ⁶
Sidan 19	2.7	NE China	X 178	3	PB
Total	22.6		Total	38	

¹ N = north, ² NE = north-east, ³ Dom = domestic varieties (Luda Red Cob and Sipingtou),

⁴ Lan = Lancaster, ⁵ PA = varieties derived from United States hybrids, ⁶ PB = varieties derived from pioneer hybrids (P78599 and P78641).

Source: Zhang Shihuang, 2003 (research notes).

Table 3. Top five hybrid varieties and inbred lines used in Guangxi in 2007

Hybrids			Inbred lines		
Name	% of total maize crop area	Region	Name	% of total maize crop area	Heterosis group
Zhengda 619	38	Joint-venture seed company	F019	38	Sewan
Dika007	14.3	United States seed company	Double M9	15	POP28
Longyu 2	5.8	Provincial public organization	Nan 99	8	Sewan, M9
Nanxiao18	4.1	Provincial agricultural university	CML161	5	Tropical lines
Yumeitao102	3.7	GMRI ¹ (provincial public organization)	M9	5	POP28
Total	65.9			71	

¹ GMRI = Guangxi Maize Research Institute.

Source: Guangxi Maize Research Institute, Nanning, 2008 (unpublished data).

Reflecting on maize development in China over the past five decades, we can speculate that the shrinking genetic base is the result of rapid technological development, aggravated by a missing link between scientists and farmers concerning maize technology needs and interests (Song, 1998). We elaborate this point in the following section.

Challenges faced by the formal R&D system

The Chinese government has adopted a modern, technology-oriented approach to food production, relying heavily on its massive formal R&D system. Growing from almost nothing in the 1950s, the system is now the largest in the world in terms of number of research staff, with about 70,000 researchers in 2002, almost triple the number in the United States and Japan (about 25,400 and 23,600, respectively). Like that of many other developing countries, China's R&D system is mainly public; in terms of number of researchers, the private-sector share of agricultural research was less than 1 per cent in 2002. Agricultural extension staff numbered 98,000 the same year, representing the largest public extension system in the world. In chapter 6, we discuss the extension system in more detail.

As national food security via food self-sufficiency has been the number one agricultural goal of the Chinese central government, the target crops for public agricultural research have been food grains, mainly the three staples – rice, wheat and maize. Increasing the productivity of these crops via hybrid technology has become the main aim of agricultural research. A strategy based on hybrid varieties has become a kind of bible for policy makers and hybrid breeding has become almost the only focus of formal plant breeding in China.

Chinese farmers had been using semi-dwarf varieties several years in advance of the Green Revolution elsewhere. China was the first country to develop and implement the use of hybrid rice. Chinese-bred corn, wheat and sweet potatoes were comparable to the best in the world during the pre-reform era (Stone, 1990).

Since the early 1970s, about 30 per cent of China's food is the result of the development and rigorous promotion of improved plant materials, especially hybrid wheat, rice and maize (Lin, 1998; Fan and Pardey, 1997). Hybrid maize is now grown on about 80 per cent of the total maize-production area in China. However, these hybrids are used mainly in the monoculture and high-yield areas of the northern plain, China's 'corn belt'. Farmers in the remote, harsh uplands of the south-west were more or less marginalized by the introduction of modern technology.

The agricultural research system

New varieties of field crops and hybrids are developed by research institutes at a number of jurisdictional levels. The national research system, which reports ultimately to the Ministry of Agriculture, includes key organizations that are responsible for national breeding programmes: the Chinese Academy of Agricultural Science, provincial academies of agricultural science and prefectural research institutes. Agronomy departments in agricultural universities also have a number of breeding programmes. Figures 2 and 3 show the various organizations involved in agricultural research at the national and provincial levels.

National level research centres account for about 10 per cent of the total research staff and about 15 per cent of the total research budget, whereas the provincial centres have 41 per cent of staff and about 51 per cent of the budget. After hybrid varieties are developed, tested and approved, they are distributed and disseminated through the public seed companies, which have been increasingly privatized in the past decade.

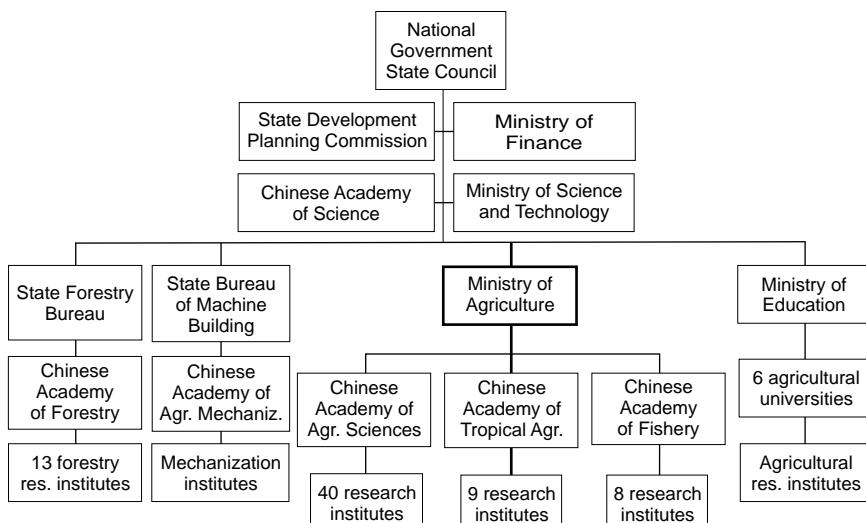


Figure 2. Organizations involved in agricultural research at the national level

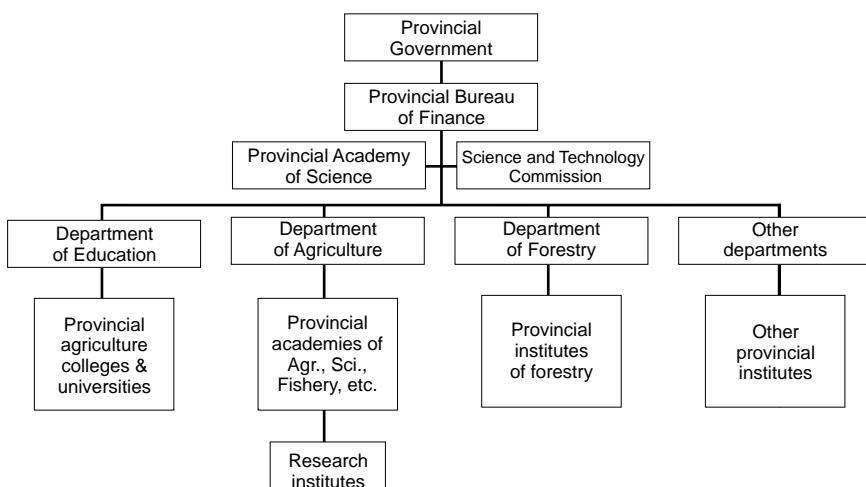


Figure 3. Organizations involved in agricultural research at the provincial level

The rapid development of maize technology and missing links

Chinese research on hybrid maize began in 1923 and, in 1943–45, the first double-cross hybrids were released in Sichuan province. Since the 1950s, the technological development and dissemination of maize can be roughly divided into four main stages:

1. 1950–1960: Formal work focused on improving OPVs and varietal crosses. High-yield dent varieties from the United States were used in breeding and adopted in production. For the first time, exotic dent varieties largely replaced the Chinese flint landraces, especially in the northern corn belt. This resulted in an increase in annual average yield of 14.5 kg/ha.
2. 1961–1970: The first double-cross hybrid based on the new formal breeding programme was released in 1958 (Stone, 1990). The early 1960s saw rapid spread of the double-cross hybrid, leading to a gain in an average annual yield of 88 kg/ha. These hybrids were based on Chinese flint varieties crossed with American public dent lines; they were more genetically uniform than OPVs and landraces, but had a much more limited genetic base. Despite increased yields, these hybrids were susceptible to corn blight and major epidemics of this disease occurred in 1961 and 1966. In 1967, the government stopped selling double-cross hybrids.
3. 1971–1995: After the shock of the nationwide corn blight epidemics, scientists started breeding single-cross hybrids based on dent germplasm from the United States. The first of these were released for commercial use in 1966. Breeders had added resistance to multiple diseases to these varieties for the first time. Starting in the early 1970s, F1 single-cross hybrids were rapidly disseminated, replacing OPVs and double-cross varieties and becoming the dominant maize cultivars in China. Average annual yield increased by about 120 kg/ha. Maize plants were now genetically uniform; however, the genetic base became very limited, as already demonstrated and, according to our recent observations, continues to decrease.
4. 1996 to present: This has been a period of rapid economic development. Public seed companies have been privatized and some foreign seed companies have entered the Chinese market. Numerous new hybrid maize varieties have been distributed widely through market forces. More and more farmers are increasingly relying on hybrids, although the average yield has not increased much. Since 1998, maize landraces have been disappearing at an alarming rate.

During these four stages, the Chinese maize-breeding sector jumped from reliance on landraces to use of mainly hybrid varieties, to double-cross hybrids, then single crosses. This is a very short period. Technically, maize production benefited directly from advanced hybrid technologies and uniform exotic germplasm imported from the United States. Also, the dominant breeding method is selection of F2 lines, which involves crossing closer inbred lines, then selecting F2 lines for hybrid breeding. This has no doubt sped up the

process, but at the same time it has narrowed the genetic base. By the end of the 1990s, about 70 per cent of the varieties used belonged to four F2 lines. Meanwhile, improvements in local landraces and germplasm, which provide a base for breeding, but take time and effort, have been neglected and overlooked by the national formal breeding system. Table 4 shows us a clear picture of this trend at the national level and Table 5 illustrates the situation at the provincial level, using Guangxi as an example.

These data indicate that there is a vital missing link in the rapid technology development process. The main factor now limiting maize breeding in China is the lack of germplasm resources. Of course, many scientists have contributed to developing elite inbred lines and have released a number of useful hybrids (see Table 3) and maize yields rose dramatically during the 1960s, 70s, 80s and early 90s (Figure 4). About 40 per cent of the total gains in productivity are due to genetic improvement of hybrids (Huang Jikun et al., 2003; Zhang Shihuang, 2004).

However, between 1995 and 2001, increases were limited and a slight downward trend was evident (Figure 5).

Table 4. Number of maize varieties developed (Dev) and disseminated (Diss) in China, 1954–2002

Period	Improved OPVs		Hybrids		Double		Single crosses		Total crosses	
	Dev	Diss	Dev	Diss	Dev	Diss	Dev	Diss	Dev	Diss
1954–60	28	16	14	8	—	—	—	—	42	24
1960–70	17	5	12	6	33	20	4	4	53	35
1970–80	12	5	5	3	23	20	56	49	96	75
1980–90	—	—	—	—	3	3	111	75	114	78
1990–02	—	—	—	—	1	1	198	131	199	132
Total	57	26	31	17	60	44	369	259	504	344

Source: Data provided by CAAS and compiled by CCAP, 2003.

Table 5. Number of maize varieties developed (Dev) and disseminated (Diss) and crop area in Guangxi, 1954–2002

Period	Improved OPVs			Hybrids			Double crosses			Single crosses		
	Dev	Diss	Area (ha)	Dev	Diss	Area (ha)	Dev	Diss	Area (ha)	Dev	Diss	Area (ha)
1954–60	30	30	3,467	15	8	2,666	0	0	0	0	0	0
1960–70	30	30	12,670	20	10	6,667	20	5	3,333	10	3	666
1970–80	20	20	14,667	15	10	3,333	10	8	2,000	25	15	13,334
1980–90	15	15	30,000	5	5	666	15	10	6,667	10	8	1,333
1990–95	10	10	30,000	5	5	666	15	13	10,667	15	10	2,000
1996–07	7	7	333	0	0	0	0	0	0	45	20	5,333
Total	112	112		60	38		60	36		105	56	

Source: Guangxi Maize Research Institute, Nanning, 2008, unpublished data.

Note: Areas converted from mu (1 mu = 0.067 ha).

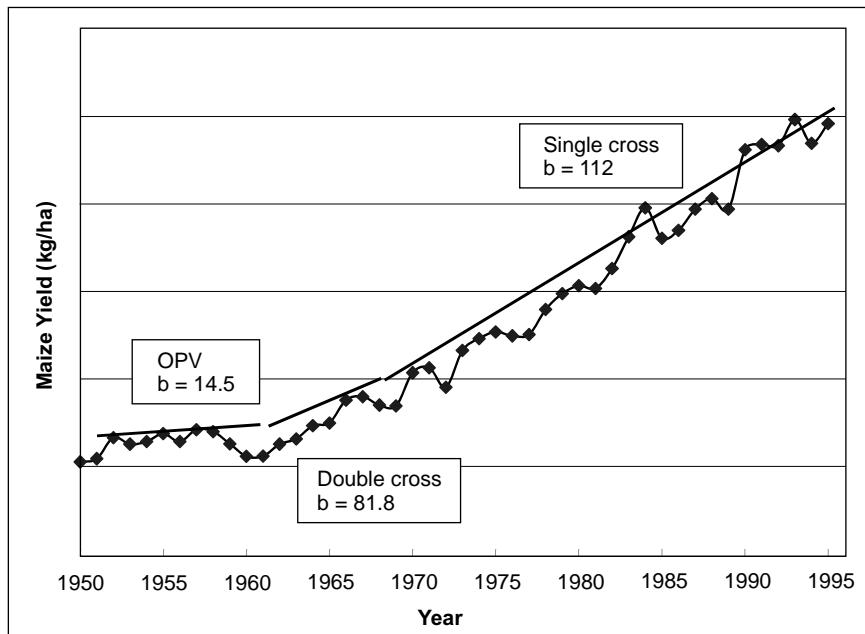


Figure 4. Increases in maize yields in China, 1950–1995

Note: b = average annual increase in kg/ha (kilogrammes per hectare) over the indicated period.

Source: Zhang Shihuang (2004).

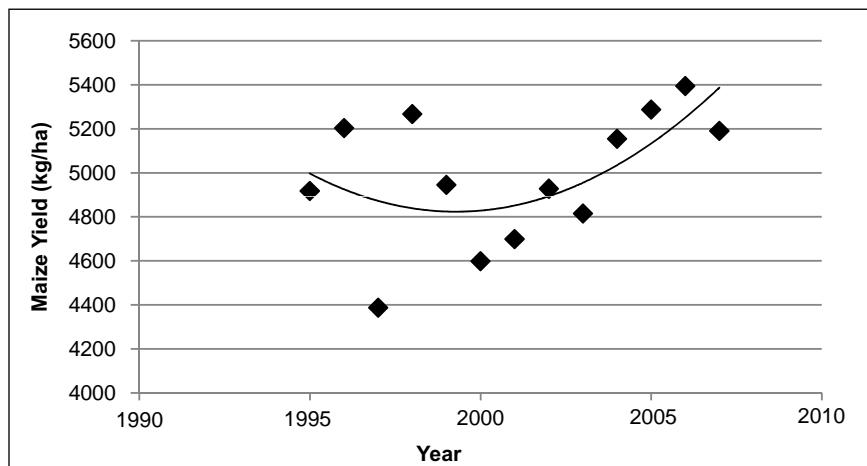


Figure 5. Maize yields of hybrids only, 1995–2007

Note: b = average annual change in kg/ha over the indicated period.

Source: CCAP and CAAS databases, 2009.

We should also note the negative aspect of the use of the modern hybrid technologies, which have replaced traditional varieties. Today, maize breeding and production in China are like a huge inverted pyramid resting on a precariously narrow genetic base. So, to a certain degree, the increased yields have come at the cost of biodiversity, agricultural and livelihood sustainability and future food security.

Access to hybrid varieties by poor farmers in remote areas

It is obvious that, in the past half-century, the formal maize-breeding system in China has been overwhelmingly biased toward hybrids in the search for high-yield potential to fulfill the national goal of food security. The impressive increases in yield have resulted in large-scale adoption of hybrids in the northern plains. More than 83 per cent of the total maize area is planted with hybrids (Zhang Shihuang, 1995), with the northern plains taking the largest share.

However, these hybrids are unable to adapt to the diverse conditions in remote mountainous areas, such as Guangxi and other south-western provinces. They are also susceptible to diseases and pests. Thus, improved OPVs and landraces continue to play an important role in these provinces, especially in mountainous areas, where hybrids are used in about 65 per cent of the total maize area (as estimated by national and provincial breeders). We summarize the pros and cons of hybrids and landraces below.

Characteristics and limitations of hybrids

- Hybrids need large amounts of chemical inputs to realize their high potential yield.
- Hybrids are appropriate for more favourable growing areas.
- Hybrids are good for commercial maize production.
- Hybrids are not adaptable, economically or ecologically, for subsistence farming in remote and mountainous areas with complex and diverse environments.

Advantages and weakness of OPVs and landraces

- As a whole, OPVs are stress tolerant and adaptable to complex and harsh farming contexts.
- Landraces are locally adaptive, very stable and locally preferred, selected and maintained.
- Although OPVs and landraces are more sustainable and stable, greater effort is required to improve their yields and other agronomic characteristics.

As an example of the evolution of maize breeding in Guangxi and other south-western provinces, we offer the story of one variety, known as Tuxpeño 1.

Box 2. The experience with Tuxpeño 1 in south-west China

Tuxpeño 1, the name used by Guangxi farmers, is an improved population that was developed by the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT) from a landrace that originated in Tuxpau, Mexico. Tuxpeño 1 was introduced to south-west China in 1978, originally as a constituent for variety improvement and hybrid combination.

However, because of its adaptability, stability and stress tolerance, especially its resistance to lodging, Tuxpeño 1 was rapidly disseminated throughout the three provinces (Guangxi, Yunnan and Guizhou, mainly through informal seed exchanges, and became particularly popular with farmers in the remote mountainous areas. Over the past two decades, it has contributed significantly to household food security and poverty alleviation in those areas. In addition, because of the poor quality of government-supplied hybrid seeds, Tuxpeño 1 has also been adopted increasingly by farmers in relatively favourable areas.

However, without attention and improvements from the formal breeding system, Tuxpeño 1 has degenerated significantly through out-crossing, resulting in decreased yields, increased plant height and some loss of stress-resistant characteristics. Farmers asked the government to help them improve the strain but received no response. This led to significant efforts by local women farmers to revitalize the variety.

Source: Song, 1998

Note: The tropical and subtropical maize germplasm developed by CIMMYT has been introduced in and used by a number of national agricultural research programmes all over the world. This germplasm pool (populations and lines), derived largely through collection from centres of maize diversity in various parts of the world, possesses great genetic diversity and is, therefore, expected to broaden the genetic base of hybrid maize breeding, prevent genetic vulnerability and enhance the heterosis level in temperate zones. However, the use of the pool for hybrid maize breeding in temperate zones is hampered by several problems. Often, exotic species are the only good source of resistance to diseases, but they are difficult to propagate as they are seldom adapted to the long-day conditions in northern China. Most are tall plants, with high ear placement, small ears, too much leafy coverage, low economic index, weak root systems, poor stalk quality, susceptibility to lodging, very late flowering and significantly delayed silking. Some plants tend to be sterile. These shortcomings are related to photoperiod sensitivity.

Conclusion: the need for an alternative system

We have seen that the genetic basis for the maize production and breeding programme in China has become limited and that, as a consequence, crop production is in danger. This is mainly a result of the rapid changes brought about by the adoption of modern technology and exotic germplasm from abroad and neglect of traditional knowledge and local genetic resources.

This situation became worse after the introduction of a market economy. As a result of privatization and commercialization, the formal seed system has become increasingly involved in profit-driven competition. Hybrid breeding and hybrid seed production are attracting more attention than ever before.

However, in marginalized areas, farmers' seed systems continue to play a major role in meeting the need for a supply of seed, while maintaining the diversity that is essential to sustain the livelihoods of all farmers (and the country at large). The CIMMYT impact study (Song, 1998) revealed that, in

the south-west remote mountainous area, more than 80 per cent of the seed supply was from farmers' own seed systems. Our recent study (CCAP, 2008) shows that 30–40 per cent of the total maize-growing areas in the three south-western provinces is planted in OPVs which rely on farmers saving seeds. OPVs also still cover more than 70 per cent of the mountainous parts in those areas.

Limitations of the past and current system include:

- conflicts between public and market functions (public versus private enterprise);
- weak coordination among institutions (central versus local; between regions) and duplication of efforts;
- overstaffing and low human-resource capacity: low salary, lack of incentives, loss of high-quality scientists;
- lack of stakeholder participation (especially farmers) and accountability;
- inability to respond to change: new science, new agenda, new actors;
- weak links between the generation and dissemination of technologies.

To meet this challenge and bridge the gap between local needs and the world of modern plant breeding, we must rely on local maize germplasm from centres of maize diversity in China, i.e., the south-west, and on exotic germplasm collected by CIMMYT from other centres of diversity around the world. The recent efforts of farmers and scientists in the south-west are bridging this gap. Farmers and breeders have begun to cooperate and, in the remaining chapters of this book, we will learn more about how this is unfolding.

A cooperative and complementary relation between the formal seed system and farmers' systems, rather than the current separate and conflicting situation, is urgently needed to address the challenges of achieving food security and maintaining biodiversity. Moreover, there is a need to empower farmers, who in this case are mainly women, to become active partners in plant breeding, on-farm biodiversity management and seed marketing. This was the central issue and the core reason for starting the current participatory plant breeding efforts and related initiatives in south-west China, which we discuss in Chapter 3.

About the authors

Zhang Shihuang received a PhD in maize improvement from the Chinese Academy of Agricultural Sciences and went to the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT) as a visiting scholar in the 1990s. He is a leading maize breeder and currently a chief scientist in maize research and production in China. He is the director and a professor in maize improvement in the research department of the Institute of Crop Science, Chinese Academy of Agricultural Sciences, Beijing.

Huang Kaijian obtained bachelor's and master's degrees at Guangxi Agricultural University in Nanning and has worked as a maize breeder at the Guangxi Maize Research Institute since the 1980s. He is now a senior maize breeder and deputy director of the institute. Since the beginning, he worked as provincial coordinator of the Guangxi research team.

Song Yiching is a social scientist with a special interest in rural development (especially working with women), farmer organizations and agricultural extension. She received a PhD in rural sociology and rural development studies from Wageningen University. Currently, she is a senior research scientist at the Center for Chinese Agricultural Policy, Chinese Academy of Science in Beijing, leading a long-term action research programme to create synergies between the seed systems of farmers and the Chinese government. She has led the research in Guangxi since 1999.

This page intentionally left blank

CHAPTER 3

Farmers' changing livelihood strategies in rural Guangxi

Song Yiching, Wang Xiufen, Li Jingsong and Ronnie Verwooy

MAIZE IS CHINA'S THIRD most important crop, after rice and wheat. As described in Chapter 2, there are two major maize-producing regions in the country. On the northern plains, more than 90 per cent of maize is produced for the market and as animal feed. In the south-west, maize is the staple food for farmers, especially in remote mountain areas. Here, maize cultivation is primarily in the hands of small-scale farmers with an average land holding of about 0.7 mu (about 470 m² [1 mu = 667 m²]). Maize can be grown, but productivity is much lower than on the plains. Unlike the plains region, hybrids have not been widely adopted here as neither agro-ecological nor socioeconomic conditions favour their use. Instead, in the highly diverse mountainous micro-environments, farmers rely on local landraces they have selected themselves from their own crops. The remoteness and harsh living conditions contribute to a high rate of rural poverty, which is aggravated by poor or non-existent agricultural extension services. Although farmers in this area have cultivated and relied on maize for their survival for generations, they have received little help from the formal public research system to support the conservation and improvement of their landraces, with the exception of the initiative described in this book.

In this chapter, we present an overview of the way farmers in Guangxi live and of the central role played by maize. Livelihood strategies are diverse and are becoming more so, leading to greater social differentiation. The rural population in Guangxi (and other rural regions of China) is both ageing and feminizing, dramatically reshaping all features of everyday life. Five major farming strategies are emerging. Maize remains central, but the features of maize production, marketing and use are changing. Farmers, nowadays mostly women, are knowledgeable maize producers and improvers, have significant relevant expertise and are interested in learning more about the formal science of plant breeding. Among other things, farmers have learned that local landraces respond more adequately than high-yielding varieties to heterogeneous local conditions and are preferred because they do not depend on external inputs. Farmers – again, women farmers in particular – are very interested in seed production and commercialization and have the capacity and expertise to produce high-quality seed.

Maize in farmers' everyday lives: a photo essay

Today, rural Guangxi is a treasure trove of maize genetic diversity that is vital to the future of maize cultivation in China. Maize has played and continues to play a key role in farmers' livelihoods in rural Guangxi. In the remote mountainous communities of the province, farmers grow maize as their subsistence food and for a variety of other uses. They plant maize in minute pockets of soil on steep mountain slopes and between rocks on flat fields. Water is limited, as the calcareous underlying rocks are porous and do not retain rainwater. Heavy rains flood the land and wash away the crops. The incidence of flooding seems to be on the rise in recent years, possibly because of climate change. There are no roads and access to market is limited. Maize is produced mainly for consumption and is a traditional staple crop in the area, which has a diversity of maize landraces. Waxy maize is believed to have originated in this area.

As images are often worth a thousand words, we present the following photos to illustrate the role and importance of maize in farmers' everyday lives in Guangxi. These photos were taken recently by members of the research team to document their work.

Walking through the limestone mountains of Guangxi, one gets the impression that the main crop is rocks. They are everywhere and of all sizes. On closer inspection, however, one discovers green plants reaching for the sun.



Credit: CCAP

Photo 1. Maize is planted among the rocks; sometimes, small terraces are created and maize is sown in rows. Reaching for the sky (and the required sunlight), plants can grow up to 3 m tall, making them susceptible to wind. There does not seem to be such a thing as a perfect maize plant.



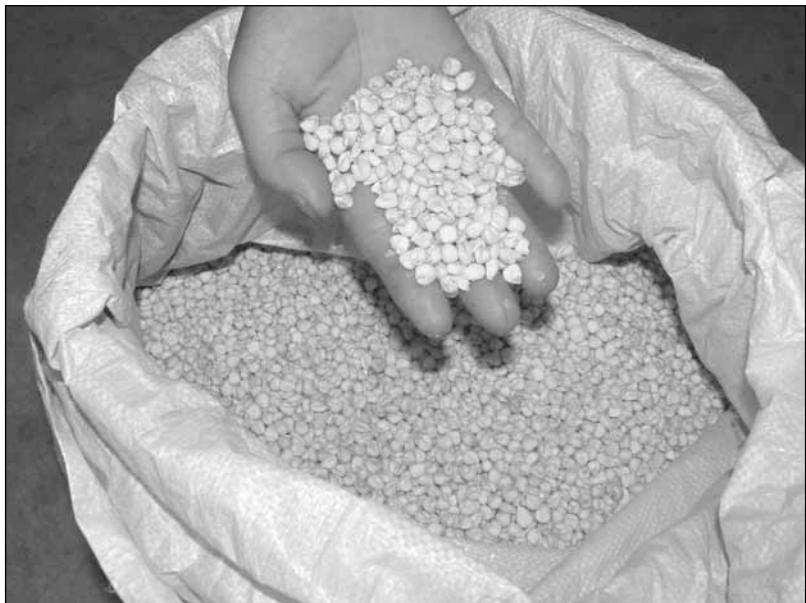
Credit: Ronnie Verwoerd

Photo 2. In the valleys, where there is a bit more space, maize is intercropped with beans, sweet potatoes, or other vegetables. Traditional varieties of maize require wider spacing than hybrid varieties, allowing for this practice, which is also beneficial in terms of diversity and soil management.



Credit: Ronnie Verwoerd

Photo 3. New maize production practices have emerged as a result of participatory action research in selected villages (see Chapter 4). One of these is the careful, small-scale production of maize seeds of improved varieties. Plots, such as this one in Mashan, are kept close to homes, allowing for daily inspection and care and a vigilant eye. Interest in the new and improved seeds is growing rapidly.



Credit: Ronnie Verney

Photo 4. Maize can be turned into a variety of useful products, including grain, of course, for animal or human consumption. In the south-west, food for human consumption remains the top priority, although the use of maize for animal feed is increasing; in the north, maize is mainly grown for animal feed.



Credit: Ronnie Verney

Photo 5. Apart from grain and thanks to the collaborative efforts of farmers, breeders and extension agents, the new maize also produces valuable seeds. The waxy varieties are very popular. This is the waxy variety Guinou 2006, a result of PPB efforts (see Chapter 4).



Credit: CCAP



Credit: CCAP

Photos 6 and 7. Maize can be eaten fresh and farmers and the Guangxi research team enjoy it that way. Maize is also processed in a variety of ways to make dough for pastries of various sorts (6), porridge (7), juice and 'wine' of various kinds.



Credit: Ronnie Verney



Credit: CCAP

Photos 8 and 9. Maize has other useful parts: the dried leaves are used for a multitude of purposes, including baskets and mats (8) and bedding for animals (9).



Photo 10. Farmers are working together to produce the seed that will improve their lives.

A rapidly changing agrarian system

Although maize continues to occupy a central role in the livelihoods of poor and marginalized farmers in rural areas of Guangxi, major economic and social transformation in China is changing the structure of agriculture and rural households. With opening markets, massive migration from rural areas to cities has been occurring in the past two decades. All over the country, small-scale subsistence farming is in crisis, while, at the same time, farms are being enlarged for specialized and highly commercialized agriculture.

Guangxi has experienced rapid transitions too. Assessments carried out by the Guangxi research team in 10 villages (in five counties) in 2008, along with other field studies (see Chapters 4, 5 and 6) revealed significant changes in all aspects of farmers' livelihoods and the agrarian system at large. In this book, we focus on the major changes in terms of labour, income, farm structure and agricultural biodiversity. Together, these elements determine rural livelihoods in Guangxi.

Our assessments were conducted using a variety of qualitative methods and quantitative tools, including a questionnaire, interviews (individual, key informant and group), participant observation and some participatory assessment tools, such as ranking and scoring. In each county, a pair of villages, one of which is taking part in the participatory action research (PAR) process, was selected for comparison. This study revealed an overall increase in per capita income in all 10 villages; on average, income approximately doubled between 1995 and 2007 (Table 6).

36 SEEDS AND SYNERGIES

Table 6. Average per capita income (CNY¹) in selected villages in five counties in Guangxi, 1995–2007

Village	1995	2000	2007
Duan county			
Village 1	500	800	1,000
Village 2	680	850	1,200
Hengxian county			
Village 3	800	1,400	1,700
Village 4	450	550	600
Long'An county			
Village 5	300	400	1,000
Village 6	260	380	895
Mashan county			
Village 7	1,500	1,600	1,860
Village 8	950	1,200	1,890
Wuming county			
Village 9	687	980	1,730
Village 10	2,100	2,670	3,650

¹ 6.83 Chinese yuan (CNY) = US\$1.

Note: Villages 2, 3, 4, 6, 8 and 10 are participating in the PAR project; villages 1, 5, 7 and 9 are not.

Source: CCAP field assessment, 2008.

Nevertheless, we observed large variations between villages (Table 7). Income gaps are increasing between villages and also within villages. The highest household income is more than 10 times the lowest, a huge discrepancy.

Table 7. Variation in household incomes in the study villages, 2007

	Household income (CNY ¹)		
	Average	Highest	Lowest
Duan county			
Village 1	16,033	59,000	3,000
Village 2	28,363	62,000	4,000
Long'An county			
Village 5	31,302	60,495	8,500
Village 6	17,625	32,550	4,130
Mashan county			
Village 7	22,231	55,000	0
Village 8	27,394	61,000	9,260
Wuming county			
Village 9	23,145	67,888	5,070
Village 10	36,991	128,900	5,000

¹ 6.83 Chinese yuan (CNY) = US\$1.

Note: Villages 2, 6, 8 and 10 are participating in the PAR project; villages 1, 5, 7 and 9 are not. The Hengxian villages were omitted from this comparison as both are PAR villages.

Source: CCAP field assessment, 2008.

There were also significant changes in income source over this period, although the changes were qualitatively different for relatively poor villages (villages 1–8) than for those that were better off (villages 9 and 10). For most of the poor villages, the proportion of income from those who have migrated to cities has increased, while crop and livestock income has decreased. For the villages that are better off, income sources have diversified (Table 8).

Looking at farming structure will tell us who is doing what under the changing circumstances. The average age of the actual farmers (the household members who stay on the farm and do farming for more than 6 months annually) is about 50 years and 76 per cent are women (Table 9). This represents a reshaping of the whole social fabric of villages, townships and counties. From our field experience, we know that the impact of this new reality is more dramatic than the numbers suggest.

The main driver of this change is migration to cities and non-farming sectors. Because land is so limited and of relatively low potential, more and more farmers – especially the young and especially young men – are leaving the farm to seek cash incomes and new opportunities outside farming, leaving women and the older generation, who must also often care for their grandchildren. However, given the differences in resources and capabilities,

Table 8. Changes in source of income in the study villages, 1995–2007

	Crops (%)			Livestock (%)			Migrants' wages (%)			Other (%)		
	1995	2000	2007	1995	2000	2007	1995	2000	2007	1995	2000	2007
Village 1	25	20	15	5	5	5	70	75	80	0	0	0
Village 2	25	30	35	20	25	20	55	45	45	0	0	0
Village 3	60	60	60	30	20	10	10	20	30	0	0	0
Village 4	35	30	35	30	20	20	25	35	40	10	15	5
Village 5	28	30	18	45	37	34	27	33	48	0	0	0
Village 6	60	60	25	30	20	45	10	20	30	0	0	0
Village 7	10	10	20	10	10	15	70	70	60	10	10	5
Village 8	40	40	30	30	30	30	30	30	40	0	0	0
Village 9	11	75	85	2	15	9	87	10	6	0	0	0
Village 10	90	74	72	5	16	8	3	6	8	2	4	12

Note: Villages 2, 3, 4, 6, 8 and 10 are participating in the PAR project; villages 1, 5, 7 and 9 are not.

Source: CCAP field assessment, 2008.

Table 9. Sex and age of de facto farmers in study villages

Sex	Average age (years)	Proportion (%)
Men	49.59	24
Women	49.55	76

Source: CCAP field assessment, 2008

different households have different livelihood or coping strategies. We now turn to the major livelihood patterns that we found at our research sites.

Major livelihood patterns and strategies

Given that our survey data, which rely on averages, might hide the diversity of livelihoods and the coping strategies of rural people, we also carried out qualitative studies, using key informant interviews, individual and group discussions, participant observation and in-depth case studies to discover the major livelihood patterns. This research revealed great variations in experiences depending on opportunities, life cycle, assets and coping strategies envisioned and put into practice. In terms of dependency on farming (farming income and migrant status), in general, we identified four major livelihood patterns in the villages. (The following section also draws on Wang Xiufen's (2007) in-depth field research.) Based on our knowledge of the province at large, we believe these four main patterns represent rural areas in Guangxi more broadly.

Subsistence farming in transition is the dominant pattern, applying to 70–75 per cent of the households in the research area. In these households, men are engaged in non-farming activities (actively searching for new income opportunities), whereas women undertake most of the farming, maintaining a diversified subsistence agriculture. Among these households, some are planning to migrate to the city (sometimes both the husband and spouse); some are just waiting to see.

Traditional subsistence farming is the livelihood pattern of 10–15 per cent of the households. They stay on their land and depend primarily on farming. Most are extremely poor; they include those who are ill and older people with little non-farming income. The gender division of labour and decision making remain traditional in these households. Men do the farm work while women do the domestic and child-rearing work.

Professional farming by specialized households is a pattern that has emerged in the last decade. These households represent about 5–10 per cent of the total, depending on the economic situation in the communities. These households specialize in certain agricultural commodities (crops and livestock) on a relatively larger scale, with land often rented from relatives and other villagers. The better-off areas tend to be more specialized. It is interesting to note that, during the last decade, more and more women heads of household are actively pursuing this new kind of agriculture.

Non-farm livelihood, the last category, accounts for 5–10 per cent of all households. Most of these households consist of young couples, who have migrated to urban areas and taken up non-farming professions, leaving their land in the care of relatives. However, they are still considered rural households with a land title and a residency permit, known as *hukou*, in their village of origin. They maintain ties to the land and to the village, perhaps as a sort of insurance, as the life of migrants is highly uncertain. The economic slowdown

of 2008–09 forced many to return home, at least temporarily, and the future prospects for regular off-farm employment are not at all clear.

Although this overview describes the general situation in rural Guangxi, looking closely at a particular village gives us a clearer picture of farmers' livelihood patterns and strategies, which are linked to the amount of land they hold, available labour, education, skills and other factors. Wang Xiufen (2007) carried out MSc field research in one of the PAR villages, Wentan, in 2007 and the following is part of her study results.

A case study: major livelihood patterns and changes in Wentan village

Wentan is located in Wuming county. In 2007, there were 58 households with a total population of 222. The community had 439 mu (about 30 ha) of arable land. The major produce consisted of rice, maize, cassava, sweet potatoes, fruit trees, pigs, chickens, ducks and cattle. Rice fields covered 47 mu (3.1 ha) and maize 85 mu (5.7 ha); the rest of the land was mainly used for cassava and fruit trees. Most of the household incomes came from employment in nearby rural enterprises and from cultivating cassava, which is a new and lucrative cash crop in the village.

Land for agriculture is a key factor deciding farmers' livelihood patterns. In the early 1980s, the state's land reform policy with its major land reallocation had an impact that is still felt today. In the 1990s, the right to land reallocation was given to village committees, the lowest administrative authority. Village committees all over the country implement the policy differently. In Wentan, the committee decided not to provide more land when families increase in size (or take any away from those that decrease). Thus, since the 1980s, no land reallocation has occurred, which is also the case in most remote villages of Guangxi and other south-west provinces.

Farmers are unable to obtain more arable land if their family increases through marriage or the birth of children. On the other hand, they retain their land when family members leave or die. Thus, women who have married into a farm family since the early 1980s and their children have no way of obtaining land, but must rely on their husband's land for a living. In 2007, the average per capita arable land holding was only 1.98 mu (about 0.13 ha), but variations among households were huge (Table 10).

Table 10. Distribution of land in Wentan village

<i>Amount of arable land (mu¹ per capita)</i>	<i>No. of families (%)</i>
< 1.8	7 (15.8)
1.8–4	25 (65.8)
> 4	6 (18.4)

¹ mu = 0.067 ha.

Source: Wang Xiufen, 2007

Among the 38 households interviewed, seven had less than 1.8 mu per capita arable land and three had only 0.8 mu. There were 14 families with more than 3 mu of arable land per capita and six had more than 4 mu. There were also great differences in terms of arable land per family: some had over 20 mu while others had only 2.5 mu. Couples married after the early 1980s and young couples usually have only a very limited amount of land. Older couples and families with several daughters, who have married and left the family, have more land than average. Some households have given up their land and farming. The situation is quite diverse. The following examples illustrate various household types in Wentan village.

Household A consists of four people with 0.65 mu of paddy fields and 2.5 mu of dry land. This amount of arable land is not enough to grow food for the whole family. They grow rice together with a brother-in-law in a 1.1-mu paddy field, which produces barely enough to feed the household. The family has to buy noodles from time to time to make up for the shortage of grain. They need at least 1.3 mu of paddy fields to grow enough food for four people; that is, they have only about 50 per cent of the minimum land needed for food self-sufficiency. The reason that their landholding is so limited is because the husband has three brothers and one sister, who each received a fifth of their parents' land when they married. His wife and their two children are allocated no arable land; the household of four relies on the husband's share alone.

In contrast, some households have more land than they need.

Household B includes six people; a mother, father and four children. All four children work in the county. They have a considerable amount of arable land: 23 mu, of which 3 mu are paddy fields. As the couple is getting older, they can no longer cultivate all the land. They are now planning to rent out a 1-mu paddy field and a neighbour has expressed an interest in using 0.5 mu. The remainder is a flooded paddy field, which may be difficult to rent out because of its poor quality.

Some families still have rural household or residency status (*hukou*), although they have abandoned agriculture completely. The arable land they owned in their home village has been transferred to relatives or friends on a long-term basis, as example C illustrates.

Household C consists of four people. The husband operates an auto repair garage in the Wuming county seat. They have bought a house and all live there. Their land back in the village is now used by a brother of the husband.

In summary, farmers' ability to cope with the changing situation depends on their key agrarian resources and capacities. Table 11 is a summary of the types of households, resources and coping strategies in Wentan village.

The feminization of agriculture and implications for maize development

Significant changes are occurring in Guangxi and, as we know from other studies, in other regions of China in terms of the structure of rural households, the key features of the farming system and related changes in the role of women

Table 11. Livelihood strategies of various household types in Wentan

Type of household	Agrarian resources	Coping strategy
Mostly women-headed or middle-aged couples with husbands in the non-farming sector	<ul style="list-style-type: none"> – Mid-size landholdings – Some labour – Some skills 	<ul style="list-style-type: none"> – Women engage in farming fully and steadily – Men look for new opportunities in non-farming
Elderly couples, both working in farming	<ul style="list-style-type: none"> – More land – Limited labour – No new skills 	<ul style="list-style-type: none"> – Undertake traditional farming – Transfer part of farmland temporarily
Poor households, often with sick or handicapped members	<ul style="list-style-type: none"> – Some land – Limited labour – Lack of skills 	<ul style="list-style-type: none"> – Children drop out of school to help with farming
Young couples and middle-aged couples	<ul style="list-style-type: none"> – Very limited land 	<ul style="list-style-type: none"> – Members work in factories – Some work as farm labourers

Source: Wang Xiufen, 2007

(and to some degree, also of men) in farm production. We have characterized this last factor as the 'feminization of agriculture' (Song, Zhang Linxiu et al., 2006). In many rural areas, women have become the de facto farmers, taking on the responsibility of running the farm.

As pressure on poor rural households to participate in the cash economy increases, men are migrating in ever-larger numbers to seek employment in cities, local industries, or irrigated agriculture in the lowlands. The bias toward male migration is partly a result of the patriarchal view of the family. The husband is supposed to provide for his family financially, guide the household's decisions and mediate its relations with the outside world. Male migration is also favoured by gender discrimination in the wage labour market, where men are more likely than women to be hired and to be paid a higher wage, even for the same work. Thus, women are assuming greater and greater responsibility for meeting the household and food needs of the rural family, while men seek to make their way in the modern economy, creating a system known as 'two households, one family'.

Rural women are assuming the cost of bringing up children, which has increased, although the numbers of children are fewer because of the 'one child' policy. At the same time, the policy has drastically reduced the amount of household and farm labour available to support women. In the absence of their male relatives, women are also taking on unfamiliar roles in community leadership, when government support is giving way to the uncertainties and challenges of the market. The traditional division of farm labour between men and women, captured in the folk slogan 'the men till and the women weave', is surrendering to a new reality: 'women till and the men work in industry'.

A 2008 field-level survey of farming households in which members of the Guangxi team participated showed that, in selected areas of the three south-western provinces of Guangxi, Yunnan and Guizhou, women make up more than 85 per cent of the agricultural labour force (detailed results of this survey

have not yet been published). At the same time, the traditional expectation that men control the outside world and women the inner world of the home is giving way to the reality that women must stretch their inner world to include farming and community responsibilities. How women are dealing with this on a daily basis has not received much attention either from researchers or policy makers.

Women's roles in the local seed system

Two of the most difficult challenges that women farmers face in their new roles as heads of household are obtaining viable improved seed from the public-sector agencies responsible for seed management and maintaining a range of varieties that have the characteristics they prefer and are suited to local farming conditions.

As described previously, there are two parallel seed systems: formal and informal. The former is supported by the plant-breeding sector (backed up by central and provincial governments); the latter is maintained by poor farmers, mainly women. The formal sector is focused on the breeding and dissemination of hybrid, high-yielding varieties and is driven by the government's push to raise yields. Under favourable conditions, these hybrids provide stable and high yields; however, many are the result of single crosses and lack the buffering capacity to withstand environmental shocks or sustain yields in the face of production constraints.

In most smallholder farms in Guangxi, the conditions are not at all favourable and farmers are also experiencing great difficulty in gaining access to hybrid seed. Therefore, farmers rely on exchanging seed from their own harvests and on their indigenous maize selection, breeding and dissemination practices. The changing macro-environment, as well as the changes occurring at the household and village level, are adversely affecting these practices.

When it comes to seeds, women farmers prefer open-pollinated varieties (OPVs) for a number of reasons:

- Seeds from the current crop can be saved for the following year, unlike hybrids, which lose their vigour after one cropping cycle.
- Farmers can manipulate the genetic material themselves to produce varieties that have desired characteristics related, for example, to yield, stress resistance, taste, storage and cooking qualities and the intensity of crop management.
- OPVs offer the continuing potential for evolution at the local level. The 1998 study by Song was one of the first to document in detail the way women acquire, maintain and refresh their preferred varieties through OPV hybridization.
- OPVs can be crossed with varieties from elsewhere, including those obtained through the formal seed system. The word 'creolization' is used in this context to refer to the processes by which farmers maintain and improve introduced cultivars (more about this in Chapter 4).

Several women who are known in the villages to be expert maize breeders skillfully control the breeding process, from field design, through pollination, to seed selection. These women have maintained their traditional landraces and improved OPVs, such as Tuxpeño 1, which were developed through formal breeding long ago, through generations by separating the planting of landraces in space and time.

The seed that is destined for the following year's planting is harvested, cultivar by cultivar, in a three-step process known as 'mass selection.' The first step is to select the best plants from the middle of the field, i.e., healthy, vigorous plants with large ears. Step two is to select the best ears based on cob size, length and number of seed rows. The best grains, based on kernel size, shape, quality and colour, are then selected from the middle portion of each ear. The women maize breeders also make new seed crosses using manual and mechanical methods to remove tassels from the seed plants before they shed pollen and collect pollen from male plants for artificial pollination.

Recently, thanks to a large extent to the PAR initiative, women farmers in the villages have become more interested in commercialization of their local waxy maize and other local products, such as, for example, organic rice.

Women have played a central role in the custody of seeds and the management of local agro-biodiversity for generations, but it is only as labour and commodity markets have penetrated further and further into the remote areas of the south-west that this role has come to light. Although plant-breeding expertise certainly existed and continues to exist among male farmers and individual male enthusiasts take pride in their knowledge and management of plant diversity, the men's skills and knowledge are eroding as they move off the farm.

The changes related to seeds are multiple and complex, on the one hand leading to more stress on local practices and on women farmers in particular; on the other hand, thanks to the PAR initiative, there are also some new opportunities emerging to revive the local seed system. In the following chapter we offer more insights into this dynamic process, which is currently evolving.

Conclusion

Geographical variation is one of the major characteristics of Chinese agriculture. Regional variability in farming structures and variation among farmers' households and villages are significant and increasing as a result of the rapid changes that have occurred since the reforms – most notably, the development of rural industry, the commercialization of agriculture and the feminization of agriculture. At the same time, agriculture-related natural resources – in our case, biodiversity of local crop varieties – have experienced a rapid decrease in Guangxi and elsewhere in China because of the rapid spread of modern varieties and the forces of commercialization as well as changing socioeconomic conditions at the local level. Maize continues to play a central role in the diverse livelihoods and coping strategies of farming communities

in Guangxi (as the photo essay illustrates), but new forces are impinging on its production.

Farmers depend on varied farming systems with diverse patterns of use of maize. They have different needs for, and interests in, technology and genetic diversity. The big gap between the breeders' limited supply and farmers' diverse needs has led to the activation and development of indigenous knowledge systems through which farmers work on the neglected OPVs and landraces to meet their own needs. Because of the feminization of agriculture and other socioeconomic factors, local seed selection and breeding in Guangxi are carried out mainly by women.

Farmers, nowadays mostly women, are knowledgeable maize producers and improvers, have significant relevant expertise and are interested in learning more about the formal science of plant breeding. Among other things, farmers have learned that local landraces respond more adequately than high-yielding varieties to heterogeneous local conditions and are preferred because they do not depend on external inputs. Farmers – again, women farmers in particular – are very interested in seed production and commercialization and have the capacity and expertise to produce high-quality seed. They have come to play a key role in the PAR process, which brings us to the next chapter.

About the authors

Song Yiching is a social scientist with a special interest in rural development (especially working with women), farmer organizations and agricultural extension. She received a PhD in rural sociology and rural development studies from Wageningen University. Currently, she is a senior research scientist at the Center for Chinese Agricultural Policy, Chinese Academy of Science in Beijing, leading a long-term action research programme to create synergies between the seed systems of farmers and the Chinese government. She has led the research in Guangxi since 1999.

Wang Xiufen obtained an MSc degree in rural development and management from China Agricultural University. She found the inspiration for her field research in Guangxi during the community-based natural resource management course offered by the university. She is now working as a government officer at the county level in Hubei province.

Li Jingsong earned a BSc degree in sociology from China Agricultural University and a master's degree in environmental management from Wageningen University in the Netherlands. She works as a senior research assistant at the Center for Chinese Agricultural Policy and has a special interest in rural development and environmental management. In September 2007, she began PhD studies at Wageningen University in the Netherlands.

Ronnie Verwooy is a senior programme specialist at the International Development Research Centre, Ottawa, Canada. He received a PhD in the sociology of rural development from Wageningen Agricultural University. He has conducted and directed a number of rural development research projects in Nicaragua and currently contributes actively to community-based natural resource management research in a number of countries in Asia, including China, Vietnam and Mongolia. He is also an adjunct professor at China Agricultural University.

This page intentionally left blank

CHAPTER 4

Seeds of inspiration: breathing new life into the formal agricultural research and development system

Song Yiching, Zhang Shihuang, Huang Kaijian, Qin Lanqiu, Li Jingsong and Ronnie Vernooy, with the collaboration of farmer plant breeders from Wentan, Guzhai and Gushang villages and Dujie township

IN CHAPTERS 2 AND 3, we described and illustrated the central role of maize in the livelihoods of Guangxi farmers. A dynamic and viable seed production system is crucial to maintain maize production, continue the process of crop improvement and adapt to local changes in the environment, both natural and human-made. Such a system is also the basis for the conservation of biodiversity for future generations. Organized women farmers at the research sites have taken the initiative to become qualified seed producers and distributors and new organizational forms are emerging to support these efforts. Their efforts are encouraging, although not without challenges and hurdles to overcome. In this chapter, we discuss the process and results of introducing and experimenting with participatory plant breeding (PPB). This was a first in China for any agricultural crop. The story of PPB in Guangxi encompasses attitudinal, technical, organizational, political, policy and legal dimensions. At its heart, it is a story about rural innovation.

PPB efforts have been underway in Guangxi since 2000. The work builds on an earlier study carried out from 1994 to 1998 to assess the impact of CIM-MYT's maize germplasm on poor farmers in south-west China (Song, 1998; see also Chapter 2). This study critically analysed the processes of technology development and diffusion and one of its key findings was the systematic separation of the formal and the farmers' seeds systems. This separation resulted in inadequate variety development, poor adoption of formally bred modern varieties, an increasingly narrow genetic base for breeding and a decrease in genetic biodiversity in farmers' fields (Song, 1998). As we saw in Chapter 2, these problems affect other regions of China as well.

The study of the maize breeding programme, the varieties it produced and contact with farmers in south-west China led to the authors' shared interest in experimenting to explore possible improvements. The research set out to identify technological and institutional options for developing more effective

Box 3. The limitations of conventional plant breeding research

In most countries, the majority of crop research and extension services continue to be guided by on-station experimentation. This is almost always carried out under optimum environmental conditions with the research design and execution fully controlled by plant breeders or agronomists. Yield increase is considered to be the ultimate goal and often the single variable by which variety improvement is gauged. Following a series of on-station test cycles, improved varieties are released by breeders and, with the collaboration of extension agents, channelled to farmers. These new, so-called 'modern' varieties, which are promoted in lieu of locally used varieties, often require specific additional inputs such as fertilizer and pesticides.

Key research decisions are made at the top of the organizational hierarchy: which crops to focus on, which researchers to fund, which methods to use, which achievements to reward. Experiments take place at one or a few experimental stations. Variety release requires formal approval and seed regulations are defined centrally. Decision making and information flow is from the top down. Farmers or others interested in crop development have no say in the process nor are they able to provide meaningful feedback on the resulting crop varieties. The research process is very introverted and disconnected from the diverse and often rapidly changing environments in which farmers grow their crops.

Beyond plant breeding, the sustainable use of biological resources is a matter of global concern. Distinct types and varieties of plants, animals and micro-organisms are vital for our food and health security. Biologically diverse ecosystems perform essential, although often poorly appreciated, environmental services that make life possible. Variety among species is crucial for the development of agricultural, pharmaceutical and technological innovations. Genetic variability within plant and animal species is the base for resistance to diseases, pests and climatic stresses. Agricultural biodiversity is vital for sustainable rural livelihoods. Women and men farmers, gatherers and fishers in rural communities around the world have been and continue to be the stewards of the greater share of this diversity.

However, today's agriculture is like a huge inverted pyramid; globally, it rests on a precariously narrow genetic base. Less than 3 per cent of the 250,000 plant varieties available to agriculture are in use today. Sources of agricultural biodiversity are under threat and disappearing in many regions. The top-down system of agricultural research, where farmers are seen merely as recipients of research rather than as participants in it, has contributed to this dependence on a relatively few plant varieties. Modern plant breeding approaches have contributed to it, particularly in the case of the staple cereals. This trend and the increasing industrialization of agriculture are key factors in what can only be called genetic erosion: the disappearance and displacement of diverse, local populations of crops.

Source: Adapted from Vernooy, 2003 and Vernooy and Song, 2004

links and mutually beneficial partnerships between those in the formal and farmers' seed systems. The goals were to enhance sustainable crop development and *in situ*, on-farm management of genetic resources and to bring direct benefits to poor maize producers. At the same time, the research aimed to strengthen women and men farmers' capacities to manage agro-biodiversity and improve their livelihoods (CCAP 1999, 2004).

In this chapter, we document progress made in improving local crop varieties over almost 10 years, especially PPB in the field (Part 1). In Part 2, we discuss relevant policy and legal issues, such as the integration of PPB into the

research agendas of the Guangxi Maize Research Institute and the Crops Research Institute, the broadening of the genetic base for maize, the protection of farmers' indigenous knowledge and their access to and sharing of benefits of genetic resources with the State Environmental Protection Agency and the mainstreaming of social and gender analysis in rural development research and policies at large. As this long list of policy and legal issues suggests, maize is not just a crop and its improvement is not just a technical intervention; this issue has a variety of socioeconomic and political implications for farmers' livelihoods. Through the efforts of farmers and others, maize seeds 'give' and create synergies in often unforeseen but impressive ways.

This chapter builds on earlier publications, including Song (2003), Song and Jiggins (2003), Vernooy (2003), Song and Vernooy (2003), Vernooy and Song (2004), Song, Zhang Shihuang et al. (2006), Vernooy et al. (2007), Vernooy et al. (2009).

Part 1. Linking the formal and farmers' seed systems

Poverty and farmers' livelihood security remain major issues in the remote mountainous areas of south-west China, perhaps even more so since China's entry into the World Trade Organization (WTO) and the increasing and rapid market-oriented economic development currently underway, which is not generating the expected benefits for all farmers. Cooperative and complementary relations between the formal seed system and farmers' systems, rather than the current separate and conflicted situation, is urgently needed if the country is to address the challenges in food security and biodiversity. Cooperation is also necessary to empower farmers – mainly women, as most men have migrated to the cities – to become active partners in plant breeding, on-farm biodiversity management and seed marketing. This central problem was the core reason for initiating PPB research in south-west China.

Key actors

PPB can help conserve and improve landraces existing in the diverse ecosystem in south-west China; enhance variety diversity and genetic diversity; and empower farmers by capacity building and involving them in decision making. The disadvantages are that normally the yield of PPB varieties is not high and only a small group of farmers has participated. The challenges are that more and more farmers living in mountain areas accept and rely on hybrid varieties; this may negatively affect the *in situ* conservation of genetic resources. Also, farmers, especially the younger generation, are losing interest in on-farm activities. The opportunity is that in the 1950s and 60s, local farmers and communities used to learn and practise purification and rejuvenation and PPB can benefit from such experiences.

*Huang Kaijian, Guangxi Maize Research Institute,
Nanning (interview, 2009)*

The Center for Chinese Agricultural Policy (CCAP) is providing coordination and guidance with regard to research design, implementation and use of the research results. The research is carried out by a team of women and men from various organizations and groups (see below), with various disciplinary and professional backgrounds and operating at various administrative levels. From the beginning in 2000, five groups of women farmers, six villages, six township extension stations and two formal breeding institutes have been directly involved in the PPB and participatory variety selection (PVS) design and implementation process. In recent years, other villages have joined in the project. In 2008, similar work started in the neighbouring provinces of Yunnan and Guizhou led by CCAP, the Institute of Crop Science (Chinese Academy of Agricultural Sciences) and the Ministry of Agriculture.

In Guangxi, the key actors are:

- *Institute of Crop Science (ICS)*. This institute, which is the leading Chinese organization for crop research and breeding, falls under the Chinese Academy of Agricultural Sciences (CAAS). It works on technological and related policy issues in maize improvement and genetic biodiversity management. Professor Zhang Shihuang heads the ICS.
- *Guangxi Maize Research Institute (GMRI)*. This provincial-level organization under the ICS collaborates in the formal plant-breeding work with direct involvement of selected villages and other related local organizations. GMRI has become a key player in the province, promoting and institutionalizing PPB.
- *Six plant-breeding villages*. The farming villages of Wentan, Zicheng, Niantan, Zurong, Guzhai and Huaguang and five groups of women farmers from these villages represent the farmers' seed systems. They collaborate with formal-sector plant breeders, extensionists and other stakeholders in the research activities (see Chapter 5 for more information).
- *Five township extension stations*. Extension stations in the areas where the trial villages are located operate as local facilitating groups and link the formal and informal systems by facilitating the PPB processes (see Chapter 6 for details about the role of extension services).

In addition, several postgraduate students from the College of Humanities and Development (COHD), China Agricultural University (CAU), have also joined the local research efforts. Since 2005, students have been carrying out fieldwork for their masters and PhD degrees in collaboration with and supervised by the CCAP-led team (for more details about the collaboration between COHD/CAU and CCAP, see Vernooy et al., 2008; Zhang Li, 2008). Their research is contributing directly to the larger initiative and their findings and reflections can be found throughout this book (note contributions from Gao Xiaowei, Li Jingsong, Zhang Li, Yang Huan and Wang Xiufen).

Field research methods

Through participating in the PPB process in Guangxi, I have collected and analyzed many valuable landraces from local communities; at the same time, I got some deep understanding about the traditional knowledge that farmers have about those landraces, which will benefit my future research.

*Qin Lanqiu, Guangxi Maize Research Institute,
Nanning (interview, 2009)*

Our research uses a PPB method adapted to the local context. The work of the entire team, including farmers, builds on local women farmers' maize-breeding experience and expertise developed over many years (Song, 1998). At the same time, we actively involve and seek knowledge and expertise from formally trained plant breeders. As far as we know, our work is the first of its kind in China and, as such, we are experimenting with a variety of methodological elements. We are making improvements through a number of crossing techniques and through various variety selection processes, which involve de-tasselling, mass selection and line selection by farmers with support from breeders. Breeders use more complex methods on-station, in the fields of the GMRI in Nanning.

Our work has covered a range of parallel activities over a number of years using various methods to identify parental materials (through participatory variety selection), improve populations (involving local and formal system genetic materials) and do further selection to obtain individual varieties. Trials in the six villages and at GMRI include both PPB and PVS experiments. These trials are evaluated by both breeders and farmers after each cycle and, subsequently, new designs are discussed and agreed to jointly. The trials allow for comparisons in terms of locality, approach, objectives and the types of varieties tested (Song, 2003; Song and Jiggins, 2003; Song, Zhang Shihuang et al., 2006).

Breeding materials used

In north-east China, individual farmers prefer to adopt a few hybrid varieties. However, farmers in south-west China normally plant several varieties on different parcels of land. The farming strategy in south-west China is to conserve many landraces which can adapt to the local ecosystems and this is an opportunity for carrying out PPB activities. The diverse variety adoption in the south-west can reduce farmers' risks and maintain local landraces. In the short term, PPB can help such in situ plant genetic resource conservation, but in the long term, the national-provincial gene bank needs to take this responsibility.

PPB can also benefit hybrid breeding. On one hand, with help from the Guangxi research team, farmers can afford good hybrids from the market; on the other hand, breeders can access more landraces through PPB, which

will broaden the genetic base. Of course, we need to take access and benefit-sharing issues into account.

*Zhang Shihuang, Institute of Crop Science,
Beijing (interview, 2009)*

As a result of a series of discussions among farmers and formal plant breeders, jointly and separately, we decided that the PPB and PVS field experiments would target four types of OPVs and landraces, i.e., so-called 'exotic' populations (from CIMMYT, other Asian countries and other regions in China – see Chapter 2), so-called farmer-'creolized' varieties (varieties developed by breeders but further adapted by farmers, sometimes by crossing them with landraces), farmer-maintained landraces and formally conserved landraces. More than 70 varieties were identified for PPB and PVS during on-station and on-farm trials between 2000 and 2005. The characteristics of the four types of these varieties and the purposes of the trials are as follows.

- *Exotic populations.* Populations, i.e., Tuxpeño 961, 962, 963, 964, 965 and 966, introduced by CAAS from CIMMYT in 1996, were identified as starting points for improving OPVs based on farmers' preferences and requirements. They were planted for field experimentation and selection for regional adaptation at GMRI during the first cropping season of 2000. (Note: there are two maize cropping seasons per year in the research area – from February to the end of June and from July to November). During the pre-harvest season, the first PVS field day was facilitated by the project team with participation of farmers from the six villages (80 per cent women), formal-sector plant breeders, extensionists and public seed company managers. Based on the results of these field trials, joint discussions and voting, two varieties (961 and 963) were selected for inclusion in farmer-led PVS trials in farmers' fields in the following cropping seasons. Other exotic materials, such as Suwan 1, Zhongmai 1 and Shanzhon, were then also introduced and tested using similar PVS methods and processes.
- *Creolized varieties.* These are materials originally provided by formal breeders, then improved and locally adapted ('creolized') by farmers. One popular variety, Tuxpeño 1, which came from CIMMYT in the early 1980s and was effectively diffused through farmers' systems in southwest China, then creolized by farmers (see Song, 1998), was included in on-station and field trials. These materials were tested through farmer-led PVS trials.
- *Farmer-maintained landraces.* About 25 landraces currently used by farmers in the trial villages were collected and included in on-station and field trials. These materials are being tested through farmer-led PVS and PPB trials.

- *Formally conserved landraces.* During field days at the GMRI station, farmers have selected more than 15 varieties from 100 formally conserved landraces for farmer-led PPB trials in the two in-depth case-study villages (Wentan and Zicheng), to be crossed by farmers with the landraces they are currently using. GMRI's landraces were collected between 1995 and 1997. Originally, the aim was to use them for conventional formal breeding and test and analyse their genetic features for population improvement. Since 2001, 100 landraces have been tested together with four standards, i.e., M17, 330, Bass (Reid) and Lancaster.

Trials

The field experiments use both breeder-led and farmer-led approaches to compare various research foci. After a baseline study, varieties were collected and discussions among farmers and formal-sector breeders led to field trials with four varieties in the second cropping season of 2000. Work started at GMRI and at two case-study villages: Wentan and Zicheng. In the following cropping seasons, the trials were scaled up to include all six villages. Each trial site has its own focus for PPB and PVS comparisons. Decisions about the trials and the division of labour between farmers and breeders differ depending on the type of trial.

Selection criteria

Farmers and formal plant breeders discussed and decided which morphophenological and other characteristics of the tested varieties were to be recorded. Farmers' preferences regarding these trial varieties are elicited during the PPB and PVS processes, e.g., in the course of discussions during trial design, PPB/PVS field experimentation and field visits. The farmers (predominantly women) from the six villages, extensionists, formal-sector breeders and other relevant professionals were invited to evaluate and 'vote' on the tested varieties in both the farmers' fields and on-station plots during the growing season, pre-harvest and post-harvest. It was important that after each voting event, a meeting was held for the voters to explain the reasons for their selections: this led to an agreed summary.

The assessments made during the field trials, field visits and field days by the farmers and the formal-sector breeders were regularly analysed by the team according to sex, type of household and local agro-ecological conditions to identify and reflect on the main differences and changes over time (Song and Jiggins, 2003). Table 12 illustrates one example of farmers' variety preferences, disaggregated by sex. There are several similarities between women's and men's criteria, but important differences also exist.

Table 12. Comparison of variety selection criteria used by women and men¹ farmers in trial villages

Criterion	Frequency of selection (%)	
	Women	Men
Drought resistance	100	100
Lodging resistance	90	83
High yield	80	83
Seed self-saving	80	50
Grain colour	70	50
Cooking quality	50	33
Plant shape/intercropping	50	83
Low fertilization rate	40	33
Maturing time	40	33
Plant height	30	33
Rate of damage resistance	30	33
Disease resistance	20	33
Insect resistance	20	33
Growth cycle	10	50

¹ The sample size was 20 women and 20 men.

Source: CCAP, data collected in selected villages in Guangxi in 2001.

The harvest

So far, more than 80 varieties have been used in our trials at the GMRI station and in the villages. Based on eight years of experimentation, four farmer-preferred PPB varieties have been selected and released in the research villages. (We know from observations and anecdotal evidence that they also have spread beyond these villages.) In addition, five varieties from CIMMYT that were showing increasingly poor results have been adapted locally. Another five landraces from the trial villages have been improved thanks to the joint efforts of farmers and formal breeders. Agronomic traits, yields, taste and palatability of all these varieties are satisfactory. They are also showing better adaptation to the local environment (CCAP, 2004; Song, Zhang Shihuang et al., 2006).

A women-farmer-improved variety, known locally as New Mexico 1 (i.e., Xin Mo 1) – whose parents are a variety from Wentan village and a local white maize from Zicheng village – has been tested over a number of cycles and certified by the formal breeding institution. Its robustness and taste make it very popular and it is now widely used locally. Farmers from neighbouring areas, who have heard about this variety, are coming to learn more and to ask for seeds. In the research area, varietal diversity is increasing. Meanwhile, formal breeders have identified in farmers' fields a number of very useful breeding materials with a valuable, broad genetic base.

After several years of PPB, the team has isolated four varieties. The first three are OPV varieties and the process used to breed them is shown in Figure 6.

- **Xin Mo 1** (New Mexico 1) was derived from a cross of farmer-improved Tuxpeño 1 (as the female line, from Wentan village) and Jiahe White (as the male line, from Zicheng village) in 2002.
- **Zhong Mo 1** was derived from crosses of Xin Mo 1, Suwan 1 and Amarinto 966 (as the male line) in 2004. This variety was developed because PPB farmers wanted to improve on Xin Mo 1, which is white, by creating a yellow variety, which would have a higher commercial value.
- **Zhong Mo 2** was derived from a cross between Xin Mo 1 and Amarinto 9 in 2006. The objective was to produce a yellow variety and improve taste.
- **Guinuo 2006** is a hybrid waxy variety, also called Guangxi Wax 2006. It was produced by GMRI breeders using one line from a PPB project (in Duan county) in 2001 (see Figure 7). Since 2002, it has been tested, adapted and used for seed production in the PPB villages.

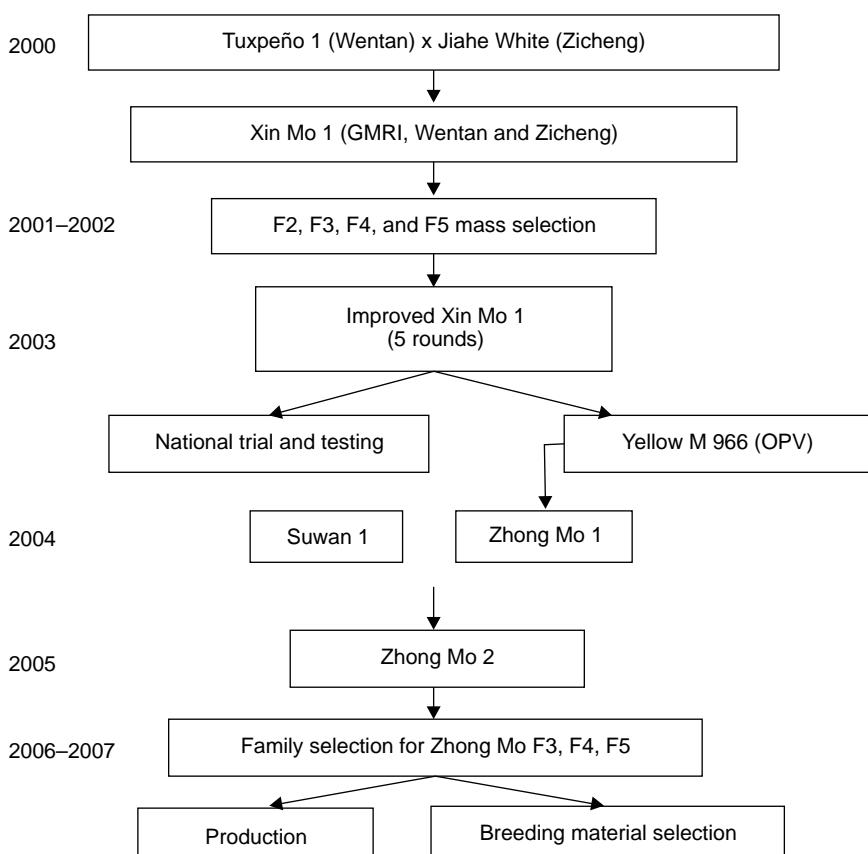


Figure 6. Breeding process for three open-pollinated varieties (OPVs)

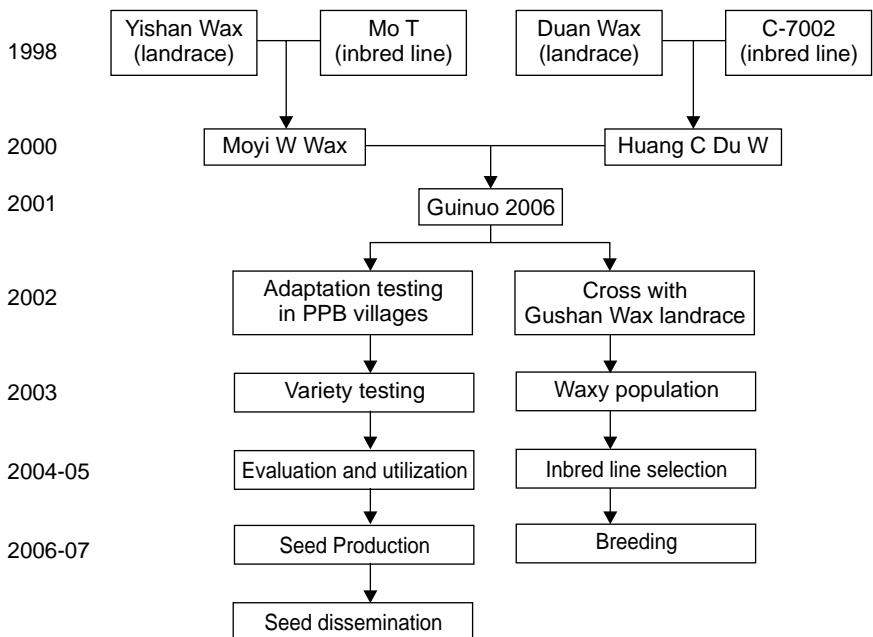


Figure 7. Breeding process for Guinuo 2006

Seed production

Among the four PPB varieties listed above, Guinuo 2006 is the favourite among farmers and local communities, not only because of its exceptional taste, but also because of its market potential. In 2006, the PPB villages in Mashan and Long'An counties started local seed production of Guinuo 2006. At first, the main difficulty for farmers was the lack of knowledge of hybrid seed production, but with help and technical support from GMRI breeders, they learned the basic skills and knowledge within two years. To manage the process better, farmers have set up a seed production group (see Chapter 5), who now produce seeds each season for their own use and to sell to neighbouring villages.

To share the benefits of PPB products, we encouraged farmers and GMRI breeders to establish some agreements concerning the exchange of breeding material and seed production methods to further enhance their collaborative relationship. This sort of collaboration is still very new and requires time and effort by all parties to embed the practice. It represents novel policy making in practice and is being followed with interest by both the Ministry of Agriculture and the State Environmental Protection Agency (see policy and legal challenges, below).

Reflections on the PPB experience

The PPB field experiments, both in farmers' fields and on-station, have been functioning successfully as a platform to involve the main stakeholders from both formal and informal systems, facilitating effective interaction, communication and collaboration. Initially, several women farmers showed great interest in seed and selection activities; later, more women and men joined the research activities. A few key women have been involved from the beginning and have become core team members. Farmers, especially women, are now speaking up at meetings and expressing their ideas, needs and interests. In a still strongly top-down research and policy environment, this represents a major change. It should also be seen in the wider Chinese context in which men increasingly seek work elsewhere and women are left with responsibility for the farm (Song and Jiggins, 2003; Song, Zhang Linxiu et al., 2006).

The participatory breeding activities have also strengthened local-level organizational and decision-making capacity among farmers. Groups of farmers have started to define specific support they would like to receive from extension services. They have suggested initiating seed production and marketing, in particular of OPV varieties bred by the team. Market research is also underway in Guangxi and its neighbouring provinces (CCAP 2004). The aim is to add value to the produce and to make ongoing activities, the PPB process and agro-biodiversity management more sustainable. In addition, following the first successful diversity fair in 2003, PPB villages are planning an annual diversity fair in their villages and possibly in Nanning, the provincial capital (Vernooy and Song, 2003; CCAP, 2004). The farmers have started to sell their seeds at these fairs.

Towards institutionalization

Some changes can already be observed in the attitudes of those in the formal system and in policy making. For instance, starting in 2001, farmers' needs and interests have been considered and included in the breeding plans and research priorities at the two participating breeding institutions. The Guangxi Rice Research Institute, under the Guangxi Academy of Agricultural Sciences, has also asked the research team to introduce PPB and PVS approaches into their rice-breeding programme, which is one of the biggest in China. This new collaborative activity is currently being planned in more detail. The Ministry of Agriculture recently agreed to include the project's participatory approaches and methods introduced by the Guangxi team in its national extension reform pilot programme. Another result is that the GMRI has adopted an approach to combine gene bank conservation with in situ conservation of landraces, realizing that landraces continue to play a vital role in farmers' livelihoods. In addition, Guangxi local germplasm conservation efforts are expected to be included in the national plan for the broadening of the maize genetic base by the Institute of Crop Science. This plan is expected to be approved by the Ministry of Agriculture in early 2009.

The research approaches, activities and achievements of the Guangxi team have been presented to various high-level policy makers and at conferences. For example, the project was presented and discussed in a national policy-planning workshop on maize-research priority setting, coordinated by CCAP and CIMMYT in Beijing, March 2002. This was the first time the farmer-participatory approach as an alternative and complementary method for crop improvement and agro-biodiversity management was discussed and considered by a group of prominent national policy makers and scientists (Vernooy, 2003). The PPB and PVS approaches and results were also presented at the 9th Asian Maize Research Workshop coordinated by CIMMYT and CAAS in Beijing (September 2005) and again at the 10th Asian Maize Research Workshop in Indonesia (October 2008). Participants from across Asia provided positive feedback to the team. The Guangxi experience is also being used as a case study in new rural development studies courses developed at China Agriculture and Jilin Agriculture universities (Vernooy et al., 2008).

However, PPB practices have created new institutional challenges, such as how to claim the ownership and rights over new varieties. To date, four new PPB maize varieties have been generated. In addition, other valuable local genetic resources have been identified and 'taken' from the villages and farmers for scientific use and conservation purposes. During the PPB process, more than 80 germplasms were exchanged by farmers and scientists. Unfortunately, according to the state Regulation on Protecting New Plant Varieties (1997), there is no policy for or legal recognition of farmers' contribution to germplasm creation or breeding better-adapted varieties. There are neither formal protection mechanisms nor incentives to support PPB innovation. If the new PPB varieties or other new varieties emerging from the collected germplasm were to be registered by the state, they would no longer belong to local communities or farmers, but become professional breeder-developed varieties. If farmers then wanted to obtain the seeds, they would have to go to the market, despite the fact that the genetic material was collected from their own fields and they participated in the entire breeding process.

Facing these emerging, but considerable, institutional barriers, the PPB core team has tried some experiments to 'break the ice' and encourage farmers' continuing active participation in variety improvement. For example, an informal agreement developed by the team involving both GMRI and farmer breeders allows farmers to benefit from their contribution to the development of Guinuo 2006 through small-scale marketing of seeds supervised by the GMRI breeders. Local seed production can thus be seen as a follow-up to PPB and as a concrete means to improve livelihoods. From the point of view of the GMRI breeders, the continuous PPB practices increase awareness of the farmers' contribution.

We are still looking for novel ways to address farmers' ownership of and rights to varieties they have worked on. The most important approach is to create bridges between farmers and formal breeders so that they work together.

This is the starting point for the PPB efforts and will also be the platform for further discussions.

Part 2: Policy and legal challenges

Policies and laws governing plant breeders' rights exist in China, but is there a need for new policies and legislation to address farmers' rights? Who owns the newly developed PPB varieties – New Mexico 1, Zhongmai 1 and 2 and others (Verwooy, 2005, Halewood et al, 2007, Verwooy et al, 2007)? PPB varieties result from the efforts of farmers, plant breeders, other researchers, extensionists, etc. How can the contributions of these participants – their ideas, knowledge, skills, time, energy, money, genetic materials and other resources – be recognized? How can adequate access to the new varieties be ensured and how can the commercial and non-commercial benefits from them be shared fairly? How can unfair practices be avoided?

Since early 2004 when these questions emerged from our field experience, we have been involved in two global initiatives and networks dealing with these questions: one is focusing on access and benefit-sharing issues of plant genetic resources; the other is about protecting traditional knowledge and local genetic resources. By sharing experience and attitudes with partner teams, we have clarified the common conflicts over plant genetic resources occurring in most developing countries. We have also defined the specific context surrounding the regulatory framework for plant genetic resources in China and for maize in particular. Finding a way to sustain PPB activities and PPB products within the Chinese context is our longer-term task.

Key questions

With the transition from a planned to a market economy, China is experiencing major changes. Even remote areas, such as our research site in Guangxi, are affected by these changes. China's entry into the WTO has led to a series of national policy reforms. Increasingly, the government is paying attention to the reform and enhancement of the legal system, including the formulation and implementation of some urgently needed new laws and regulations in the field of agriculture and the life sciences. However, in general, legislation is lagging behind the need for rapid development of the market economy. Of particular concern are the needs of farmers and their rights and interests in the open market.

Domestic legislation also lags behind the need to implement the international conventions and protocols that China has signed, such as the Convention on Biological Diversity. A review of the state's policies and regulations concerning intellectual property rights and related issues, such as those discussed here, suggests that the country's most relevant policies are still weak in practice. Some policies related to the Convention on Biological Diversity and intellectual property rights are not sufficiently developed; they focus more on

state rights and the interests of individual scientists, neglecting the collective knowledge and rights of farmers and local communities.

Constraints

Economic development *for all* remains one of the major challenges for many countries. One problem that many are facing is the unauthorized use and misappropriation of traditional knowledge and the genetic resources of indigenous and local communities for the development of new commercial products, such as drugs and seeds. No recognition is made of the contributions of local communities nor do these communities share in the benefits of the new products. In many countries around the world, an increasing number of patents on traditional-knowledge-based products are filed each year, granting private rights to community resources, such as certain crop varieties and medicinal plants. This is partly driven by the WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement, which requires upgrading of patent and plant variety protection in developing countries (we discuss TRIPS in more detail in the next section). It is also due to the spread of United States-style standards regarding intellectual property rights through bilateral or multilateral free trade agreements.

Existing laws and mechanisms are unsuitable for protecting traditional knowledge because they safeguard individual rights as opposed to collective rights (which emerge from collaboration and sharing rather than profit seeking) and are exclusively for commercial purposes. These same laws and mechanisms also have limited applicability to new collaborative innovation processes, such as PPB. Therefore, indigenous and farmers' organizations have called for alternative, so-called 'sui generis' systems to recognize and protect traditional knowledge and practices (and new practices that build on traditional knowledge) that are based on the customary laws and practices of communities. A number of national and international policy processes are underway to allow for the development of sui generis systems to protect traditional knowledge. So far, however, progress has been slow. One of the challenges has been to broaden the policy and legal debates beyond the sphere of international policy makers and experts, by including the knowledge-holders, i.e., farmers, herders, or fishers. The following are among the most important international processes underway with national repercussions.

Convention on Biological Diversity. In December 1993, the international Convention on Biological Diversity (CBD) came into force to conserve biological diversity, use biodiversity components sustainably and share the benefits arising from such use fairly and equitably (CBD 2001). The CBD provides an international, legally binding framework. Although not without problems, the importance of the CBD seems widely accepted and the governments that are parties to it have created a series of bodies or instruments, such as the Conference of the Parties

and the Subsidiary Body on Scientific, Technical and Technological Advice, to implement the convention.

Article 15 of the CBD and decisions IV/8 and V/26 (CBD 2001: 11, 487–489, 653–659) spell out the general guidelines concerning access and benefit sharing. Also of crucial relevance is Article 8(j) ‘In situ conservation’, which stipulates the need for equitable mechanisms related to indigenous and local communities’ knowledge, innovations and practices. An ad hoc, open-ended inter-sessional working group has been providing inputs into the design of a programme to implement Article 8(j), with emphasis on participatory mechanisms for indigenous and local communities.

During the 5th Conference of the Parties in 2000, an ad hoc, open-ended working group was established to develop guidelines and other approaches to access to genetic resources and benefit sharing. To date, draft guidelines (known as the Bonn guidelines) and a capacity-building action plan have been prepared. Notwithstanding these ongoing discussions and negotiations, including those taking place under the umbrella of the World Intellectual Property Organization, many practical issues on the CBD agenda remain unresolved. In the meantime, local farmers’ access to and use of many biodiversity resources are further restricted.

World Trade Organization: the TRIPS agreement. Apart from the CBD, another important international agreement impinges on issues surrounding plant varieties: the WTO’s Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). The WTO’s adoption of the TRIPS agreement has made the protection of plant varieties – by patents or by other means under effective *sui generis* options or by a combination of both (WTO 1994) – a requirement for developing countries. Although TRIPS has been in force for some time, many countries have yet to fully develop or implement plant variety protection. An uneasy and unclear relation continues to exist between the CBD and the TRIPS agreement, despite a formal review process underway to examine the coherence or incoherence of the two international legally binding frameworks. Among other issues, more effective recognition and protection of traditional or indigenous knowledge and related innovation processes are warranted. Sorting this out remains a major challenge.

Free trade agreements. Recently, other international movements have become more prominent. It seems that bilateral trade and investment agreements are increasingly used in a strategic fashion by powerful countries to incorporate ‘TRIPS-plus’ commitments that have been politically difficult to achieve at the multilateral level. In Asia, this trend is evident in recently agreed-to bilateral agreements and negotiations, such as the free trade agreements between the United States and Singapore and between the United States and Vietnam, as well as current negotiations between the United States and Thailand.

In this context, developing countries in Asia continue to face serious challenges, particularly with respect to pressures from their trading partners to

adopt more stringent protection of intellectual property rights. The consequences of many of these bilateral or free trade agreements, which may result in unintended negative consequences for small farmers and other producers, are not often assessed or thoroughly understood by decision makers. In agriculture, the Union of Plant Varieties 1991 convention (UPOV, 1991) is often being imposed through free trade agreements, which will make it difficult for developing countries to enhance farmers' (collective) rights and permit exceptions.

We argue that some form of recognition and support for the development of plant varieties is critical to the sustainability and economic growth of countries. WTO members have several options under Article 27.3b of the TRIPS agreement for protecting plant varieties, including patents; specific plant variety protection regulations, including Union for the Protection of New Varieties of Plants-type mechanisms; home-grown or *sui generis* schemes; and agro-biodiversity laws. Most plant variety protection laws focus on protecting high-yield crops and not on agro-biodiversity conservation.

The legal obligations contained in various international agreements including the TRIPS agreement, the Union of Plant Varieties convention, the CBD and the new Food and Agricultural Organisation's Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA; FAO 2009) have created a complex web of obligations not only surrounding access to and use of genetic resources, but also regarding the products and technologies derived from such resources. Lack of legal certainty and coherence at the international level is a serious limitation to effective implementation at the national level. The lack of recognition and engagement in the CBD and the ITPGRFA by important members of the international community is a barrier to the search for constructive solutions to the problem of illegal access and use of genetic resources.

In many countries, a divide exists at the national level in terms of policy and legal attention paid to plant breeding and plant varieties. On one hand, there is a sector with good incentives for commercial breeders and the biotechnology industry (e.g., private- and public-sector investments). The main legal supportive tools are patents and UPOV and patent-like protection models. On the other hand, there is a second sector, small and at the margins, consisting mostly of people concerned about agro-biodiversity. This sector uses a more holistic approach that promotes biological innovation while allowing the incorporation of public-interest considerations, including exceptions, farmers' rights, biodiversity conservation measures, contractual obligations, protection of traditional knowledge, land and property laws, competition law and technology transfer. The issue of the protection of traditional knowledge is central here and *sui generis* forms of protection and preservation that could address the concerns of traditional and local communities are favoured. Our research finds its home here.

As we have described, we have made some progress in acknowledging the role of traditional knowledge and practices (including some of the changes taking place related to these) and their importance for innovation processes. We

have also had some achievements in new-crop-variety breeding and landraces conservation and collection, through joint planning efforts and a multi-stakeholder, collective research process. However, several challenges have emerged. For instance, the first PPB variety, named New Mexico 1, which was bred out in 2002, is a collective achievement of farmers, breeders and extensionists in terms of effort, knowledge, breeding materials and other inputs. Despite the collective nature of the innovation process, the variety can only be registered under the name of a breeder or formal breeding institution, according to the existing new variety registration system (the Protection Regulation for New Plant Varieties) implemented by the Chinese Ministry of Agriculture in 1999.

Another example is the approximately 80 landraces collected by formal breeding institutions and gene banks during the research process. Unfortunately, farmers' and local communities' rights and interests were not recognized and their access to these and their share of any benefits were not considered in the process. Our research suggests that there is need for new policies and legislation concerning farmers' and local communities' rights. For example, for the newly developed PPB variety New Mexico 1, a key policy and legal question is, to whom does it belong? How will the law recognize the multiple contributions to the new variety? How will it provide for adequate access to new varieties, for their use and for the sharing of (commercial and non-commercial) benefits they may bring?

Creating synergies: conclusions

Introducing and practising PPB in Guangxi has been a rich experience. Starting on a small scale, farmers enthusiastically expanded the test areas, neighbouring villages followed and, more recently, neighbouring provinces have also followed in the footsteps of the pioneers. Our participatory approach has enabled small farmers – women and men – in the marginal areas of southwest China to participate in maize breeding as equal partners alongside professional breeders, other researchers and extensionists. Together, these partners have been sharing their know-how, expertise and seeds and contributed, in a complementary manner, toward agricultural diversity enhancement, crop improvement and farmers' livelihood security.

We realize that to put such a new approach into practice on a large scale and to further address farmers' and local communities' rights over PPB products will require fundamental organizational, institutional and policy changes in agriculture and related research and policy fields. We have made some inroads here, but more effort is required. In the following two chapters, we present and discuss key dimensions of organizational, institutional and policy change: farmers' cooperation and organization and agricultural extension.

About the authors

Song Yiching is a social scientist with a special interest in rural development (especially working with women), farmer organizations and agricultural extension. She received a PhD in rural sociology and rural development studies from Wageningen University. Currently, she is a senior research scientist at the Center for Chinese Agricultural Policy, Chinese Academy of Science in Beijing, leading a long-term action research programme to create synergies between the seed systems of farmers and the Chinese government. She has led the research in Guangxi since 1999.

Zhang Shihuang received a PhD in maize improvement from the Chinese Academy of Agricultural Sciences and went to the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT) as a visiting scholar in the 1990s. He is a leading maize breeder and currently a chief scientist in maize research and production in China. He is the director and a professor in maize improvement in the research department of the Institute of Crop Science, Chinese Academy of Agricultural Sciences, Beijing.

Huang Kaijian obtained bachelor's and master's degrees at Guangxi Agricultural University in Nanning and has worked as a maize breeder at the Guangxi Maize Research Institute since the 1980s. He is now a senior maize breeder and deputy director of the institute. Since the beginning, he has worked as provincial coordinator of the Guangxi research team.

Qin Lanqiu obtained a bachelor's degree from Guangxi Agricultural University and has worked on maize genetic resources at the Guangxi Maize Research Institute since the early 1990s. She has been a local coordinator for grassroots level extensionists and farmers since 2001. She is also studying part time in the participatory extension degree programme at China Agricultural University.

Li Jingsong earned a BSc degree in sociology from China Agricultural University and a master's degree in environmental management from Wageningen University in the Netherlands. She works as a senior research assistant at the Center for Chinese Agricultural Policy and has a special interest in rural development and environmental management. In September 2007, she began PhD studies at Wageningen University in the Netherlands.

Ronnie Verwooy is a senior programme specialist at the International Development Research Centre, Ottawa, Canada. He received a PhD in the sociology of rural development from Wageningen Agricultural University. He has conducted and directed a number of rural development research projects in Nicaragua and currently contributes actively to community-based natural resource management research in a number of countries in Asia, including China, Vietnam and Mongolia. He is also an adjunct professor at China Agricultural University.

CHAPTER 5

Farmer cooperation and organization: new challenges, new networks, new identities

Yang Huan, with Gao Xiaowei and Li Jingsong

CROP IMPROVEMENT is not merely a technical challenge. In practice, organizational, institutional, policy and legal dimensions all intermingle to ‘make it work’. The accumulated field experience in Guangxi suggests that, at the heart of the process of crop improvement – and, by extension, of rural development – are questions and challenges related to farmers’ cooperation and organization. Without vital farmers’ organizational processes, regardless of whether they are supported by others, innovation has only a limited chance of gaining ground and bringing benefits to many.

Today, in rural areas across China, farmers, researchers and extensionists are trying to find novel ways to join forces and work together. Unfortunately, there are barriers: history; the presence of a still-very-dominant state apparatus; and the heterogeneity of the farmers themselves. Increasingly, rural areas and the country at large are becoming more differentiated socioeconomically and, to a lesser degree, politically.

Although the Guangxi team has always paid attention to organizational dynamics, this interest has intensified recently because of the evolution of the participatory action research process at the local level and policy changes at the national level. Farmers all over the country are actively searching for and trying out novel ways to cooperate and organize, as described in this chapter. We believe that this is one of the most important societal changes underway in China.

Novel ways for farmers to organize

Household-based farming was and is at the heart of China’s farming systems. The average farm size is only 5.44 mu (about 3,600 m²) and this situation is not expected to change (Tan, 2006). For households such as those described in this book, whose primary goal is to grow enough food for their own needs, this makes the production of a significant marketable surplus difficult.

In the mid-1990s, markets, which are free to a certain degree, started to become the dominant source of agricultural technology and inputs. New markets also led to rapidly growing demand for higher-quality, safer and fresher food from farmers (Fock and Zachernuk, 2005). In many regions, however, farm households are at a disadvantage compared with other market

stakeholders, such as traders and representatives of large companies (e.g., supermarket chains). For farmers in poor and remote areas, such as Guangxi, the situation is even worse.

To face challenges in the marketplace (in the broadest sense of the term), farmers' organizations are seen as a viable link between individual farmers and input and output markets. As a group, farmers can have more voice and choice and a stronger position when dealing with intermediaries, consumers and government. But farmers' organizations could also serve other purposes: to organize production more effectively and efficiently (e.g., through joint or co-management of natural resources such as water, grasslands, forests); to gain better access to credit (and avoid being exploited by middle-men), information and other services, including support from researchers; to keep, gain, or regain control over local issues of importance, such as access to, use and maintenance of infrastructure (roads, wells, playgrounds, irrigation systems); and for entertainment and culture (for example, keeping alive or reinvigorating local dance, songs and theatre). Farmers' organizations have yet to emerge in the country as strong political actors.

Recently, farmers' organizations, the role they play and their significance in rural development have attracted new interest in both policy and research circles. In summer 2008, the Chinese government passed a new law recognizing farmers' financial cooperatives. The National People's Congress (NPC) had been advocating such a law for a number of years and its Agriculture and Rural Committee worked ardently on it, with the cooperation of other agencies, including the Ministry of Agriculture (Agriculture and Rural Committee, 2004). In 2008, the College of Humanities and Development of China Agricultural University and the Center for Chinese Agricultural Policy (CCAP), building on their past efforts and those of partners across China, initiated a large research project on farmers' organizations to better understand the current situation and identify needs, the main constraining factors, and opportunities. They wanted to determine whether farmers could organize to engage meaningfully in agricultural innovation; design, test and assess supportive policies and appropriate mechanisms to promote the development of farmer organizations in different contexts in China (i.e., make the state's Farmer Cooperative Law, Regulation on Farmers' Financial Cooperatives, Regulation on New Seed Protection and Extension Law work in practice); and enhance the organizational, research and policy making capacities of various stakeholders at different levels. Our research on farmers' cooperation and organization in Guangxi contributes to this larger initiative.

In this chapter, we focus on the efforts of Guangxi farmers, who are facing many new challenges, to organize themselves in novel ways. In addressing this issue, a number of important questions emerge: What is the existing nature of cooperation among farmers? What is the basis for cohesion in new farmers' organizations? How can farmers be helped to fully develop and use locally adaptable knowledge and establish links with the 'external world' (including markets and service providers) that are effective, efficient and fair? As

our own recent overview of the literature suggests, this is a relatively under-researched field and answers to these and other relevant questions are still to be found for China (Yang Huan et al., 2008). In this chapter, we aim to provide some initial answers to these questions.

We address larger questions as well. How China addresses the challenge of rural innovation, including the many forms of local farmers' organizational practices that are now emerging (some led by government, some supported by nongovernmental organizations (NGOs), some farmer-led) and develops a follow-up to the green revolution model for agriculture will have impacts beyond its borders. The future vitality of rural areas will be influenced to a large degree by the success or failure of these new emerging organizational forms and how 'external' agencies provide adequate and timely support to them. From our field research, we know that there is an enormous wealth of creativity in China's rural areas; the challenge is how to uncover it and make farmers' 'inventions' known to the wider world.

Key insights from the literature

Nowadays, farmers (especially small farmers) are facing several challenges. Market-driven development and a dynamic environment are two of them (World Bank, 2007). In this changing context, farmers' organizations that focus on strengthening production have emerged as a mechanism to increase small households' participation in the market and ensure that their members benefit from that participation (Bernard and Spielman, 2009).

Farmers' organizations are defined as those created by farmers to provide services to themselves (Rondot and Collion, 2001). These services can take many forms: information, credit, extension services, research support. Whatever the form, when functioning well, farmers' organizations play the role of interface between individual farmers and the wider environment. Producer organizations have to deal with internal and external relations. Within the organization itself, members are expected to define a common agenda, solve conflicts, make joint plans and commit to them. Connecting to the outside, the organization as a unit of operation has to manage multiple relations, locally, regionally and sometimes nationally or internationally (Rondot and Collion, 2001; Bijman and Ton, 2008).

The potential roles of farmers' organizations can be described as follows:

- Building networks and operating as a social force for agricultural innovation. Several studies show that farmers' organizations may be viewed as a new channel for the government to provide extension resources (Rivera and Alex, 2004). In China, this is not yet common (more about this in Chapter 6).
- Organizing the exchange and sharing of knowledge among members, as well as with other stakeholders, for example, by establishing multi-stakeholder platforms (Wennink and Heemskerk, 2006). This is

compatible with what Klerkx and Leeuwis (2009a,b) have described as forging peer networks and involves establishing functional relations between different farmers' organizations ('bridging') and with other actors ('linking') that operate within the sector or region.

- Coordinating services provided to their members and ensuring complementarity of knowledge as well as economic services. Berdegué Sacristán (2001) found that in markets characterized by high transaction costs, membership of a farmers' organization could significantly improve market access, reduce risk and increase price obtained for produce.

The success of a farmers' organization depends not only on well-designed rules within the organization, but also on the embeddedness of the organization in the local context. Limnirankul (2007) argues that collective action can trigger new forms of collective action in technology development. Shared knowledge, norms, rules and expected behaviour in interactions among farmers are helpful for developing common action (Limnirankul, 2007) and designing appropriate and fair fines or sanctions within the organization (Berdegué Sacristán, 2001). According to Ostrom (1999), social capital may improve with use so long as participants continue to keep prior commitments and maintain reciprocity and trust. This points to the important feature of organizing as a process, more than as static event fixed in time and space.

This summary of insights from the literature provides some useful entry points for examining farmers' organizations in practice. We will use these entry points as a basis for describing some real-life experiences.

New farmer organizations: an emerging feature in society

In 2003, a national survey of 2,500 villages indicated that 2.9 per cent of farmer households had recently joined one or more farmer organizations (all types) and that 10 per cent of all villages had at least one kind of farmer organization (Zhang Linxiu et al., 2007). Even if we view these numbers with some caution, the growing importance of new forms of farmers' organizations seems evident.

The emergence of new types of organizations occurred in stages. From the early 1980s to the early 1990s, farmers' organizations mainly took the form of 'professional associations,' engaged in the exchange of technology and the provision of extension services to members (Han, 2007). During the middle and late 1990s, as China entered the WTO and food product chains were developed, the number of farmers' organizations increased steadily (RAF, 2004). The services carried out by the organizations extended to supplying inputs, market information, marketing and transportation. At the same time, the scope of the organizations expanded from local communities to trans-town and trans-county coverage (Han, 2007). From the late 1990s to 2007, the number of farmers' organizations increased even more dramatically, with the total number quadrupling during this period (RAF, 2004; Han, 2007).

However, the development of farmers' organizations was not balanced across regions. In the western provinces and remote areas, they developed slower than in other parts of the country and even within provinces, growth was uneven. Their distribution is correlated with agricultural population (the more people, the more organizations) and the importance of agriculture in the region's economy (the higher the importance the more organizations) (Zhang Linixu et al., 2007).

These macro-level data offer a glimpse of the emergent patterns and significance of new farmers' organizations. Given China's vast and diverse area, however, only local studies provide a detailed picture.

Challenges

The rapid agrarian and socioeconomic changes occurring all over rural China are having an impact at the Guangxi research sites. The first challenge is the change in the structure of farm household income (see Chapter 3 for details). As farmers find opportunities for off-farm work, agriculture is no longer the only or even the main source of household income. According to our recent field assessments, about 60 per cent of household income in the study villages comes from off-farm work. At the same time, more and more farmers raise livestock; 11 per cent of households in our survey obtain the major part of their income from husbandry. These changes result in a new division of labour and new challenges for the households concerning management of time and energy, monetary income and marketing.

Because men and young people have greater access to off-farm work, women and older people are becoming the main agricultural labourers at the household level. In our survey, only 39 per cent of men aged 15–65 years engage in agriculture for more than half the year. In contrast, 61 per cent of women in that age group are mainly engaged in agriculture. The average age of those who work in agriculture more than half the year is 49.5 years. Also, the educational level of 56 per cent of those who work mainly in agriculture is primary school or below, whereas among those who work mainly off-farm, 73 per cent have junior middle school education or above. Comparatively 'disadvantaged' people are now engaged in agriculture, which results in changes in the agricultural production system. As we have observed, these farmers find it difficult to innovate or to join innovation processes.

In the past, farmers received most technical information and agricultural services from the official extension system. However, as mentioned above, some farmers are now engaged in husbandry and some are producing cash crops and the extension system has not been able to respond or adapt to these diversified needs (more about the extension system in Chapter 6). On the one hand, it appears more difficult for women and older people to learn how to use new technology or develop new skills. On the other hand, extensionists lack proper communication skills to interact with farmers and understand the changing ecological situation. According to one farmer leader, 'The extensionists do

not understand our agricultural production at all. Now, facing more frequent droughts and floods, they give us little help.'

In addition to being poorly served by the extension system, farmers are barely able to obtain credit from the formal banking system. In our survey, 44 farmers thought that the loan application procedure was very complicated. According to one farmer, 'The bank simply refused to issue credit,' regardless of his assets. Lack of financial resources keeps farmers from enlarging the scale of their production or improving production conditions. For example, although raising pigs and cattle is more efficient than raising chickens and ducks, these activities require more money at the investment and development stage. Our research team tried to help farmers obtain small loans to cover the basic needs for expanding animal husbandry, but time and effort are needed to get started this way.

When farmers are able to expand their scale of production and become more market oriented, they then need access to effective and fair marketing. Lack of market information leads many to make 'wrong' decisions, resulting in either overproduction or market shortages at times. Although overproduction is often local, most individual farmers are limited to local markets (as they lack a means of transportation) and must endure low prices for long periods. Thus, a blind rush to participate in and trust the market is unlikely to do much good in the long run.

Agriculture in general and in rural areas in particular is becoming more and more disadvantaged due to the low levels of human capital and limited access to new and useful technology, funds and information. How farmers can organize, with or without outside support, to improve their position and keep pace with the rest of society is becoming an increasingly urgent question.

The Guangxi research team recognized this problem after their initial research and set out to develop some novel ways to support farmers to organize themselves and solve some of the problems they face through collective action. As researchers working with farmers in this process, we gained much useful experience and learned some valuable lessons, which we describe in the following sections.

Farmers' coping strategies and external support

Starting in 2004, the Guangxi team began to support farmer organizations at selected sites. Farmers in villages in Wuming, Duan and Long'An counties established community development committees (CDCs). In 2006, two villages that are engaged in organic production in Hengxian county joined forces with the team. The local CDCs try to meet the needs of farmers, guided by the basic principles underlying our participatory action research (PAR) efforts (see Chapter 1). Table 13 lists the various activities of the CDCs at the research sites.

Although an impressive variety of collective actions are being carried out in the villages, the nature of these efforts, the timing and the results vary

Table 13. Activities carried out by farmers' organizations at the project sites

<i>Site</i>	<i>No. of CDC members</i>	<i>Activities carried out by CDC¹</i>
Duan county	20	<ul style="list-style-type: none"> – Evaluation of maize varieties (PVS²) – PPB³ training – Local plant resource collection – Management of VDF⁴
Mashan county	69	<ul style="list-style-type: none"> – Evaluation of maize varieties (PVS) – Guinuo 2006 maize seed production – Local plant resource collection – Collective marketing of maize seeds and poultry – Management of VDF
Wuming county	19	<ul style="list-style-type: none"> – Evaluation of maize varieties (PVS) – Local plant resource collection – Management of VDF – Experiments in cassava planting
Long 'An county	25	<ul style="list-style-type: none"> – Evaluation of maize varieties (PVS) – Local plant resource collection – Management of VDF – Training in cattle raising – Repair of meeting room – Sports activities
Chentang, Hengxian	35	<ul style="list-style-type: none"> – Organic rice and kohlrabi production and marketing – Irrigation sub-channel construction – Local plant resource collection – Management of VDF
Sancha, Hengxian	35	<ul style="list-style-type: none"> – Organic rice production and marketing – Irrigation sub-channel construction – Local plant resource collection – Management of VDF

¹ CDC = community development committee, ² PVS = participatory variety selection, ³ PPB = participatory plant breeding, ⁴ VDF = village development fund.

Source: CCAP, Guangxi field research evaluation results, 2008.

considerably. However, in general, farmers are satisfied with these organizational processes. To provide more detailed answers to the central questions of this chapter and to highlight specific examples, we selected three cases. The first, in Wuming, mainly addresses the changing nature of informal cooperation among farmers. In the second, in Hengxian county, activity focused on one kind of production. In the third, in Mashan, activities are diverse, but the overall aim is to improve the general livelihood of local households.

In addition to Guangxi team staff members, a master's student and a PhD student from China Agricultural University were involved in the research on farmers' organizations, which added new perspectives to the work. The master's student (Yang Huan) focused on informal cooperation among farmers in Wuming. The PhD student (Gao Xiaowei) mainly studied the local embeddedness of organizations that were established through the PAR process. They shared their research results with the Guangxi team and the case studies that follow reveal their findings (Yang Huan, 2007; Gao Xiaowei, 2008a, b).

Case study 1. Understanding farmers' informal cooperation in Wentan village, Wuming county

The power of organization, both formal and informal, and the power of culture are very important in maintaining cooperation (Wu Licai, 2004). It is therefore important to understand the extent of cooperation between farmers and the social and cultural factors behind it.

Cooperation in replacing crop varieties. As the commercialization of inputs and products increases, farmers' incentives to replace crop varieties and find new varieties multiply. Networks play an important role in their efforts to identify, acquire, plant and experiment with new varieties. Crops, old and new, are not merely plants, but an integral part of social relationships that evolve over time and space.

Changes in varieties of cassava, which is the main cash crop in Wentan village and has a long cultivation history there, relied heavily on social affinities. The traditional variety that was grown in the 1950s was 'poisonous' and could only be eaten after special treatment. In the 1970s, a woman introduced a new variety that she had obtained from her sister in another town. It is not poisonous, can be fed to cattle and is easy to prepare for human consumption. In the early 1980s, when cassava began to be used for starch production, another variety with a high starch content was introduced. This time, the new variety (locally called 'slender leaves cassava') was introduced by a woman who obtained it from her mother's home town; it happened to be the variety promoted by the county extension system.

As government-supported starch production increased quickly in the county and adjacent ones, smaller traders purchased 'slender leaves cassava' from Wentan and sold it to villages that lacked access to new varieties. 'Slender leaves cassava' spread rapidly and widely as a result.

A new variety of another cash crop – sugar cane – was introduced by yet another woman, who brought it from her home town when she first settled in the village. (The key role of women in crop production, replacement and enhancement is evident from these examples.) When the government centralized the sugar industry, the local factory began to distribute new varieties directly to farmers to improve the quality of the raw material.

For the main food crops, including maize and rice, farmers increasingly obtain hybrids from the market and only a few households maintain local varieties on a small scale (Table 14). At the same time, although relatives and friends are no longer the key sources of new or improved varieties, they remain important sources of information and knowledge. While the trend towards a greater role for the market in variety replacement seems irreversible, social relations continue to be important as a reliable source of technical information.

Table 14. Farmers' channels of access to rice varieties

Method of obtaining rice varieties	10 years ago		Now	
	No. of households	%	No. of households	%
Self-saved	59	81.9	29	40.3
Obtained from relatives or friends	2	2.8	—	—
Purchased on recommendation of relatives or friends	3	4.2	24	33.3
Purchased on recommendation of extensionist or seed dealer	16	22.1	30	41.6

Source: Adapted from Yang Huan, 2007

Cooperation in the use of labour and small agricultural machinery. Cooperative use of labour and agricultural machinery is still common and benefits the farmers who face labour shortages and lack resources for mechanization (Table 15). According to our survey, 43.1 per cent of households borrow an ox and machinery (including a 'walking' tractor, a small ploughing machine and a small water pump) from others; 31.9 per cent share an ox and machinery with others. These are relatively high percentages.

Figure 8 shows the network of labour involved in sugar cane production in Wentan village between 1987 and 1995. It indicates that farmer households relied on relatives for labour much more than they do today and that the exchange of labour was based on mutual benefit. Nowadays, households hire labourers. This change is more obvious in sugar cane and cassava production than rice, because these two crops are sold rather than used for home consumption.

There are two reasons for this phenomenon. First, farmers are recognizing the opportunity cost of their labour as they engage in off-farm work. Second, the transformation from the collective production system to a household-based production system (known as the 'Household Responsibility System' reform) is causing increasing differentiation in production scale among farmer households, resulting in labour shortages and labour surpluses in different

Table 15. Cooperation among farmers in the use of labour

	Rice		Cassava		Sugar cane	
	No. of households	%	No. of households	%	No. of households	%
Households lacking labour	14	20.3	24	33.3	9	90
Source of assistance						
Relatives	7	50	17	70.8	2	22.2
Hired labour	4	28.6	7	29.2	8	88.9
Friends	3	21.4	3	12.5	0	0

Source: Adapted from Yang Huan, 2007.

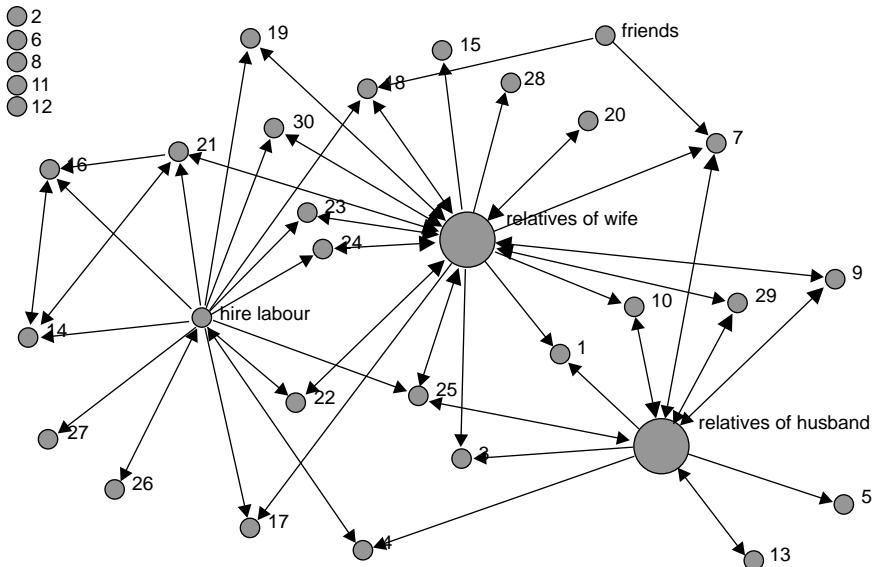


Figure 8. Mutual help network for sugar cane production in Wentan, 1987–1995

Note: The numbers indicate individual households. Households 2, 6, 8, 11 and 12 do not engage in labour exchange.

Source: Yang Huan, 2007.

households in the same local market. The differences in scale of production are partly a result of the ‘long-term-use right of arable land’ policy, forcing families with more sons to divide land into smaller parcels for the next generation. In Wentan village, land reclamation in the 1990s also put previously uncultivated land back into use.

Compared with 10 years ago, farm households are facing fewer labour shortage problems. This is partly because of a change in planting patterns – away from rice, which requires a lot of labour – to cassava, which can be managed on a larger scale and brings higher profits. In addition, nowadays households use some machinery and other labour-saving technologies. The ‘walking tractor’ and a small ploughing machine are used by almost every household in the village. Modern combines for harvesting are also available to the villagers at a rate of CNY 60–70 per mu of crops harvested (or 132–153 US\$/ha, but note that average farm size is far less than 1 ha). A new transplanting technology has been popular in the villages since the beginning of the 1990s.

The same trend can be seen in terms of sharing agricultural machinery, with both the scale and the amount of cooperation decreasing over time. The reasons are a weakening of traditional cultural practices (the process of individualization) and the need for efficiency (stronger market forces). It is more difficult for households that share machinery to coordinate work during the busy season (when ‘time is money’) and share the cost of repairs fairly.

Kinship is still important in terms of cooperation in Wentan, especially for sharing agriculture machinery. At the same time, household relations with the 'outside' are now extending beyond kinship to colleagues and business-oriented connections. Farmers now have more choices in selecting 'partners'. For example, several households now get help from friends rather than relatives. New social networks and identities are emerging as a result.

Case study 2. Organic farming associations in Hengxian county

Two organic farming associations, established by local farmers themselves, are becoming more and more well known in Hengxian county in south-east Guangxi. Their organic products – rice and kohlrabi – are welcomed by many customers from Nanning, Liuzhou and even as far away as Hong Kong. In the city of Nanning, a new organic food restaurant purchases organic produce directly from the two associations. This restaurant, the first of its kind in the province's capital, is becoming popular very quickly.

The associations, based in Chentang and Sancha villages, were established in 2005, a year after organic farming was initiated. Motivated to do things differently, farmers began to reorganize their work, relying on local resources (such as organic fertilizers) and a collective spirit. Starting with only 10 farmers, they were soon able to obtain technical guidance and some financial support from Partners for Community Development (PCD), a Hong Kong-based NGO operating in various provinces of South China.

PCD staff organized and financed a visit by the farmers to a project site run by Oxfam in Dahua county, where several farmer associations were established and running well. Based on what they learned, the Hengxian county farmers reorganized their own associations. In the following season, the number of farmers engaged in the organic farming doubled in both villages – mobilized by the new associations. In 2006, PCD staff began working with researchers from the CCAP and the Guangxi Maize Research Institute (GMRI) to improve local varieties – for example, through participatory plant breeding and developing market opportunities through action research. By 2008, the Chentang organic farming association had 35 members and the Sancha association had 38 members. Most are middle aged and older – as are farmers elsewhere in rural China.

Each association has a chairperson, vice-chairperson, cashier, accountant, technician and one person in charge of storage; for each of these functions, members have defined rules of behaviour. The associations encourage the farmers to make improvements themselves. Apart from technical training delivered by CCAP and GMRI staff, the associations organize regular communications among the members to improve their farming skills and give them a deeper understanding of the advantages of organic farming. The associations also carry out crop variety experiments to find higher-yielding and better-tasting varieties. The members are divided into small groups to monitor each

other's planting efforts and make sure that everyone avoids the use of chemical fertilizers and pesticides.

The associations try to provide services to the members. As they gradually enlarge the area devoted to organic farming, the local supply of fertilizer can no longer meet their needs. Because homemade fertilizer is the best choice, as it allows for strict quality control, the associations have begun to purchase the raw materials – such as bran and bone meal – for the members and organize the farmers to experiment to determine the best proportions of the materials and the most effective amount of organic fertilizer to use.

The association in Chentang village organized the members to rebuild an irrigation channel in the organic field with some funding from PCD and money contributed by village households. This association is also mobilizing the members to donate money to build a new meeting room for the association; the chairperson has offered to provide the bricks.

With extension of the area used for organic farming, yields are increasing and more and more organic rice and kohlrabi are being produced each year. How to ensure benefits for the farmers is becoming the most important issue for the associations. With the help of groups in Nanning and Liuzhou made up of urban customers who are interested in organic food and willing to support farmers, farmers have the opportunity to communicate directly with consumers and help them understand their organic farming system. Every season, the associations invite the customers to the village to experience organic farming and taste organic food.

Now, the price of organic rice is 7.6–8 CNY/kg (1–1.1 US\$/kg), which is higher than the price of ordinary rice by a third to a half. Organic kohlrabi is also more expensive. According to farmers' calculations, the profit on the organic rice is about the same as that from ordinary production. Although the price is higher, inputs are also higher and yields are generally lower. Farmers are motivated to produce the organic food, however, convinced of the health benefits it offers them and consumers of their produce. They say that food safety is important for them.

In 2008, sales of organic rice reached more than 2,100 kg for each association, but several new problems emerged. First, there is a shortage of rice-processing machines. Both associations process rice in small local mills that cannot produce rice of high-enough quality. The associations plan to buy their own, modern rice mills, but do not have enough money. Members also do not wish to invest more money at this point, given the current low profit. A second problem concerns transportation: both villages are quite far from the county centre and encounter difficulty getting their rice to consumers on time.

The growth of the associations has not been without challenges. The leaders, especially the chairpersons, both of whom are men, have invested a lot of time and energy, and also their own money, in organizing activities and exploring the market for the benefit of the whole association without receiving any payment. Their voluntary efforts are not sustainable in the long run, as

they must earn money for their own families. The associations' income, which comes from the annual fees of members and a small percentage of the sales of organic products, is just enough to meet the associations' office expenses. Thus, how to reimburse the leaders for their time and efforts is an issue.

Another challenge is how to respond adequately to the growing interest in the associations. As more members join, the associations struggle with adequate and timely provision of training in basic techniques and skills of organic farming. The associations need to professionalize, although this challenge can be viewed in a positive light: it indicates that the association is serving an important function.

Case study 3. The Community Development Committee and farmers' troupe in Guzhai village, Mashan county

Community Development Committee. The Community Development Committee (CDC) in Guzhai village was established in August 2004 with the support of the Guangxi team. It was started after several farmers visited a community in Luquan county in Yunnan province known for its microcredit initiative and learned how other communities had established a CDC and a common fund. The research team provided an initial small community fund; the interest from this fund would belong to the community and be used for community development. The villagers appointed a director, an accountant, a cashier, two general members and a monitoring manager. The duties of each member and those of the committee were identified and recorded. Three experimental groups were established: for science and technology, for crops, and for fish and poultry.

After discussions, villagers from the various communities agreed to set up a microcredit scheme, primarily for farming, although it also could be used for medical purposes and to support children's education. Credit was limited to small amounts ranging from 100 to 1000 CNY (14–140 US\$). According to the rules, people participating in the microcredit programme would be divided into four groups, with five families in each, and each group would have a leader. Villagers also developed a related liability assurance system governing the scheme. They dedicated much time and effort to setting it up and making it work.

The research team supported the Guzhai CDC through other activities, such as participatory plant selection and breeding (which started before the formation of the CDC), registration of community resources and setting up community farming schedules. The CDC functions as a kind of platform to bring villagers and researchers together to work toward a common goal.

Community Development Fund. A Community Development Fund (CDF) was initiated shortly after the CDC was established and was eventually used by most of the households in the village. In our recent evaluation, interviewees mentioned lower interest rates, easier access and simpler procedures as the

main advantages over microfinance mechanisms at commercial banks. Loans are used by households according to a predesigned plan, leading to greater transparency, which is appreciated by all participants. As of the latest round of lending, 61 households had borrowed money from the CDF at least once; the interest accumulated to date now accounts for a sixth of the total fund.

The CDC is responsible for the distribution and recovery of loans and reaches consensus on how the money is used. At the beginning of each round of lending, the members who want to borrow from the fund submit applications to the committee. Then, the director, monitor, accountant and cashier decide to whom to lend money. The criteria used in these decisions include the borrower's ability to repay the loan, their credit rating in the community, number of previous loans and the use to which the money will be put.

The CDC is using the accumulated interest to fund concrete roads to households that are not on the main road.

Women's seed production group. Participatory plant selection and breeding activities were already in progress when the CDC was first established. In spring 2006, the GMRI selected Mashan for a pilot study and trained farmer members of the CDC to produce hybrid maize seed; the GMRI also supplied female and male parents of the variety known as Guinuo 2006, which is very popular in the area.

After the first training session, four women, including the director of the CDC, participated in the participatory plant breeding (PPB) activity. Because of the farmers' lack of experience, the first season's harvest was not very good – only 10.5 kg. But the price of the seeds they produced was 10 times the price of maize for consumption, which attracted more women to join the project. In autumn 2006, seven women were involved in producing Guinuo 2006 seeds, with the number increasing to 11 in 2007 and 2008. In spring 2008, when the total yield reached 188 kg, the women were very happy with the extra cash income it brought them.

Compared with growing maize for consumption, hybrid maize seed production is complex and requires great care, which can be a problem for the women farmers, especially the elderly. The leader divided the women into smaller groups and asked the more skillful members to be group leaders and show the others the various techniques. The leader, who speaks both Mandarin and the local language, is available to respond to questions, while the small group leaders are responsible for supervising their group members to make sure things operate smoothly. This way of working has been very successful.

Farmers' troupe. Farmers do not organize only for productive or economic reasons. In Guzhai, the farmers' troupe originated from a group of women dancers, organized by the older women, who wanted to continue the tradition of 'Lang Clout.' During the harvest, farmers (mostly women) used to use a tool called 'lang' to husk rice and the rhythm of their work was captured in Lang Clout dances. With the introduction of new harvesting machines, the lang

tool was seldom used and the dances were being forgotten by the farmers, but two old women in the village formed a dance group, along with six of their colleagues, to carry on the tradition. At first, they performed during the harvest and on festival days and they were invited to attend the Folk Music Festival, representing their township. Later, some younger women were attracted to the group, doubling their number.

Adding singing and theatre to their dance repertoire, the group evolved into the farmers' troupe, which was established in 2006. That same year, the troupe had an opportunity to perform at the China Agricultural University in Beijing. This publicity attracted new members – young women and men. Their performance by then included 12 numbers, all created by the group, which had also designed beautiful costumes for each number. The audience at the university was very impressed and gave the troupe a standing ovation. Following the Beijing show, the troupe became more and more famous in the Nanning area. They are invited to perform often in their county and township.

The relationship between the CDC and the farmers' troupe is very close. The members of dance group are the most active members of the committee as well as the first beneficiaries of the CDF. It was support from the research team (together with support from the College of Humanities and Development of the China Agricultural University) that allowed them to visit Beijing, become more popular and attract the younger members. Troupe rehearsals offer a friendly venue for communication among the CDC members. Some members of the troupe whom we interviewed mentioned that they often exchange technical information and skills during these rehearsals.

Leadership plays a key role in farmers' organizational processes. We illustrate this with a story about the current leader of the Guzhai CDC and farmers' troupe. Although unique in terms of details, Rongyan's story contains many elements that are common in the emergence of leaders.

Rongyan's story. When talking with farmers about the CDC and the troupe, Rongyan's name is mentioned frequently:

Rongyan has high prestige in our village and is willing to take care of many things. She is considerate in her work and takes our suggestions seriously. The work as village leader is tough and not well paid. Sometimes, she pays for the public affairs. She uses her own money in our troupe and did good things for the village all the time.

Who is this dynamic, well-known and respected Rongyan? She is the leader of both the CDC and the farmers' troupe in Guzhai village. She also chairs the village committee. She won the government's 'Woman Pacesetter' award and was one of the torchbearers for the 2008 Beijing Olympic Games, representing Chinese farmers. She is a true farmer leader and innovator, committed to improving the lives of her fellow villagers and more. She is an inspiration to others, never gives up and is always trying new things.

Rongyan's story is a long one (see Gao Xiaowei 2008a, b for details). She has been a core member of the CDC since its establishment, because she was already the leader of village's women's association and had some experience with a microcredit project run by the Women's Federation in Mashan county. At first, she was responsible for accounting. As noted by the villagers, she devotes a lot of time to public affairs and, as a high school graduate, she is relatively well educated. When the CDC's chairperson became ill, Rongyan started to take charge.

The CDC links the community with the outside world through project activities. Researchers, plant breeders and extensionists come to the community regularly and provide opportunities for training and reciprocal visits. As leader of the CDC, Rongyan has more contact than others with outsiders and has more opportunities for training and visits. These opportunities have contributed to her natural leadership qualities and capacity for innovation and she has gradually become more self-confident. In her words:

After we got support from the project, our activities became famous in the county. I obtained many awards from then on, such as Woman Pacesetter, Outstanding Women Cadre. I run a small rice mill and supply services to villagers. I am acquainted with many villagers through this business. I was selected as chairwoman of the village committee in 2005.

Success in work stimulated her to devote more time and energy to public affairs. She put a lot of effort into the farmers' troupe and has tried many ways to improve the livelihood of villagers – for example, by organizing maize seed production and organic duck and chicken production.

The farmers' troupe has a close relationship with the CDC and Rongyan plays an important role in both. She took charge of the troupe when it was still a dance group. After the farmers' troupe was established and performed in Beijing in 2006, she organized members to practise regularly and used her own money to purchase costumes for the whole troupe. Her aim is not only to preserve local culture, but also to entertain farmers: 'More and more people in village joined in gambling in the recent two years. I want more people to join in our troupe and spend spare time without gambling. Many people are indeed attracted by our activities.'

Rongyan's story is inspiring. Her involvement and that of others in the CDC gives it legitimacy in the local context. When activities of the CDC go well, the CDC gains more prestige for the community in a wider context. In turn, the leader also has more influence in the community. For a leader, this is a process of reinforcing prestige and capacity building. For the CDC, leadership is an important factor that influences the embeddedness of the organization. A local organization's links with the community are strengthened when the leader gains prestige.

Beyond the case studies

These case studies give us insight into the emergence of farmers' organizations and the factors that influence the process. First, farmers' organizations can be an interface between farmers, the extension system and other information suppliers, such as researchers. Lack of useful information, both technical and market information, is one of the key constraints on improving agricultural production. From the point of view of the extension system, meeting the needs of farmers and promoting the sustainable development of agriculture is the key problem. The case studies show how farmers' organizations identify common problems and communicate farmers' concerns and desires to professional staff; together, they find solutions and support the organizational processes.

The Guangxi team has played the role of transmitter of information to relevant governmental and non-governmental organizations and proved to be more effective and efficient than individual farmers. Informal networks between farmers are important channels for farmers to get information about new technologies and markets, but the quality of this information and who receives it are uncontrolled. Farmers' organizations make local networks more formal by holding regular meetings, organizing training and exchange events and ensuring that every farmer receives accurate information in a timely manner.

Second, farmers' organizations, such as those highlighted in the cases, provide a platform for active information exchange and for self-directed community management. In traditional rural communities, information exchange and outreach occur through networks of personal relations. In most of these cases, dissemination used to be one-way. The new organizational forms provide a more open platform for multi-way communication – people can exchange information, discuss and debate ideas and experiences and share more widely. At the same time, because traditional relationships (such as those based on kinship) that bind people together are gradually becoming looser or disappearing altogether, the emergence of farmers' organizations based on mutual interests is one approach to organizing farmers in a 'modern' way.

Third, farmers' organizations can promote the local adoption and adaptation of technology and reduce the associated risk. The information farmers receive from extensionists or other outsiders tends to be scientific and theoretical in nature and it sometimes cannot be applied in the local environment. This raises the risk for farmers that the new technology might not work. In contrast, organic farming, for example, is typically based on the local environment and resources. The farmers' organizations allow farmers to experiment collectively with the proper amount of fertilizers for sustainable production and the varieties with higher yields and better taste. The members join in these experiments voluntarily and share the results to ensure improvement of their crops the next season. In the women's seed production group described above, the young members translated information on seed production into the local language to share with older members.

Fourth, we can see from the cases that changing traditions can have a positive impact on farmers' organizations. In the first case, farmers' concepts of cooperation have changed with marketization. Now, they have come to appreciate the potential value of their labour in terms of producing a market surplus. However, given that labour surpluses are not common in rural areas, it is difficult for farmers to organize unless their joint activities result in some foreseeable profit or advantage. New forms of leadership are also visible, although not without challenges.

In the third case, farmers' desire to cooperate to improve their livelihood was inspired by their common culture and collective activities. Most of the women who are members of the farmers' troupe are also in the seed production group. For them, the troupe activities are a vivid and gratifying platform to communicate agricultural information as well as to engage collectively in entertainment. It is interesting to observe that the farmers' troupe, which is truly endogenous, reinforces the exogenously supported CDC.

Last, but not least, women and the elderly can play important roles in farmers' organizations. In our case studies, women and older people are the organizations' main members. As more and more young people and men engage in off-farm work, women and the elderly become the main labour force in agricultural production – and more than a labour force, they are also becoming the main managers of rural life. Compared with men and young people, however, they are at a disadvantage when it comes to receiving new information about technologies and markets because of their lack of education and their poor connections with information resources, although they tend to have more traditional knowledge about farming and care about the environment and sustainability.

The formation of small groups is one way to promote the mutual exchange of knowledge and interactions with useful sources of information. In the case of the organic farming group, most members are middle-aged-and-older farmers who are still familiar with the traditional farming practices: without the use of chemical fertilizers and pesticides. They understand and agree with the concept of organic farming. In the case of the seed production group, women have started to earn money from sales. This makes them feel more confident and they appreciate being able to contribute to the family and knowing that their labour is valued in a more visible way.

Conclusion: voice, choice and inclusion

In China's rural areas, especially those that are poor and remote, limited natural resources and physical and financial capital are obvious, while labour is increasingly flowing toward off-farm work. Social capital seems an important entry point for development. Our findings indicate that farmers' organizations are both the 'product' and the 'producers' of social capital. Farmers are cooperating with each other and organizing in new ways to satisfy their inter-dependent cultural and socioeconomic needs and achieve a better livelihood.

In the process of organizing themselves, they strengthen their individual and collective capacity, accumulate mutual trust, develop new identities, make their voices heard and improve their access to physical resources and financial capital. At the same time, this approach includes those who are excluded from the current development agendas, allowing them to strive for some choice instead of being told what to do and how to do it. As a new emerging phenomenon, farmers' organizations are attracting much attention. Our research team appreciates their contributions to livelihood improvement and is trying to find better ways to support them.

About the authors

Yang Huan obtained a master of science degree in rural development and management from the College of Humanities and Development in 2007. She carried out her thesis field research in Guangxi province, in collaboration with the Center for Chinese Agricultural Policy, where she is currently a research assistant. In September 2008, she started PhD studies at Wageningen University in the Netherlands.

Gao Xiaowei earned MSc and PhD degrees in rural development and management at China Agricultural University in Beijing. She first went to Guangxi as part of the community-based natural resource management course offered by the university and chose her PhD research topic based on this experience. She carried out fieldwork for her PhD in Guangxi, in collaboration with the Center for Chinese Agricultural Policy. Currently, she is working as a researcher at the Development and Research Center of China Association for Science and Technology in Beijing.

Li Jingsong earned a BSc degree in sociology from China Agricultural University and a master's degree in environmental management from Wageningen University in the Netherlands. She works as a senior research assistant at the Center for Chinese Agricultural Policy and has a special interest in rural development and environmental management. In September 2007, she began PhD studies at Wageningen University in the Netherlands.

This page intentionally left blank

CHAPTER 6

Opening our eyes: renewing the Chinese public extension system

Zhang Li, with Luo Haichun, Huang Bailing and Pan Qunying

FOR DECADES, China's agricultural extension system, the largest in the world, contributed to improving agricultural production in a significant way. However, a crisis occurred in the 1990s when the pace of change was accelerating and new challenges and opportunities were emerging in growing numbers. Slow to adapt and even slower to envision future conditions, the agricultural extension system collapsed. Toward the end of the decade, the Chinese government set out to do something about the situation. This chapter describes and reflects on the renewal process or reform of China's agricultural extension system. It summarizes the key features of the conventional system, the problems it faced and how ideas for change came about and were put into practice. Guangxi is one of the pilot sites for reform of the extension system and, as such, offers vivid insights into the challenges and achievements. This chapter builds on first-hand experiences, including the fieldwork carried out by the principal author for her PhD dissertation at China Agricultural University in Beijing.

A system in crisis

China's national public extension system developed in the 1950s. For a long time, it was seen as a key government instrument for transferring agricultural technology to farmers from 'advanced' research institutes across the country (agricultural academies, agricultural universities, specialized research centres), i.e., it was a component of the top-down managed agricultural research and development system. The prevailing vision was a linear model of 'modernization,' and there is general agreement among scholars that this massive and well-resourced extension system contributed to the country's agricultural development, especially in increasing food production during the 'planned economy' period from the 1950s to the 1980s.

However, with China's transformation to a more market-oriented economy, the extension system gradually became paralyzed and obsolete. In the 1990s, the whole system nearly collapsed: no real service delivery took place, few or no innovations reached farmers, connections with other rural development

Box 4. Challenges in China's extension system

Unjustified tasks and narrow focus – According to a 2002–2003 Center for Chinese Agricultural Policy (CCAP) rapid rural appraisal in 28 counties in seven provinces across China, the local public agricultural technology extension (ATE) system is engaged in many tasks in addition to agricultural technology dissemination. Examples include commercial business, implementation and monitoring of regulations, family planning, township budget management, village elections, fire protection, local disputes among farmers and township administration. The appraisal also revealed that these multiple functions of ATE agents result in a significant weakening of their core function as technicians and financial resources are diverted to commercial and other non-extension activities. Conflicts arise when ATE stations impose regulations (e.g., fertilizer and pesticide quality control and market inspections), but meanwhile expand their business activities, making them both 'referee' and 'player.' The private sector is complaining about unfair competition for many inputs, such as seeds, fertilizers and pesticides, not only because extension agents are involved in policy and business functions, but also in large part because their business costs (e.g., salary, credit and facilities) are shouldered by the government. This situation might be impeding private-sector delivery of extension services regarding non-public-oriented technologies.

The technologies provided by public extension agents are often dominated by new varieties, chemical inputs and machinery, as these can be easily traded in the market. Much information that is badly needed by farmers (e.g., farm management, organization and marketing information) and by the public (e.g., environmental conservation, biodiversity and pollution) is often ignored.

Inappropriate organizational setting – China's ATE system is enormous (Hu et al., 2004). Every township has ATE agents, but agents with different specialties are administered by different bureaus at the county level. There may be five to seven extension stations in the agricultural bureau, including ones for grain technology, cash crops (sometimes further divided into horticultural crops and local special crops), seeds, plant protection, soil quality improvement, agricultural machinery and economic management. Several extension stations come under the water bureau (e.g., irrigation and drainage), the livestock bureau, the fisheries bureau and the forestry bureau in the same county. Conflicts between stations or bureaus and lack of coordination contribute to the inefficiency of the system (Hu et al., 2004).

The ATE institutions also have a large number of staff, more than a million employees, with generally poor qualifications. Overstaffing (relative to the available budget) increasingly shifts limited resources from ATE to non-ATE tasks. Budget constraints further limit training and professional development for extensionists and the ability to hire qualified technicians. The CCAP survey showed that, in 2002, on average, extension technicians spent only 82 working days on real ATE work in the field. Of the 1,245 agricultural technicians interviewed, only six had attended a short training course recently. At the county level, 68 per cent of stations had not recruited a technician with a BSc degree since 1996.

Inadequate funding and budget deficits – Insufficient funds have become one of the key factors affecting all aspects of the ATE system. The public ATE system is largely locally funded; less than 10 per cent of their total budget comes from the central government (Huang Jikun et al., 2003). Most of the remaining 90 per cent comes from county and township governments. Overall, agricultural extension expenditures as a proportion of agricultural GDP have declined since the early 1990s (Huang Jikun et al., 2000; Xu et al., 2003). According to the CCAP survey, government funding amounted to only 65 per cent of township ATE stations' budgets (or 6,136 CNY (US\$898) per extensionist) and about 80 per cent of the budget at the county level (or 13,467 CNY (US\$1,972 per extensionist) in 2003. These levels of funding do not cover the salaries of current staff, let alone the

pensions of retirees, administrative costs and extension projects. The survey also revealed that, among 363 extension stations in 28 counties, 77 per cent had no funds for technology extension and 25 per cent could not pay technicians' salaries on time. Embezzlement and diversion extension project funds to pay technicians are common practices at township and county extension stations.

Lack of accountability and incentives – Accountability is a common problem for all publicly funded ATE agents. Extensionists usually feel that their responsibilities are supervisory rather than farmer directed. It is difficult for supervisors to assess extensionists' achievements. Extensionists are more likely to engage in activities that bring in revenue rather than being motivated to promote technologies that do not result in remuneration. Although no detailed study has examined accountability and the incentives of extension technicians for conducting ATE, our field interviews revealed that, in many cases, extension staff are not accountable to anyone at all. Their salaries are related, not to their ATE performance, but more likely to their 'commercial performance'. To address these issues, some provinces (e.g., Hubei) have started to introduce new policies aimed at establishing a better incentive system for technicians.

Lack of innovative approaches and methods – The ATE system uses a 'top down' transfer of technology approach. Although this worked well and contributed significantly to the increase in agricultural productivity before 1980 under the planned economy, it is not meeting farmers' needs and interests in the new economic environment. International experience and various recent case studies in China show that top-down technology transfer has failed to promote rural development, particularly in agro-ecologically diverse, resource-poor and risk-prone regions.

An ongoing search for demand-driven and responsive extension services, especially for small farmers, in the developing world has led to the adoption of participatory or farmer-led extension, which was introduced in China in the early 1990s (Li Xiaoyun, 1999). However, it has never become part of the mainstream in national ATE programmes, despite various successful cases conducted by NGOs and research communities (Song, 1998, 2003; Li Zhinan and Chen, 2001; Cao Jianmin et al., 2005). Although higher-level authorities are now recognizing the urgent need for demand-driven extension, it is still very difficult to obtain wide acceptance of a bottom-up participatory extension approach within the top-down system. There is a clear need for training and education of new extensionists at both central and local levels.

Sources: Li Liqiu et al., 2003; CCAP, 2005 and unpublished 2008 data; Huang Jikun et al., 2008

agencies were non-existent or ineffective, the system itself had not been updated and most staff dedicated time and energy to activities other than serving farmers and contributing to sustainable rural development.

During these years, the extension system remained dominated by officials and technicians. Farmers were mainly passive recipients in the technology transfer process and extension services consisted largely of technology – e.g., improved varieties, equipment, chemical inputs. Services were delivered from the top down; the choice of technology dictated at the national level, with no opportunity at the grassroots level for input, participation, or feedback concerning technological needs or interest. (See text box for more about the challenges facing the system.)

Top-down ‘conventional’ extension systems exist elsewhere in China as well and, every year, the research institutes and universities dedicate themselves to many projects and areas of research. However, identification of research topics is not based on the practical needs of farmers. On the contrary, they are selected by the researchers according to their own professional interests. Many also follow the ideas or interests of a funding agency or some key decision maker located in an office far from the reality of the field.

Meanwhile, with decentralization continuing and the market economy becoming stronger and stronger, alternative technology suppliers are emerging: NGOs, private companies, farmer organizations and individuals. However, these service providers are still very weak, their number is limited and most of them operate in the more-developed eastern part of the country. In remote and underdeveloped regions, farmers must rely on the public extension system as the main supplier of technology.

The single-disciplinary approach of extension professionals has created difficulties in rural development and extension. So-called experts and technicians trained in one discipline are unable to cope with the complexities of rural areas. They tend to recommend development options and technological alternatives they are familiar with, but these options and alternatives do not respond to the highly diverse needs and interests of farmers.

In many areas across China, farmers are asking the dysfunctional public extension system to do something. But is the public extension system the agency to ‘do the job’? With new players appearing and, perhaps, showing the way forward, what is the role of the public extension system? Can it be made more effective in addressing emerging needs and interests and meeting new challenges? How can the Chinese public extension system be renewed and how can research contribute to the process?

Renewing the moribund agricultural extension system

In 2003, the CCAP, together with partners from the National Agricultural Technology Extension Center of the Ministry of Agriculture, the Guangxi provincial extension station, the Guangxi Maize Research Institute (GMRI) of the Guangxi Academy of Agricultural Sciences and four counties in Guangxi – Mashan, Duan, Long’An and Wuming – set out to contribute to renewing the public agricultural extension system. In Guangxi, the work was integrated into a larger research initiative that was already underway – the one described in this book.

In the following pages, we describe and reflect on how the reform process came about in Guangxi. Much of this section is based on PhD field research carried out by Zhang Li (2009).

Paradigm shift

Before starting the new reform initiative, we reviewed the various components that together (at least in theory) constitute an extension system. We identified the rigid top-down approach and linear-thinking paradigm as the most limiting bottleneck in the current system and we decided to embrace a holistic, dynamic and more participatory approach.

In the top-down, linear model, public agricultural innovation is split into investment, research, extension and application. The central government provides the funds and sets the overall direction, research institutes take charge of new technology development and extension workers transfer technologies to farmers. In this model, the farmers' role is to accept and apply the new technology. This reductionist perspective and 'line of command' approach ignores the relationships and interactions between the various components and social actors involved in the process and does not consider the agency of people. Farmers are excluded from the research and extension parts and they have no say in the overall direction set in Beijing.

However, researchers have discovered that many new ideas come from practitioners – the farmers themselves. In addition, farmers often change the new technology they receive from scientists and adapt it to their own conditions. From research around the world, we know that farmers actually play an important part in generating new technologies (Leeuwis, 2004).

The 'knowledge and inform system' approach developed by Niels Röling and others provided us with a new perspective from which to view agricultural innovation processes (Leeuwis, 2004). It addresses the interactions and relationships among different stakeholders and stresses the importance of collective work. It also emphasizes the 'soft system' side: the communications and networking among the elements of the system. Soft systems are flexible and do not have fixed boundaries between their components. Innovation is seen, above all, as a process of network building (Leeuwis, 2004). Influenced by these theories, the new extension reform initiative led by CCAP viewed extension as a communicative and interactive process involving multiple stakeholders and a social-learning and joint-action process leading to agriculture innovation.

In keeping with this paradigm shift, another important issue relates to the design and implementation of a reform policy. In China, policies are usually designed by researchers and policy makers, tested in a few selected areas, then, after a number of years, evaluated and, if results are positive, promoted in other areas by the government. The process is linear, top-down and similar to the conventional extension delivery process.

The problem is the lack of relevance and the absence of room for adaptation. In the design process, only the researchers and policy makers are present; local people, who will experience (benefit from or endure) the policy are excluded. Can a policy developed at the top level without the meaningful involvement of local people really work at the local level? Given the great

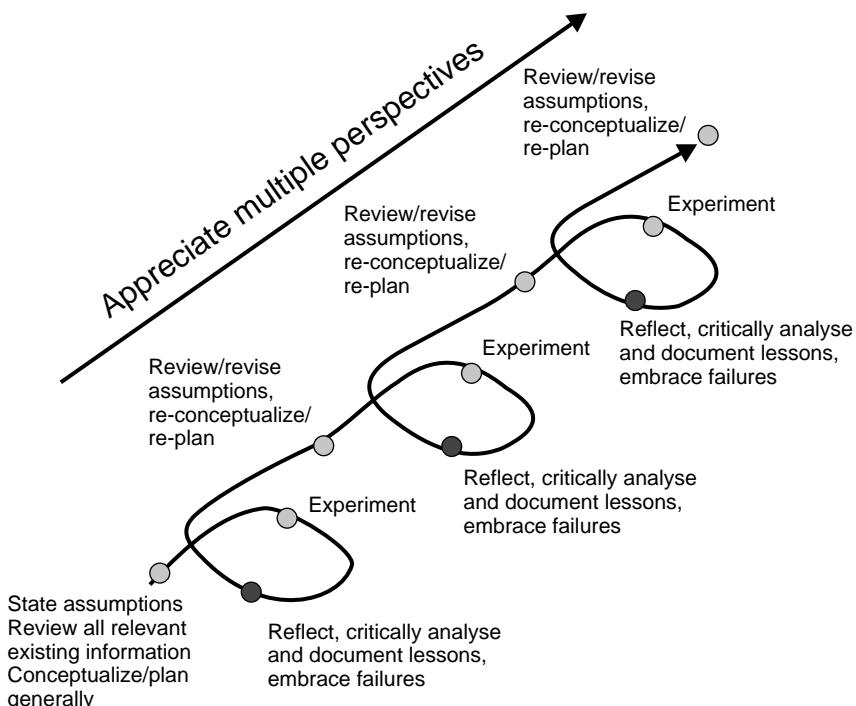


Figure 9. Participatory action research spiral

Source: O'Hara, 2006.

diversity in China, its multiple natural resource contexts and different social and economic development conditions in different regions, policies based on local conditions are very important.

There is yet another shortcoming of the current policy making method: in everyday practice, policies are usually reshaped by local people when implemented and experimented with locally (Long, 2001), but little attention is paid to this issue.

To overcome these shortcomings and make the extension reform process more relevant and adaptive to the local context, we used a participatory action research (PAR) framework – joint action by multi-stakeholders in a certain context. The process can be viewed as a spiralling cycle of practice–reflection–practice (Figure 9), which makes the policy making process more relevant (user-driven and adapted to local contexts) and dynamic (learning by doing, making adjustments along the way and using a process of collective action and reflection).

Research objectives, strategies and activities

In line with the new paradigm, the team worked with the main stakeholders to develop research objectives, strategies and activities. The team was made up of people from very different disciplines: maize breeders from the Chinese Academy of Agricultural Sciences and the GMRI, extensionists at the province and county level, policy researchers from the CCAP, PhD and MSc students from China Agricultural University (most of whom had a social science background) and farmers from the research sites.

Because of the different backgrounds, scopes of knowledge, perspectives and needs of the team members, it was necessary to establish common ground before taking action. After a series of face-to-face discussions, the team found that they shared some common concerns: poverty, the decrease in crop varieties and the paralysis in the extension system. Based on these, the team developed the following vision:

- Technical development and extension should be driven by farmers' needs and combine top-down and bottom-up approaches.
- Technology-centred extension is too narrow; extension services should include other aspects of livelihoods, such as diversification, adding value to local production, off-farm employment, marketing, organization and empowerment.
- Researchers and extensionists should act as collaborators and facilitators, co-learning with farmers and other stakeholders.
- Farmers' knowledge should be recognized, valued and used in the innovation process; interactions and communication between researchers, extensionists and farmers should be increased.
- Extensionists and researchers should understand more about rural realities and farmers' livelihoods.
- There is a need to strengthen farmers' capacity in terms of improved livelihoods, especially their capacity to organize.
- It would be beneficial to offer students a chance to become involved in extension reform research, to link theory with practice and better prepare them for future work.

The team also decided that the key entry point for realizing this common vision was to improve people's and organizations' relevant capacities. Thus, the whole initiative focused on capacity building. The main goals were to strengthen the capacity of individual extension workers, researchers and students to understand rural realities, facilitate interaction and do joint action research; to make the public extension organization understand farmers' needs and supply effective services to meet those needs; and to enable farmers and farmers' organizations to express their needs, dialogue with other social actors, self-organize, negotiate, adopt new knowledge and evolve from passive recipients to active participants.

To achieve the common vision and these objectives, the team developed four main strategies: carrying out PPB (see Chapter 4); supporting change agents ('champions'); creating organizational and institutional space for exchange and sharing; and carrying out participatory monitoring and evaluation. These strategies were interrelated and evolved gradually during the practice and reflection processes.

Constructing an extension system driven by farmers' needs

Reorienting extension services means not only individual change, but also organizational and institutional innovation. For example, directors of extension stations have a great deal of impact if they support the work of their field staff with the CCAP team and give them more space to work. In addition, to ensure that the initiative is long-lasting and sustainable, the extension organization as an agency must change to create space and incentives to operate in a more efficient and effective way.

In February 2007, representatives of CCAP (Huang Jikun, Song Yiching, Zhang Li, Yang Zhijian and Zhi Huayong) and the Ministry of Agriculture (Xia Jingyuan, director general of the ministry's extension centre and his colleagues) had a policy discussion and planning meeting with the county authorities and related extension management teams. Two townships were selected as 'reform pilot sites,' and implementation plans were developed by the county management team and the CCAP team. After investigation of the local extension situation, a PAR process was designed and implemented. Distinct from other reforms, local participation plays an important role in this pilot reform process. The involvement of local officials, extension workers and farmers is reducing the cost of reform and enhancing the implementation process. The participatory approach includes the following five key steps.

Understanding the local situation through interviews with various stakeholders. Before proposing a reform plan, a series of discussions between the CCAP team and local government leaders, agricultural officials, extension workers and farmers was conducted to gain a better understanding of the current situation at local extension stations; the history of the local extension system; the main challenges for a well-functioning extension system; the pros and cons of reforming the current extension system; the main constraints of reforming the current system; the roles of major government bureaus in the reform; and the expectations of all parties about the reform.

These interviews helped the CCAP team understand the urgent problems, opportunities, potential difficulties and role each stakeholder would play in the pilot reform. During the interviews, the CCAP team also suggested possible measures for reform and asked interviewees to assess their feasibility and effectiveness. The responses were helpful in making our initial plans.

Preparing action plans through discussions with local officials. After interviewing representatives of all stakeholder groups, the CCAP team proposed a work plan, which they then discussed with local officials in each province and county. These discussions involved local government leaders, officials from various bureaus relevant to the reform and delegates from provincial agricultural departments and the Ministry of Agriculture. The CCAP team wanted to obtain general agreement on the overall goal of the reform, initial plans, major steps, key partners and the division of responsibilities among the involved parties. A local contact office and contact people were also identified at this time.

At the county level, ATE Reform Leading Groups (RLGs) were formed. Each RLG is headed by the mayor or vice-mayor in charge of agriculture for the county and the members are heads of various county governmental organizations, including agricultural extension stations; the bureaus for agricultural, livestock, forestry, fisheries, water management, personnel, cadre management, finance and education; the development and reform commission; and the government regulatory office. The RLG is a decision-making body in charge of overall implementation and coordination of the ATE reform. Under the RLG, an operations office was created to handle day-to-day work. This office stays in close contact with the CCAP team. The CCAP team's duties include giving advice, capacity building, monitoring and coordination at the county level and between county and higher levels of government (provincial and national).

Defining the new regulations. After obtaining agreement from all stakeholders, the team chose extension incentives and rewards and feedback mechanisms to assess farmers' needs as entry points. Extension workers must go into the field to understand farmers' needs and try to offer services that meet these needs. In the new system, their salary is linked to the quality of service they deliver. Unlike the old system, in which extension workers were evaluated by their supervisor and higher-level officials, the new approach is to ask *farmers* to evaluate extension workers' efforts – a radical departure.

The new incentives and feedback mechanisms are popular with local people, but the county government has been slow to accept 'whole system' reform. In January 2008, with approval of the Guangxi Extension Reforming Regulation and Plan by the provincial government, the whole reform process has speeded up and was fully implemented by summer 2008. The pre-piloting efforts of the CCAP team were crucial to this achievement.

Participatory monitoring and evaluation. Participatory monitoring and evaluation (PM&E) was introduced at the beginning of the initiative and coordinated mainly by the local team. Since the start of the reform process, the CCAP team has been visiting each county two or three times a year and keeping in touch with local officials. During the visits, the team evaluates the progress of the reform initiatives, discusses constraints and likely solutions and documents experiences and lessons in consultation with the local officials. Based

Box 5. Example of a PM&E visit

In September 2007, after reform of Mashan's extension service had been underway for about a month, the CCAP-led team visited two villages and two township extension stations. They found that most of the farmers are satisfied with the new system, but the extension workers were not.

The extension team coordinator complained, 'If the whole system does not change, the extension station still belongs to the township government and we cannot follow the participatory rules. The situation now is that we have to do the extension work using a participatory way, but we also have to finish the tasks that are assigned by the township government. These tasks are not related to extension work. Now we have two bosses: the township government and the county-level agricultural bureau.... We are becoming very tired. We hope that we can be taken on board by the agricultural bureau and just serve one boss.'

In both Mashan and Qiaoli, extension methods used by the local staff had changed, but this was not yet reflected in the larger system. The team heard over and over that there was a need for the whole system to change to support the new methods and mainstream the new practices on a daily basis. After discussions with farmers and extension workers, the team members brought this issue to the county governor, who agreed to write a proposal to the provincial-level ministry of agriculture, in hopes that total system reform could be implemented as a pilot reform experiment.

on their PM&E activities, the team has proposed adjustments to the original plan to adapt it to the local context. These suggestions have generally been accepted by all stakeholders.

Capacity building. Capacity building among local extension agents and project team members has been an important part of the reform process and is ongoing. It has included documentation of farmers' demands for technologies, the publication and distribution of *A Collection of Existing Cases on Agricultural Extension Reform in China*, the preparation and distribution of *A Training Manual on Participatory Extension* and the organization and delivery of a series of participatory extension training workshops in the four pilot counties. In addition, three PhD dissertations and one MSc thesis have been completed as part of these efforts.

Local realities and farmers' livelihoods

As 'outsiders', it was important for the team to understand the local realities and how farmers make a living. Researchers, extension workers and farmers used a variety of participatory rural assessment tools to obtain information about farmers' livelihoods and extension needs. The following is a summary of our findings.

Vulnerable ecological environment constrains local agricultural production. Most of the areas where we work are marginal agricultural land located in rocky mountains. For example, Mashan county covers 2345 km², of which 1330 km² (or 56.3 per cent) is mountainous. Although annual rainfall is 1100–1700 mm,

there is little rain during the spring sowing season and in autumn when the second crop is started. Droughts can last for more than five months. Soils are thin and infertile and don't retain water, because of the karst topography.

Drought and water-logging are the two main natural disasters affecting local crops. Maize is the main crop and farmers plant twice a year. From March to May is the best time to irrigate maize, but drought and lack of an irrigation infrastructure mean there is not enough water for the seeds and they often die. In July, the first crop is harvested and the second is planted. However, heavy rains fall in July, sometimes so heavy that channels overflow and water floods the fields for three or four days, damaging the crop to be harvested or the newly planted seeds. Maize yield is only about 250 kg per mu (3.7 t/ha), although in good areas it can reach 450 kg per mu (7 t/ha).

The land is not only poor, but also parcelled into very small units: about 0.67 mu (447 m²) per person on average. Therefore, farmers cannot depend on crops, but have to find other means of production. Some breed pigs and ducks, some have hired themselves out as migrant workers and a few are engaged in processing agricultural produce. Table 16 gives an overview of local farmers' income sources.

Feminization and aging of agriculture. The poor farming conditions have driven farmers to find other sources of income and most young people and men have left to find jobs in cities. Because it is more difficult for women to find work in the 'outside' world, women and older people are left at home to take care of the land and family (see also Chapter 3). This phenomenon of agricultural feminization and aging is obvious in the villages and townships. Women agricultural labourers make up 65.4 per cent of the total workforce and the average age of an agricultural labourer is 53 years. Compared with male farmers, women and older farmers have less education; their average education level is 5.7 years and most did not complete elementary school.

Farmers' expectations are becoming lower and lower, especially those of young farmers. The main source of income is increasingly the non-agricultural sector. For example, in the villages of Shang Gula and Qiaoli, nearly 90 per cent of farmers under 35 years of age do not want to engage in farming any longer. They say, 'Being a farmer is a burden and one can earn little money.' More and more, farmers want their children to leave the agricultural sector.

Table 16. Sources of Mashan farmers' income

Source of income	1995	2000	2007
Crop production (%)	6	10	16
Livestock breeding (%)	13	16	20
Migrant work (%)	38	53	60
Other (%)	43	21	4
Total per capital income (CNY ¹)	875	1,250	1,890

¹ In 2009, 6.83 CNY = 1 US\$.

Source: CCAP team field research notes, 2008.

They spend more money on their children's education and send them away from the village. Fewer and fewer young farmers choose to work on farms.

Lack of physical and financial capital. In Guzhai village, the average per capita income is only 1,700 CNY a year (about US\$249); 50 per cent of farmers have no savings, but simply scratch along year by year.

Farmers seldom have money to invest in agricultural production. When researchers inquired about loans, farmers reported the main three uses were for building a house, education and going to the hospital (Zhang Li, 2009). They tend to invest in life's necessities, not production. Furthermore, many farmers have debt, which increases financial pressure: in Shang Gula village, 58 per cent of farmers were in debt; in Qiaoli, 68 per cent.

In addition to the shortage of financial capital, physical capital is also scarce. Most farmers have no modern equipment or trucks and use buffalo to do heavy work (such as ploughing and transportation of the harvest).

Limited social capital, limited technology sources. Farmers' social capital is also limited. Most live within a closed network of relatives or family. There is no farmers' organization in the project area. Farmers' organizations can fill many roles: provide training, facilitate communication between farmers and extension workers, help farmers obtain access to markets, provide financial and technology support, etc. (Van den Ban, 1994–1997). Because they lack this kind of organization, small farmers must depend on their own ability to find new technologies.

Farmers usually get agricultural information and technology from their relatives, neighbours, government staff and tradespeople. New technology comes mainly from the government, but, in the past five years, only two innovations have been brought into the area. This low influx cannot meet farmers' needs and with the collapse of the agricultural extension system, it has become more difficult for farmers to obtain new technology from the government.

Farmers' extension needs. Researchers and extension workers, together with farmers, identified farmers' main needs in terms of agricultural extension. Considering the local situation, five needs were identified as priorities: drought-tolerant maize varieties suited to local conditions; financial support; an organization to increase farmers' social capital; training and capacity building, especially for women and older farmers; and links to the market.

Knowledge sharing

Different cultures and groups of people have different knowledge and perceptions of the world and also have different ideas and theories about how to solve a problem. Agricultural systems are complex and dynamic; to deal with problems in these systems requires multidisciplinary efforts and different kinds of knowledge. In our initiative, different stakeholders are coming together, sharing their information and knowledge and taking collective

action. PPB is one example. Knowledge sharing took place, not only within the project team but also with people from other projects, places and countries, during farmer diversity fairs and exchange workshops, for example.

Participatory plant breeding. Based on farmers' extension needs, the team chose PPB as an entry point (see Chapter 4). The team is engaged in ongoing dialogue to integrate farmers' indigenous knowledge and scientists' expertise. The main hypothesis is that only such new institutional development can enhance sustainable maize development and on-farm management of genetic resources. The initiative also aims to strengthen farmers' research and management capacities to maintain agro-biodiversity in the specific Chinese context.

Through their involvement in PPB, the extensionists changed their attitude in an important way. They came to respect farmers and their indigenous knowledge and began building trust and learning relationships with farmers. They believed in farmers' abilities and let them decide the direction of the extension support. The extension workers mainly act as facilitators. They link breeders and farmers, facilitate their communication, discussion, and experimentation, as well as evaluation, by using new kinds of tools, such as participatory rural appraisal methods. Because extension workers are very familiar with farmers and live relatively close to them, they sometimes become farmers' 'representatives.' As representatives, they express farmers' needs and information to breeders and bring knowledge and information back to farmers, operating as a bridge between the two groups.

Exchange of experiences. As part of our efforts, we created many opportunities to let villagers come together to share their resources and experience. Farmer diversity fairs, which we hold once a year, provide one opportunity for exchange.

The first farmer fair was held in Guzhai village on 22 January 2003. The aim was to exchange crop varieties selected by farmers themselves. Farmers from the four project counties and related organizations showed their varieties at this fair, with 48 participants in total. There were 87 varieties in the exchange fair, including 31 maize, 17 bean, 8 potato, 6 kinds of vegetable and 18 varieties of other species. More than 3,000 people attended the fair. They communicated with farmers and bought and sold varieties among themselves.

The fair-goers were impressed: 'I did not know it was possible to grow so many varieties of crops here,' said one. An older farmer examining the maize on display shook her head in wonder, 'I haven't seen these seeds since the 1960s,' she says. 'There are seven maize varieties here I have never seen before,' responds her companion.

Throughout the day the participants – farmers, researchers and officials – exchange many ideas, opinions, experiences and seeds. In the afternoon, a committee that has been assessing the wealth of diversity at the fair, awards prizes to the most outstanding displays.

Source: Song et al., 2006

The local extensionists played an important role before and during the fair. They publicized the fair among farmers, helped them prepare materials, wrote notes to explain what was being showcased and contributed to the assessment of the displays. They interacted actively with farmers, researchers and other visitors on the day of the fair, as go-betweens for the various groups. They and most others who attended increased their knowledge of local biodiversity in a significant way.

Exchange activities extended beyond the research area. The team summarized their experiences, results and lessons and shared them in other counties, provinces and even countries through formal training sessions, workshops and informal exchanges. The team also learned from other practitioners, which led to reflection on and improvement of their own activities. In December 2006, six PPB research teams from around the world came to Nanning to share their experience and knowledge and to explore problems and challenges based on previous and ongoing efforts.

In July 2007, CCAP's team, led by Song Yiching and including Ruifa Hu, Yang Zhijian, Zhi Huayong, Yang Huang, Zhang Li, Li Jingsong, Gao Xiaowei and Wang Dehai (from China Agricultural University) and Lu Min (from Jilin Agricultural University) offered training in participatory extension approaches and methods at all four pilot locations. All extension workers below county level and some at county level attended and the average size of the audience was about 30 people in each county.

In November 2007, Ruifa Hu, Zhi Huayong and Yang Zhijian met extension officials from Liaoyang, Huantai and Nanxian and officials from their respective provinces. During these meetings, reform experiences were shared and all parties agreed on the next steps of the reform experiments (Huang Jikun et al., 2008).

Broadening the extension service

The traditional ATE service provided only technology support; however, we believe this is a reductive and narrow view of agricultural extension. Farmers need more than just technology; the reality requires a mix of technical, economic, commercial, social and environmental aspects. 'One size fits all' is not a solution for the complex agricultural environment. There is a pressing need to broaden the extension service and this is what we set out to achieve.

Supporting local organizational development. There are two ways to support farmers' organizations in the area. One way is to support the existing organizations, making them function well. For example, the team encouraged the farmer troupe in Guzhai village and invited them to perform at China Agricultural University in Beijing. This opportunity was a great incentive for the troupe to improve their programme. Afterward, more and more farmers joined, including some men. They have become famous, not only in their village, but throughout the region.

The other way to support farmer organizations is to help farmers set up a new organization based on their needs and help them manage it. As some researchers suggested, farmers' organizations can play an important role in the extension process, for example, by organizing communication and negotiation among farmers, scientists, extension workers and other stakeholders; by facilitating farmers' access to markets; by providing loans; or by acquiring access to seed and animal quality control (Van den Ban, 1994–1997).

In 2004, CCAP organized a visit by extension workers to local farmers' organizations in neighbouring Yunnan province. When they learned how these organizations could be useful for improving livelihoods, they took careful notes and collected information about how the organizations operated. Back in Guangxi, the extension workers introduced the Yunnan farmers' organization experience to local farmers, who were very interested in this idea and thought it might be a very good way to manage a community development fund.

Subsequently, extensionists and farmers began to explore the formation of new organizations. The extensionists helped the farmers select a core management team. The next step was to establish rules. The extensionists introduced the rules that the Yunnan farmers had defined and the Guangxi farmers adjusted them to the local situation. They wrote and agreed on a new constitution and named the organization Community Development Committee (CDC). The CCAP team gave the CDC a small grant as a start-up fund, which farmers used to set up a rotating microfinance system. Now, several other villages have their own CDCs and develop various activities to help farmers improve their livelihoods. The text box below lists some of the activities of the Guzhai CDC in 2006. During this process, extensionists were both a source of information and process facilitators, guiding and supporting farmers.

Box 6. Main activities of the Guzhai Community Development Committee in 2006

1. Organizing participatory maize variety improvement – Includes identifying the trial variety, Zhong Mo 1, field evaluation, tracking and documenting investigation results.
2. Organizing the evaluation of new varieties – Includes identifying the trial variety with scientists, collecting and documenting farmers' interest, carrying out a trial and evaluation and identifying the variety that needs to be improved.
3. Organizing trial of planting spring and autumn maize together – Includes designing the trial with farmers and scientists, helping the farmers conduct the trial, documenting, evaluating, comparing trial and non-trial varieties and improving the trial design.
4. Organizing maize breeding – Includes technology training and helping farmers experiment and document the process and the results.
5. Setting up a community-based plant variety resource file – Includes selecting two farmers to take charge of documentation, collecting local resources and discussing the documentation with scientists and farmers.
6. Managing a community fund – Includes providing small loans to farmers who need money, tracking the use of the loans and publicizing the results.
7. Other activities – Includes training in planting and breeding, farmers' exchange meetings in the village, visiting and exchanging information with other villages and organizing entertainment.

Source: Zhang Li, 2009

Providing small grants. Farmers in the villages are poor and have few savings for investment. To alleviate this situation, the team provided a small grant to the CDCs as a start-up fund to support farmers' investment in agricultural production. CDCs lend the money to farmers at a low rate of interest. When farmers submit an application, a meeting is held to discuss whether they are entitled to a loan. All villagers can attend the meeting and vote. If a farmer receives a loan, she or he must follow the rules and return the loan on time.

During the process of setting up the small loans system, it became evident that the size of the fund was inadequate, as more and more farmers wanted to borrow money. The CDC management team brought this problem to the extensionists, who discussed it with the CCAP team. Researchers from CCAP suggested some ways to increase the core capital based on their previous experience. When the extensionists brought these ideas back to the farmers, they decided that they would each contribute a minimum of 50 CNY (US\$7.32) to the fund. This not only increased the fund, but allowed the farmers to earn interest on their contribution. The extensionists facilitated the process by setting up discussions and helping to formulate regulations, with the result that the total amount of the fund increased and more families could now benefit from it.

Changing the role of researchers and extension workers

In the traditional process of agricultural innovation, researchers carried out experiments on their research stations, usually far from farmers and rural realities. New research results or products were passed on to extension workers and extension workers were supposed to transfer them to farmers. Farmers were passive receivers of information. However, now major changes have been made and the conventional roles of researchers and extension workers have undergone a transformation. They are no longer the overseers, but rather partners with farmers and process facilitators and the change is reflected in their attitudes and behaviour.

Becoming partners. The innovations underway in Guangxi are involving many people with different capacities and areas of expertise. No single group is dominant: researchers, extension workers and farmers are all experts in their own fields and they are equal partners. As a participant breeder said, 'PPB lets breeders and farmers work together... Breeders are not the leading actors anymore and farmers are no longer just playing a supporting role. We both play an important role in the project' (Chen Tianyuan and Huang Kaijian, 2006). During the project, researchers, extension workers and farmers together diagnosed community challenges, shared a vision, exchanged knowledge and information and made decisions together.

Becoming facilitators. According to one of the extension workers, 'Usually, the government arranges for me to do some kind of technology extension task. I

took these technologies to farmers, behaving like a promoter. But now, what I do is ask farmers' needs, facilitate their discussion and use my knowledge to give help' (Huang Bailing in an interview with Zhang Li, 2007). Extension workers are no longer called 'extensionists', but 'coordinators' or 'facilitators', as their roles have changed so much.

As facilitators, extension workers put farmers at the centre, letting them speak up and make decisions by and for themselves. Facilitators are responsible for guiding and supporting the innovation process. They observe the knowledge-exchange process, make suggestions and use their social network to support farmers. This is a dramatic break from the former way of doing things. Here are some examples of how they view this change.

Before, my job was only doing what my boss commanded me to do. I only followed his orders. I never thought or wanted to understand farmers' needs. I acted just like a microphone of my boss. To farmers, we are the national cadres, they called us cadres. There was a gap between farmers and us. But participatory extension shortened the distance and now I feel much closer to farmers. Now, I am here, connected to farmers, to plant breeders and also to CCAP researchers. We communicate with each other, in joint action to improve farmers' livelihoods. By organizing farmers' discussion, my organizing and coordinating capacity improved and I have become more responsible in my work. Because there is a lot of communication for me to do and people in this team use email all the time to contact each other and to exchange ideas, I have learned how to use email, which I did not know how to use before.

Interview with Huang Bailing, Wuming county (Zhang Li, 2009)

The core of participatory extension is empowerment. This means giving the right to participate, the right to make decisions, the right to be informed and the right to manage back to farmers. We are 'outsiders'; our role is to facilitate and coordinate. Our aim is to improve local farmers' capacities. The project is a platform to do this. I like being a facilitator, to give more space and more choice to farmers.

Interview with Luo Haichun, Duan county (Zhang Li, 2009)

In participatory extension, I found there is so much communication work for us. Gaining new agricultural information, technology and the ability to communicate are of great importance for this job. Through training and practice, my organizing and communication ability improved, but I think it is not enough. Sometimes, I find I am not close to farmers. I think this is because I am a woman. If you are a man, it is much easier for you to get close to farmers. You can make friends by 'kissing the cup,' as we say. This is local culture, but I do not drink. I have to find another way. So, I think my communication skill needs to improve.

Interview with Pan Qunying, Long'An county (Zhang Li, 2009)

Involving the future generation

Almost every year since we started, one or two master's or PhD students from Beijing have joined the Guangxi research team. The team has given students a chance to become involved in the whole process of extension reform research in practice and this is allowing the future generation of rural development professionals to link theory with practice and improve their professional skills.

Yang Huan, at that time a master's student supported by the team, did her field research in one of the local villages (see Chapter 5). Here is how she described the experience:

During the Community-Based Natural Resource Management course (in Beijing), I found my research topic and applied for a fellowship to do my fieldwork in Guangxi. I think fieldwork is very meaningful. The long period in the village made me understand more about the reality of rural life, that the situation in the village is quite different from what I thought it would be. It also taught me that research is sustainable work; you have to return to the village several times to look into what happened, what is happening. Three months in the field still just didn't give a vivid picture of my research topic to me. My thesis was awarded the best thesis in my university. It gave me a big pleasant surprise and confidence for further study. I appreciated the experience in the field; otherwise, my findings and comments would not be so attractive. Meanwhile, it is a very good opportunity to practise what I learned. My experience let me think more about the reality. Because, I found, working is quite different from school. Putting theories into practice is not easy. Many questions come up: how to do participatory action research, how to influence policy in a complex setting and how to guarantee that governors will follow through. These questions made me want to learn more and do more.

Source: Zhang Li, 2008: 90–91

The Guangxi team's daily and direct involvement in the field research helped them develop many useful skills: analyzing situations and problems from the perspective of those directly living in and experiencing them; combining natural and social science knowledge and methods; developing a critical eye for the socioeconomic and sociopolitical dimensions of natural resource management and rural development at large; and using tools, such as participatory rural appraisal.

Involving students in field research not only improves their professional skills, but can also be useful for the community. Several students focused on the key issue of farmer organization, encompassing economic, sociocultural and political elements. They worked directly with CDCs, cooperatives, local agricultural research committees, associations and cultural performance groups in a number of provinces to strengthen these organizations, as a way to give more voice and space to farmers (Vernooy et al., 2008).

When Yang Huan and Wang Xiufen (another master's student from the College of Humanities and Development, China Agricultural University, who did her fieldwork in Guangxi; see Chapter 3) were in Guangxi, they organized the villagers to come together and talk about the problems they were facing in growing cassava. They facilitated a meeting between farmers and local research partners, to discuss the decreasing yields and generate some suggestions for action. The villagers were interested in diversifying and trying to grow Chinese herbs – for example, as an alternative crop. Some villagers joined forces and developed a small experiment. They are also investigating marketing options. Yang Huan and Wang Xiufen provided many good ideas and some financial support in the form of start-up funds. With the experiment now underway in the village, many farmers who were not involved in the discussions have joined the group that set up the experiment. Curious about this novelty, they quickly realized that it could benefit everyone (Vernooy et al., 2008; Zhang Li, 2008).

Zhang Li was involved in the extension reform process in 2007 and 2008 doing research for her PhD thesis. The following is part of her story (Zhang Li et al., 2010).

Who hinders the transfer of information? In a focus group discussion in Qiaoli, one of the two villages where I stayed, farmers talked about signs of land degradation. They said that it had become harder and harder to grow maize, but they didn't know why. They had been troubled by this problem for more than a year. When I asked why they did not consult the extensionists, they replied that they didn't think the extensionists knew the reasons either.

I knew that the county agricultural bureau had a device to test soil quality. Thus, I facilitated contact with the bureau so that the farmers could test their soils. The results indicated a fertility deficiency (due to poor fertilizing practices). To address this, the farmers decided to change their production practice to multiple cropping and to apply more manure. They had found an answer and it seemed easy to guide them to it.

But then I became confused. Why was something that looked so easy (just going to the county agricultural bureau and requesting a soil test) so difficult for the farmers? Why had they not found an answer to their problem in over a year? Who or what was hindering the transfer of information? By talking with the farmers more, I found out that communication between farmers and extensionists was very limited and they did not understand or trust each other. Farmers did not know what new services were available at the extension service centre or even what services existed previously... I concluded that things ought to be done to change this.

Finding the way together. Working together as a team with farmers, extensionists, policy makers and researchers, we tried to find a way to change the situation. We decided on a participatory action approach, putting farmers

first. Through a social learning process, all stakeholders discovered a new way of doing things, different from the past.

According to one farmer, 'Now they pay attention to our needs... and I have more chance to ask questions to the researchers and extensionists'; an extensionist remarked, 'We are welcomed by farmers'; and one of the researchers explained, 'I have learned a lot from the farmers.'

Today, researchers and extensionists use participatory methods to understand farmers' needs and the extent of farmer satisfaction is now one of the indicators in their performance evaluation system. At the same time, policy makers agree that it is a good way to reform the extension system and a new extension policy reform experiment is underway. It started in September 2007 and already covers villages in two townships. According to a follow-up survey, farmers appreciate the change.

Although it is only the beginning, our new way of working together, learning from each other and from the process, as well as reflecting on it, is helping us (the whole team) to find a way to adapt together.

Capacity building

If farmers obtain subsidized fertilizer, they can earn a higher income. But if they depend on the use of fertilizer, they will need to buy it the following year. Giving a farmer a fish is not the same as teaching farmers how to fish. Capacity building is a way to teach farmers how to become better at catching fish. The team complemented its action research efforts with targeted training – for example, in social and gender analysis, the use of participatory rural appraisal tools and leadership development. This training was based on the needs and interests of our partners, including researchers, farmers, government staff and students.

The CCAP-led team has supported extension workers and maize breeders to pursue formal studies at universities in China or abroad. Currently, two extension workers and one maize scientist are finishing their master's degrees at China Agricultural University in Beijing and two staff from CCAP are studying for PhD degrees at Wageningen University in the Netherlands.

In addition to learning these theories and gaining expertise through sharing, the team members have also had plenty of opportunities to practise their skills. Team members are the protagonists of the action processes, as coordinators, facilitators and researchers, doing the research and continuously reflecting on what they are doing. Through these formal and informal learning processes, the knowledge and skills of farmers, extension workers and researchers have increased and their attitudes have changed.

Learning from the process: changes so far

The farmers in the project village expressed their feelings about the changes in a song called 'Agricultural specialists coming to the village of the Yao' (Vernooy et al., 2008: xvi–xvii).

Men: Let us sing songs to the world with a golden throat
 Every folk song is about the village of the Yao
 Hearing our songs, fish and shrimp in the water smile
 Hearing our songs, all the flowers in the mountains smell aromatically

Women: The scenery of the village of the Yao is beautiful now
 A picturesque scene with new houses
 Poor life has improved
 Every household eats meat, drinks wine

Men: Honeysuckles bloom, the potpourri spreading a thousand miles away
 Attracting the specialists to come to the village of the Yao
 Making Mashan become more famous
 The golden phoenix flying out from the mountain area

Women: Specialists coming to the village of the Yao
 Busy with inquiry and research
 Traditional agriculture needs to be improved
 Please remember every person

Men: Agricultural technology develops so rapidly
 Traditional cultivation needs to be improved
 Let us experiment with the maize varieties
 Let us do something new

Women: All villagers discuss together
 Specialists give good suggestions
 We come together to change the situation

Men: Thanks to the specialists for coming to village of the Yao
 Investigating without being afraid of hard work
 Visiting hundreds of households
 Paying attention to the details of our life

Women: It's good to adjust the agricultural structure
 Adjust our agriculture to the market
 Filling the barn full of grain, filling the pocket full of money
 Everyone is happy to become richer

Together: Good policy of the central government
 The three pillars of rural development will show the way¹
 New technology will improve our agriculture
 The villagers of Yao will soon have an easy life

Changes in farmers, extension workers and researchers

We discovered that farmers have a strong interest in participatory technology development and are willing to take an active part in investigation and experimentation. Farmers acquired more understanding of maize as a crop (and of how to improve varieties) by doing field trials and evaluation together with plant breeders, extensionists and other researchers. Their ability to do research was strengthened through the PPB method introduced by the CCAP team. Some farmers have started small-scale seed production (which also requires appropriate knowledge and skills).

Through this process of discovery and joint action, the way farmers view themselves has also changed; for example, they are more confident in their own capacities. As some of the farmers said (personal communication, 2007):

Through field trials and evaluation, I know which variety has a high yield. Because in the field, I can see in person and then find which one is better.

Farmer from Long'An county

Field trials and evaluation are very good. If the variety has a high yield, we will plant it and this can improve my livelihood. If the yield is low, we also know that we won't plant it in the future. Doing the trials with others and discussing the results gives me more comprehensive information. Thus, my decision will be more reasonable.

Farmer from Wuming county

My knowledge has increased; for instance, at the farmer fair, I heard and saw for the first time the purple wax maize, and I also learned about the purpose of some herbs I did not know about. I also brought home one high-yielding cassava variety and one maize variety to do some trials in my field.

Farmer from Long'An county

My reputation is growing, not only in the village, but also in the local government. Some extension workers came to see me and asked me some agricultural technologies. Sometimes, they come to ask about farmers' needs.

Farmer from Mashan county

Collective action research is also bringing about changes among extension workers and researchers, mainly in three ways. First, their attitude is changing. Previously, they thought farmers ignorant and considered themselves better than the farmers. Now, they realize that farmers have knowledge and have become more respectful toward them. They are providing services based on farmers' needs rather than lecturing. Second, their knowledge of participatory extension has increased and they are applying this knowledge in their daily work. They have changed from being an instructor to acting as a facilitator. Third, their ability to organize and communicate has improved through exchanges and participatory activities. Here are some comments on these changes from extension workers themselves (personal communication, 2007):

My attitude has changed a lot. Before, farmers did not accept the new technology I promoted. I thought they were stubborn. Now, I look for the reason in myself why farmers did not accept. Maybe farmers did not need it or it did not fit farmers' conditions. Now I ask for farmers' ideas first.

Extension worker from Duan county

Participation means discussing and making decisions together with stakeholders. I have been working for many years and most of the work was pushed by the government. It is top-down and it was hard for me to finish my tasks, because most of the technologies were not needed by farmers. Farmers did not accept them. Now, I am bringing participatory methods into my extension work. Our work is farmer-needs driven. It has become much easier.

Extension worker from Duan county

Before, I thought extension work was useless for farmers and I had no incentive to carry out my tasks. But now, I like the job and found that farmers need this kind of extension so much. They can benefit from my work.

Extension worker from Long'An county

Participatory plant breeding training, leadership building, visiting other areas and people and studying abroad, doing master's studies, all these activities have opened my eyes, allowing me to gain more information and knowledge. Organizing farmers' meetings has improved my organizational and communication abilities and has also made me more conscientious. I have also learned how to use some modern communication methods. Before, I did not know how to use email, but now I can use it to share my ideas with others.

Extension worker from Wuming county

Changes in research institutes

The plant breeders at the GMRI were also affected by the project. They know more about participatory approaches and gained experience in using these approaches and tools. They also increased their skills in communication, facilitation and organizing. Non-participating colleagues at the GMRI (and in other agencies in the province and at the national level) became curious about the participatory process and, through interactions and sometimes involvement in such activities as workshops and field visits, also gained some basic knowledge of participatory theories and practice.

The leaders in these organizations have supported the process, creating space for their staff to be involved. In Duan, for example, the extension bureau leader has always given top priority to these efforts. The organizations that are full partners in the process are gradually moving toward a more participatory approach in how they work. The GMRI is a good example: before they joined the action research process, they used traditional scientific methods, doing

trials in the laboratory or in their own test fields at the research station, far from farmers' fields. They seldom communicated with farmers. Now, however, the institute is promoting participatory technology development and has joined the national Farmer-Centred Research Network, launched by China Agricultural University in 2001. In addition, PPB is now a formal research programme at the GMRI.

Contributions to communities

The PPB field experiments, both in farmers' fields and on station, have been functioning successfully as a platform for involving the main stakeholders in both formal and farmers' systems and have facilitated effective interaction, communication and collaboration among these groups.

This has produced many positive results. Productivity has increased by 10–15 per cent, 10 maize varieties have been improved and one new variety has been produced: Wax Gui 2006. Biodiversity has been enhanced through collaboration and exchange. The capabilities of farmers, especially women, have improved significantly. Farmers are now speaking up in meetings and expressing their ideas, needs and interests. Groups of (mostly women) farmers have started to define the specific support they would like to receive from the extension service. Farmers are now also able to organize for their mutual benefit.

Here are some changes that farmers have reported (Zhang Li, field notes, 2007):

The villagers are more united and like to help each other.

The diversity of crops has increased.

We have more communication among villagers. Before, most decisions were taken by the leader, but now, villagers discuss and decide together.

Because of the community development fund, more villagers began to breed pigs and our income has increased. People from the neighbouring village were envious, they were hoping they could have a community development fund, too.

More and more are joining the trials, five more people this year than last year and now there another four or five people who want to join. We are all very pleased with this.

Influence on policy

Two policies were directly influenced by our efforts. The genetic diversity conservation policy has incorporated participatory initiatives into the formal policy process, especially with regard to regulation of plant breeding (spearheaded by GMRI and the Institute of Crop Science), agricultural extension in relation to crops and crop improvement (spearheaded by the township extension stations, the central government extension centre and the Ministry of

Agriculture) and genetic diversity conservation (led by the Institute of Crop Science and the Chinese Academy of Agricultural Sciences). Chinese policy makers are increasingly aware of the links between biodiversity conservation and sustainable development and poverty alleviation. The assessment of food security revealed that biodiversity loss is one of the new challenges facing China in its attempt to ensure that it has enough food to feed its population in the future. The government has realized that conservation and the sustainable use of biological resources are necessary if crop yields are to keep pace with the increasing population.

The other policy is the agricultural-extension-system reform policy. Several recommendations made by the CCAP-led team were included in two formal policy briefs, which were reviewed by high-level government officials and the Ministry of Agriculture, has been assigned to follow up on the research results and recommendations. In addition, the Ministry of Agriculture has implemented some basic ideas of the reform approach in most of its 26 newly selected pilot reform counties and the CCAP team has been contracted to provide technical support for these counties (Huang Jikun et al., 2008).

Conclusion: change agents pave the way to system change

PAR is the main approach being used in the change process and again and again it has demonstrated its strength. Together, team members generated a common vision, then put the idea into practice through joint action, tracking the process, ensuring continuous and critical reflection and adjusting the plan along the way as new ideas emerged. The entry point was PPB, but more components were added and tested, such as supporting farmer organizations and extension reform.

Methods such as stakeholder analysis, participatory field trials and peer experience exchanges have been central to the process. The initiative started by identifying relevant stakeholders in the extension system to build a strong team involving a variety of partners with diverse knowledge and expertise. During the teamwork and joint action, people gained a deeper understanding of certain issues and their capacity for participatory extension was improved by peer learning, discussion, observation and practice. Scientists and extension workers noted farmers' abilities to experiment and understood farmers' needs; farmers learned the scientific way to do plant breeding; policy makers observed the positive results in person, which prompted them to integrate the approach into new policies. All these methods, combined with dynamic and flexible leadership, made the changes in individuals and organizations possible.

The main changes among individual farmers, extension workers and scientists are obvious: their attitudes have changed and their knowledge and skills related to participatory extension have increased. Farmers' social networks have expanded through participation in collective activities and self-organizing by farmer organizations. Farmers' communication and information exchange were

enhanced by these collective activities as well and women farmers are playing key roles in the whole process. Extension workers and scientists also improved their communication, facilitation and management skills.

Extension functions and the working approach of extension agents are gradually changing and becoming more oriented toward farmers' needs. In some areas, the extension stations are experimenting with novel farmer feedback mechanisms and incorporating farmers' satisfaction ratings into evaluation of extension workers' performance, which is linked directly to their salary level. The GMRI has increased its capacity for doing participatory research and collective work. Rural communities have become more active and their self-identities are stronger. They are also practising more democratic decision-making processes. The way to influence policy has been to involve key policy makers almost from the start, let them see the approach first-hand and assess the results and impact for themselves in the field.

The traditional role of the extension system, to simply transfer knowledge and information from scientists to farmers, has disappeared. New roles are based on sharing knowledge and information with scientists and farmers to facilitate the generation of new knowledge and use it to improve farmers' livelihoods. Extension agents have become change agents, although not always without difficulties. Extension agents together now represent a kind of platform on which social actors can practise, exchange and learn together. New forms of farmer organization are giving shape to the rural innovation process. These organizations are gradually becoming facilitators and organizers of change and function as a bridge between the village and the larger world.

PM&E has been very useful in the process as a joint effort by team members, farmers and government officials to monitor and evaluate the activities systematically. Through ongoing PM&E, the team knows what is going on and can adjust plans and activities accordingly.

The Guangxi experience is a vivid example of how to do extension work differently. Scientists, extension workers and farmers worked as a team to innovate and to improve farmers' livelihoods. It is also an example of how to design and carry out policy reform through PAR. With a systemic, holistic perspective on extension and by promoting collective efforts to make extension work, the field experiences show that new ideas can be generated, implemented and assessed in an effective and efficient way. However, to make these efforts sustainable and extend them to a larger scale, significant institutional change is required. Future efforts will focus on scaling up and scaling out the Guangxi achievements.

About the authors

Zhang Li obtained a master of science degree in regional economics in 2005 and is a PhD candidate in rural development and management from China Agricultural University. She carried out field research for her PhD in collaboration with the Center for Chinese Agricultural Policy. In 2008, she did a one-year

research internship with the Rural Poverty and Environment Programme of the International Development Research Centre in Ottawa, Canada. She is now a researcher at the Development and Research Center of China Association for Science and Technology in Beijing.

Luo Haichun is a graduate of Guangxi Agricultural University. Since 2002, he has worked as a government officer in Gushan township (one of the townships involved in the research) and has been a core team member at the grassroots level. He is now deputy director of the Agricultural Bureau in Duan county. He will receive a master's degree in participatory extension from China Agricultural University in summer 2009.

Huang Bailing received her university degree from Guangxi Agricultural University and has worked at the extension station in Taiping township, Wuming county since graduation. She was one of the first extensionists to join the Guangxi research team. She is currently finishing her master's degree in participatory extension from China Agricultural University, graduating in summer 2009.

Pan Qunying graduated from an agricultural school in Nanning and has worked in the township extension station at Dujie, Long'An county, since then. From the time the Guangxi research started in 2000, she has been a key coordinator in the county. She is currently studying part-time for a degree in participatory extension and expects to graduate from China Agricultural University in 2010.

Notes

1. Promoted by the current Chinese government, the three pillars or *san nong* are *nongye*, *nongchan* and *nongmin* – (the development of) agriculture, rural areas and farmers.

This page intentionally left blank

CHAPTER 7

Changing rural development in China

Ronnie Verwooy and Song Yiching

THIS ACCOUNT OF OUR RESEARCH EFFORTS in Guangxi demonstrates that cooperative and complementary relations between farmers and the national agricultural research system are both feasible and desirable. At our research site, what 10 years ago was best characterized as a disconnected and often conflicting configuration of relationships (or the absence of them) has been transformed into a web of social links based on mutual understanding, reciprocal respect, a number of common interests and activities and even friendship. The friendship grew out of doing things together, experimenting in new ways, reflecting critically on the process and celebrating positive results, as well as coping with setbacks.

The new constellation of social actors (who themselves changed during this collaborative learning process) has addressed and continues to address, through collective action, the challenges of food security, well-being, sustainable natural resource management and biodiversity conservation facing China as a whole and Guangxi in particular. Some remarkable achievements have occurred locally, with ramifications beginning to reach the world of policies and laws, as well as higher education and science.

In this concluding chapter, we summarize the main features and results of our efforts, review some of the key issues that we set out to address through the research and present, in an exploratory way, some reflections on what our learning might imply for future Chinese rural development studies. Because our efforts have already been integrated into the reform of the country's higher education system (most notably in agricultural universities in Beijing, Jilin, Hebei and Guangxi; for details, see Verwooy et al., 2008; Zhang Li, 2008; Li Xiaoyun et al., 2009), this seems a logical, although still daring, step to take.

A synthesis of livelihood changes

Maize at the heart of rural livelihoods

Chapter 2 introduced us to the world of maize in China. We observed, with great concern, that the backbone of maize production and the national maize-breeding programme is currently feeble. Maize crops are genetically vulnerable because of the rapid development of maize 'technologies', including exotic germplasm from abroad. During this process, most policy makers, researchers and rural development agents neglected the traditional knowledge base and

local genetic resources, still existing and evolving across China. This diverse knowledge and practice base is virtually unknown and, as a result, largely undervalued, ecologically, socioeconomically and politically.

Our research suggests that this situation has become worse since a market economy was introduced. As a result of large-scale privatization and commercialization, the formal seed system has become increasingly subject to profit-driven practices and fierce competition. Hybrid breeding and hybrid seed production are receiving more attention and effort than ever before, from both government and the private sector. Concerns about conservation of biodiversity and improving rural livelihoods are mostly being sidelined. It seems that little has been learned from the past.

However, in marginalized areas, such as in the mountains of Guangxi, farmers' seed conservation methods continue to play a major role in meeting their various needs. These systems are evolving and facing challenges, such as genetic erosion, but still maintaining the biodiversity that is necessary to sustain agriculture. Current and future plant breeding efforts – in the face of climate change and other impacts, such as natural disasters – will depend on these systems. Currently, the maize production and improvement systems face challenges in keeping maize a key part of China's agriculture and a basis for rural livelihoods. The participatory action research (PAR) initiative that we developed aimed to address these limitations and bring about change.

In Chapters 2 and 3, we saw that a dynamic and viable seed production system is crucial for maintaining maize production, continuing the process of crop improvement and developing local adaptations to changes occurring in the environment. Such a system is also the basis for the conservation and potential use of biodiversity by future generations. Organized women farmers, in particular, have taken the initiative to become qualified seed producers and distributors. New organizational forms are emerging to support these efforts and changes are already occurring in relevant policy domains.

Participatory plant breeding as a means and an end

By introducing, experimenting with and adapting participatory plant breeding (PPB), we enabled small farmers in the marginal areas of south-west China to participate in maize breeding as equal partners alongside professionals, other researchers and extensionists. These partners have been sharing their know-how, expertise and seeds and have contributed, in a complementary manner, towards enhancing agricultural diversity, crop improvement and farmers' livelihood security. Although it has taken time and energy, their joint efforts have brought about concrete results at the local level.

The PPB field experiments, both in farmers' fields and at extension stations, served another function as well. They formed a platform on which the main actors from both the formal and farmers' seed systems have been able to get to know each other and develop activities together, starting on a small scale. They have facilitated effective interactions, communications and collaboration.

Initially, only a few women farmers showed much interest in breeding and seed selection, although, later, more women and men joined in. A few key women innovators were involved from the beginning and have become core team members – key change agents moving the agenda forward.

These farmers, the women in particular, are now speaking up in meetings and expressing their ideas, needs and interests. In fact, they are now calling meetings. They are not afraid to contact extension agents and local policy makers, and even travel to the county or provincial capital to visit high-level decision makers. Some have travelled to Beijing and abroad to learn more about national and international ‘theatres’ of relevant action. In a still strongly top-down research and policy environment, all of this represents a major change.

The PPB activities have also strengthened the local-level organizational and decision-making capacity of farmers. Groups of farmers have started to define specific support they would like to receive from the extension agents and researchers. They are involved in seed production and marketing right now, especially of OPV varieties bred by the team. The aim is to make PPB and agro-biodiversity management more sustainable. In addition, following the first successful farmer diversity fair in 2003, the villages participating in PPB are now holding annual farmer diversity fairs, which have become part of the rural social landscape at the research site.

Our research has helped to highlight the role and importance of traditional knowledge and practices (which are evolving) to local innovation. We also have had some success in breeding new crop varieties and collecting and conserving landraces through joint planning and multi-stakeholder, collective research. However, several challenges have emerged. We realized, through learning by doing and constant reflection on our work, that putting this new approach into practice on a larger scale and addressing farmers’ and local communities’ rights to PPB products will require fundamental institutional and policy, as well as legal, changes in agriculture and related research and policy fields.

Recently, we have delved deeper into the policy and legal questions. For example, production of the first PPB variety, New Mexico 1, in 2002, was a collective achievement of farmers, breeders and extensionists in terms of effort, knowledge and other resources. Despite the collective nature of the innovation process, the variety can only be registered by a breeder or formal breeding institution, according to the Protection Regulation for New Plant Varieties, which was implemented by the Ministry of Agriculture in 1999. Through direct interactions with the ministry, the team is trying to change this unfair practice and policy.

Farmer organization central to rural innovation

New forms of farmer organization are central to rural innovation, as exemplified by our PPB programme and related efforts and illustrated by the cases

described in Chapter 5. Farmer organizations, which are dynamic entities, can serve not only the interests of farmers, but also act as an interface between farmers and other actors. We have seen that, within the boundaries of what is feasible in the changing economic and policy context, farmers in many villages are trying to organize themselves in new ways. Lack of useful information about new technology and markets is one of the key constraints on agricultural production. In the cases we described, new farmer organizations are trying to identify common problems of local farmers and communicate these to others, including extensionists, researchers and decision makers. Not all farmers are active or included in these organizations. How these processes unfold – and what they will lead to – remain an important part of the research agenda.

Existing informal networks among farmers are important channels for farmers to build on. Although these networks remain crucial for obtaining information, who receives the information and the quality of that information are often uncontrollable in informal networks. The newly emerging farmer organizations make some local networks (or parts of them) more formal by establishing regular meetings and organizing training and exchange events. This ensures that every farmer involved receives accurate information in a timely manner. In addition, the formalization of the farmers' organizations allows them easier access to certain resources – from government and non-government agencies.

The Guangxi team, which also started small but is growing steadily, has played the role of generator and transmitter of information to relevant (governmental and non-governmental) organizations. At times, the team also acted as advocate. Teamwork has proved to be more effective than individual efforts – of farmers, extension agents, or the researchers themselves.

Social capital seems to be an important entry point to development. We found that farmers' organizations are both the product and producers of social capital. Farmers are organizing in new ways to satisfy their interdependent cultural and socioeconomic needs and improve their livelihood. In the processes of organizing themselves, they strengthen their individual and collective capacity, establish mutual trust and improve access to physical and financial capital. This approach includes those who may be excluded from current development agendas. As a new emerging phenomenon, farmers' organizations attract much attention. Our research team appreciates their contribution to livelihood improvement and is trying to find better ways to support them.

Policy reform feasible, but challenges the powers that be

Chapter 6 revealed the world of agricultural extension. The huge national public extension system built up in the 1950s was seen, for a long time, as a key government instrument for transferring agricultural technologies to farmers from so-called 'advanced' research institutes across the country. For several decades, it served as one of the components of a top-down-managed

agricultural research and development system. Extensionists contributed to the 'modernization' of Chinese agriculture in the Chinese way.

However, with China's transformation from a planned economy to one that is more market oriented, the extension system gradually became paralyzed and obsolete. In the 1990s, the whole system almost collapsed: no real service delivery took place, few or no innovations reached farmers, connections with other rural development agencies were ineffective or nonexistent, the capacity of the extension system had not been updated and most staff dedicated time and energy to tasks other than serving farmers and contributing to sustainable rural development. (Many local extension stations became seed, fertilizer and pesticide shops and farmers often did not even realize that they were government-run enterprises.)

In 2007, at a connection point between local realities and national policy priorities, IDRC funding allowed the research team to start to make a formal contribution to the national reform of the extension system. CCAP and the Ministry of Agriculture designed a pilot policy reform process involving, initially, four diverse county authorities and related extension management teams. Two townships in Guangxi were selected as reform pilot sites. Through intense communication and negotiations, concrete reform implementation plans were developed by the county management team and the CCAP team. After investigation of the local extension situation, a PAR process was designed and implemented. Distinct from other reforms, local participation plays an important role in this process and we are finding that the involvement of local officials, extension workers and farmers is reducing the cost of reform and enhancing the implementation process.

Methods such as stakeholder analysis, participatory field trials and exchanges of peer experience have been central to the process. The initiative started by identifying relevant stakeholders in the extension system to build up a strong team involving various partners with diverse knowledge and expertise. During the teamwork and joint action, people gained a deeper understanding of various issues and their capacity to conduct participatory extension was improved by peer learning, discussion, observation and practice. Scientists and extension workers noted farmers' experimental abilities and began to understand farmers' needs; farmers learned the scientific way to carry out plant breeding; and policy makers observed the positive results first-hand, which prompted them to integrate the approach into policies. All these methods, combined with dynamic and flexible leadership, make changes in individuals and organizations possible.

Encouraged by the positive results to date, the Ministry of Agriculture recently (2008) extended the approach to the whole country and a detailed assessment of the process that was piloted at the four sites is now under way. The results will tell whether the reform process will find the same fertile ground elsewhere in the country as it has done so far in Guangxi.

A new professionalism emerging

Changes in the individual farmers, extension workers and scientists involved in our research – including the students who joined us in the field – are obvious; their attitudes, knowledge and skills have improved, in some cases in a transformative manner (see Zhang Li, 2008, for detailed stories). Communication, facilitation and management abilities have all been strengthened. From passive actors, they have become vocal and active. And they have inspired others to follow suit.

The functions and working approaches of extension agents are gradually changing and an organizational and institutional orientation towards serving farmers' needs is occurring. The traditional role of extensionists to simply transfer knowledge and information from scientists to farmers has been replaced by new roles: sharing knowledge and information with scientists and farmers to help generate new knowledge that can be used to improve farmers' livelihoods. Extension agents have become change agents, although not always without difficulties. Extension agents together now represent a kind of platform on which social actors can practise, exchange and learn together. In some places, the extension system is experimenting with novel farmer-feedback mechanisms and incorporating farmers' satisfaction ratings into performance evaluation, which is linked directly to salary levels.

The Guangxi Maize Research Institute has improved its capacity for participatory research and collective work. Rural communities have become more active and have stronger self-identities. They are also practising more democratic decision-making processes. The way to influence policy has been to involve key policy makers, almost from the beginning, letting them see the approach first-hand and assess the results and impact in the field for themselves. The CCAP research team has built up considerable expertise in designing and doing PAR, moving from PPB to a much broader rural development agenda. PAR elements, such as starting with farmers' realities instead of with purely theoretical insights, have also been adopted by other researchers at CCAP.

Review of key issues

Understanding through engagement/changes through engagement

Changes – both visible and invisible – are occurring everywhere in China, but they are not being lived and felt in the same way by everyone across the vast country. Some people are making impressive gains and managing to rapidly improve their livelihoods. Others, often those farther from existing or emerging centres of economic and political power and activities, are finding it difficult to 'catch up.' Divergence between those who have and gain and those who do not have and do not gain seems to be increasing – between regions, villages, households and between individual women and men. Overall,

although poverty is declining, it is still affecting a large number of people. Extreme poverty continues to exist.

One could use a political economy and political ecology perspective – adapted to the Chinese reality – to understand the change processes underway. However, another way to understand it is to actively and bravely engage with the change processes and to become political and social actors. This is what the research team decided to do. In a country such as China, this may appear to be an impossible task or one that involves insurmountable obstacles. However, surprisingly, bringing about change, not as individual researchers, but through the forging of social ties with others interested in promoting fair and equitable rural innovation and livelihood improvement for the most marginalized is feasible. Not easy, but doable.

Communicating and building on people's perspectives

Women's significant and increasing role in rural life receives little or no recognition among the key decision makers who deal with rural development issues, including health, education, service provision, prices, subsidies and wages. Women's specific needs, interests and expertise are also largely neglected in technology design, development and diffusion processes (e.g., development of new varieties, alternative agronomic practices). Most policies do not address (or do so inadequately) the important gender and social differences that exist in the countryside. Most research, including social science research, largely overlooks the question of how women and men, rich and poor, young and old, are dealing with the changes the country is undergoing. The politically charged questions of who gains and who loses and why are mainly bypassed or simply unanswered. Rural development requires addressing rural governance.

From participatory action research to participatory policy development

Policy reform – promoted by the Chinese government – requires political decentralization of the formal research and extension systems *and* meaningful involvement of women and men farmers in the design, development and implementation of innovation processes. When these processes take place, collaboration can occur and much-needed synergies can emerge. This takes considerable time and effort, patience and persistence. The work in Guangxi demonstrates that innovation can happen when synergies are created among various actors. This is not evident at the beginning, as conventional or traditional relationships of social, gendered and political hierarchy, everyday knowledge, power and control stand in the way of change. Creating space for novel practical efforts (such as the PPB experiments) through which diverse actors are able to get together, get to know each other, learn from each other and respect and complement each other has allowed for the gradual rebuilding of

relationships and, subsequently, more profound changes, such as participatory decision making and allocation of resources.

Towards revitalized Chinese rural development studies

Currently, the key issues in rural development studies are the gap between the 'classroom' (where theory presides over practice) and diverse rural realities, and the weak or missing links between research, action and policy. As a result, rural development theories and policies lag far behind the rapidly changing realities. Over the years, during frequent interactions with scholars, students and policy makers, we have realized that this is not because they are unwilling to change, but they simply lack the time and often the resources to spend meaningful time with farmers. (To read about our efforts to bring about changes in this situation at the main agricultural universities, see Vernooy et al., 2008.)

Instead of addressing only the issue of why change is needed, we decided to explore the question of how to build up new links and bridge the gaps in everyday practice, working with key actors and identifying potential new ones. Because we believe that realities are socially constructed to a large degree and, when facing rapidly changing processes and complex situations, PAR is one of the key approaches that can contribute to closing the gap between theory and practice, we used PAR to build more dynamic links between theories, action and policies.

When we reflect on the recent history of rural development studies in China, PAR is not completely new. Yan Yangcu's and Liang Sumin's approaches and theories of 'rural construction' in the 1930s and 1940s and Fei Xiaotong's 'new rural development' and social ecology of the past 60 years, especially since the reform in the early 80s, have been the academic roots from which PAR has grown in China. These researchers were personally engaged in the social construction processes of their times. They contributed significantly to our understanding of rural realities and how to change those realities through action (research) or policy influence and, more importantly, by building rural development theories based on the brave social exploration and experimentation in the rural contexts of China that they and their colleagues and students began.

Fei Xiaotong (also known as Fei Hsiao-Tung), in particular, brought western sociological and anthropological theories to China and adapted them to local social contexts. By doing so, he integrated the core elements of these theories into traditional Chinese epistemology, i.e., the notion of the creation of harmony between humans and their environment. In his writings, he emphasized the balance and links between subject and object and between the spiritual and the material. He criticized the trend in rural studies to overemphasize the material and neglect the spiritual or people focus, not only in China but also in the world in general. He encouraged collaboration and communication between western and eastern culture, between social and natural sciences

and between different nationalities. His social-ecological perspective emphasizes the diversity of and collaboration between different cultures, peoples and groups in the social construction process.

In terms of research methodology, he persistently argued and practised 'empirical studies,' going to the field and learning about and from farmers. He insisted on constructing theories based on practice and closely linked to rural realities. His social thinking, studies and experiments contributed significantly to the development of policies as well as to sociological theories after the opening up of the Chinese economy. Although, he also experienced many obstacles and even serious problems, he never gave up. At an advanced age, during the 1990s and early 2000s, he continued his systematic reflection on a sociology and anthropology of Chinese rural development. As such, he continued to inspire many, including those of us on the Guangxi team.

What we have learned from 10 years of using this approach in practice is that bringing about fundamental change is never easy. Today, it seems even more difficult given the complexity of the world and the rapid changes taking place in it. This makes us believe all the more that we need collective action by more and more brave actors actively engaged in the change process. We need to work together with scientists from many disciplines, with multiple stakeholders from multiple levels. Our experience in Guangxi has shown that field-level action can bring about change by forging social ties with others interested in promoting fair and equitable rural innovation and livelihoods. It also shows that concrete action can bring about more profound innovation through better understanding of and dealing with the complexity of rural realities, step by step.

Starting with PAR and moving to participatory policy development is very challenging, but possible and doable through joint efforts by various stakeholders, including policy makers and farmers. Change is possible, even in highly hierarchical societies and political systems. In the process of trying and learning by doing, collaboration can occur and much-needed synergies can emerge. We hope that others will follow the path first constructed by highly respected scholars such as Fei Xiaotong, and now extended by brave actors from villages to the highest level of government, toward the construction of a more harmonious world.

About the authors

Song Yiching is a social scientist with a special interest in rural development (especially working with women), farmer organizations and agricultural extension. She received a PhD in rural sociology and rural development studies from Wageningen University. Currently, she is a senior research scientist at the Center for Chinese Agricultural Policy, Chinese Academy of Science in Beijing, leading a long-term action research programme to create synergies between the seed systems of farmers and the Chinese government. She has led the research in Guangxi since 1999.

Ronnie Verwooy is a senior programme specialist at the International Development Research Centre, Ottawa, Canada. He received a PhD in the sociology of rural development from Wageningen Agricultural University. He has conducted and directed a number of rural development research projects in Nicaragua and currently contributes actively to community-based natural resource management research in a number of countries in Asia, including China, Vietnam and Mongolia. He is also an adjunct professor at China Agricultural University.

References

- Agricultural and Rural Committee (of the National People's Congress) (2004) 'Study on legislation of farmer economic cooperatives (2)' in *Management and Administration of Rural Cooperatives*, 10: 38–43 [in Chinese].
- Almekinders, C. and Hardon, J. (eds) (2006) *Bringing Farmers Back into Breeding: Experiences with Participatory Plant Breeding and Challenges for Institutionalisation*, Agromisa Special 5, Agromisa, Wageningen, Netherlands, available from: www.idrc.ca/uploads/user-S/11798591651Bringing_farmers_back.pdf [accessed 1 June 2009].
- Berdegué Sacristán, J.A. (2001) *Cooperating to Compete: Associative Peasant Business Firms in Chile* [PhD thesis], Wageningen University Press, Wageningen, Netherlands.
- Bernard, T. and Spielman, D.J. (2009) 'Reaching the rural poor through rural producer organizations? A study of agricultural marketing cooperatives in Ethiopia' in *Food Policy* 34(1): 60–69.
- Bijman, J. and Ton, G. (2008) 'Producer organizations and value chains' in *Capacity. Org.*, 34: 4–6, available from: [www.capacity.org/en/content/view/full/219/\(issue\)/17339](http://www.capacity.org/en/content/view/full/219/(issue)/17339) [accessed 13 June 2009].
- Brush, S.B. (ed.) (2000) *Genes in the Field: On-farm Conservation of Crop Diversity*, Lewis Publishers, Boca Raton, Fla., USA; International Development Research Centre, Ottawa, Canada; International Plant Genetic Resources Institute, Rome, Italy, available from: www.idrc.ca/en/ev-9392-201-1-DO_TOPIC.html [accessed 1 June 2009].
- CAAS (Chinese Academy of Agricultural Sciences) (1994) 'Maize germplasm resource in China' [unpublished], CAAS, Beijing, China.
- Cao Jianmin, Hu Ruifa and Huang Jikun (2005) 'Agricultural technology extension and farmers' modification of new technology: a study of the factors influencing farmers' participation in technology training and their willingness to adopt' in *China Soft Science*, 6: 60–66 [in Chinese].
- CBD Secretariat (Secretariat of the Convention on Biological Diversity) (2001) *Global Biodiversity Outlook*, Convention on Biological Diversity, Montréal, Canada, available from: <http://www.cbd.int/gbo1/gbo-pdf.shtml> [accessed 20 October 2009].
- CCAP (Center for Chinese Agricultural Policy) (1999) 'Exploring the potential for crop development and biodiversity enhancement: fostering synergy between the formal and the farmers' seed systems in China' [research proposal], CCAP, Chinese Academy of Agricultural Sciences, Beijing, China.
- ____ (2004) 'Exploring the potential for crop development and biodiversity enhancement: fostering synergy between the formal and the farmers' seed systems in China' [final project report phase 2], CCAP, Chinese Academy of Agricultural Sciences, Beijing, China.
- ____ (2005) 'Reforming the public agricultural extension system in China: functions, institutions, incentives and innovative extension approaches'

- [research proposal], CCAP, Chinese Academy of Agricultural Sciences, Beijing, China.
- ____ (2008) *Fair Access and Benefit Sharing of Genetic Resources and Traditional Knowledge for Rural Livelihood Security: Exploring Appropriate Policies and Laws in Rapidly Changing China* [annual report], CCAP, Chinese Academy of Agricultural Sciences, Beijing, China.
- Chen Tianyuan and Huang Kaijian (2006) 'Participatory plant breeding and influence on sustainable use of maize genetic diversity – using Guangxi maize as a case study' in *Chinese Agricultural Science Bulletin* 22(7): 491 [in Chinese].
- CIP-UPWARD (Centro Internacional de la Papa/User's Perspectives with Agricultural Research and Development) (2003) *Conservation and Sustainable Use of Agricultural Biodiversity: a Sourcebook*, CIP-UPWARD, Los Baños, Philippines.
- Crucible Group (1994) *People, Plants and Patents*, International Development Research Centre, Ottawa, available from: www.idrc.ca/en/ev-9317-201-1-DO_TOPIC.html [accessed 1 June 2009].
- ____ (2000a) 'Policy options for genetic resources: *People, plants and patents revisited*' in *Seeding Solutions*, vol. 1, International Development Research Centre, Ottawa, Canada; International Plant Genetic Resources Institute, Rome, Italy; Dag Hammarskjöld Foundation, Uppsala, Sweden.
- ____ (2000b) 'Options for national laws governing control over genetic resources and biological innovations' in *Seeding solutions*, vol. 2, International Development Research Centre, Ottawa, Canada; International Plant Genetic Resources Institute, Rome, Italy; Dag Hammarskjöld Foundation, Uppsala, Sweden.
- Degrassi, A. and Rosset, P. (2003) *A New Green Revolution for Africa? Myths and Realities of Agriculture, Technology and Development*, pp. 40–43, Open Computing Facility, Berkeley, USA.
- Fan, S. and Pardey, P.G. (1997) 'Research productivity and output growth in Chinese agriculture' in *Journal of Development Economics* 53(1): 115–137.
- FAO (Food and Agricultural Organisation) (2009) *International Treaty on Plant Genetic Resources for Food and Agriculture*, FAO, Rome, Italy, available from: www.planttreaty.org/texts_en.htm [accessed 2 July 2009].
- Fock, A. and Zachernuk, T. (2005) *China – Farmers' Professional Associations: Review and Policy Recommendations*, World Bank, Washington DC, USA.
- Friis-Hansen, E. and Sthapit, B. (eds) (2000) *Participatory Approaches to the Conservation and Use of Plant Genetic Resources*, International Plant Genetic Resources Institute, Rome, Italy.
- Gao Xiaowei (2008a) *Leading and Accepting: Research on the Process of How a Rural Development Organization is Merging into a Rural Community*, China Agricultural University, Beijing, China [PhD thesis, in Chinese].
- ____ (2008b) 'Leading and accepting: the analysis of the approach of embedded farmer organization – based on a case study of the Community Development Committee of a certain natural village' in *Journal of China Agricultural University (social sciences version)* 25(2): 178–184 [in Chinese].
- Halewood, M., Deupmann, P., Sthapit, B.R., Vernooy, R. and Cecarrelli, S. (2007) *Participatory plant breeding to promote farmers' rights*, Bioversity International, Rome, Italy.

- Han Jun (2007) *Survey on farmers' cooperatives in China*, Shanghai Far East Publishers, Shanghai, China [in Chinese].
- Howells, J. (2006) 'Intermediation and the role of intermediaries in innovation' in *Research Policy* 35(5): 715–728.
- Hsiao-Tung Fei (1946) *Peasant Life in China: a Field Study of Country Life in the Yangtze Valley*, Oxford University Press, New York.
- Hsiao-Tung Fei, Gary G. Hamilton and Zheng Wange (1992) *From the Soil, the Foundations of Chinese Society: a Translation of Fei Xiaotong's Xiangtu Zhongguo*, University of California Press, Berkeley.
- Huang Jikun, Hu Ruifa, Sun Zhenyu (2000) 'Let science and technology enter into thousands of rural households: the Set up of a new ATE innovation system' in *Agricultural Economy Questions* 4: 17–25 [in Chinese].
- Huang Jikun, Song Yiching, Zhi Huayong and Hu Ruifa (2008) *Piloting the Public Agricultural Extension System Reform: Supporting Rural Innovation in China* [research proposal], CCAP/Chinese Academy of Agricultural Sciences, Beijing, China.
- Huang Jikun, Xu Zhigang and Hu Ruifa (2003) 'Input and use of agricultural extension funds' in Chen Xiwen (ed.), *The Use and Management of Supportive Agricultural Funds: System Reform Research in China*, pp. 139–164, Shanxi Economic Press, Taiyuan [in Chinese].
- Hu Ruifa, Huang Jikun, Li Liqiu (2004) 'Chinese agricultural technology extension: present situation, questions and solutions' in *Management World* 5: 50–57 [in Chinese].
- Klerkx, L. and Leeuwis, C. (2009a) 'The emergence and embedding of innovation brokers at different innovation system levels: insights from the Dutch agricultural sector' in *Technological Forecasting and Social Change* 76(6): 849–860.
- ____ (2009b) 'Balancing multiple interests: embedding innovation intermediation in the agricultural knowledge infrastructure' in *Technovation* 28(6): 364–378.
- Leeuwis, C. (2004) *Communication for Rural Innovation: Rethinking Agricultural Extension*, Blackwell Science, Oxford, UK.
- Li Jiling (1991) *Maize Breeding*, South Press House, Guangzhou, China [in Chinese].
- Li Liqiu, Hu Ruifa, Liu Jian and Hong Yan (2003) 'To set up a public ATE service system' in *Chinese Science and Technology Forum* 6: 125–128 [in Chinese].
- Li Xiaoyun (1999) *Who is the Main Actor of Rural Development?* China Agriculture Press, Beijing, China [in Chinese].
- Li Xiaoyun, Xu Xiuli, Qi Gubo, Lu Min and Vernooy, R. (2009) 'Mainstreaming participatory rural development studies in China' in Scoones, I. and Thompson, J. (eds), *Farmer First Revisited: Innovation for Rural Development*, pp. 258–263, Practical Action Publishing, Burton on Dunsmore, UK.
- Li Zhinan and Chen Deshou (2001) 'Research on participatory agricultural technology development in Guizhou mountainous area' in *Guizhou Agriculture Science* 6: 32–34 [in Chinese].
- Liang Suming (1937) *Theories of Rural Construction – the Future of China*, Rural Book Store, Zouping [in Chinese].
- Liang Suming (1940) *Response to Critics of Rural Construction*, China Cultural Service Press, Chongqing [in Chinese].

- Limnirankul, B. (2007) *Collective Action and Technology Development: Up-scaling Innovation in Rice Farming Communities in Northern Thailand* [PhD thesis], Wageningen University and Research Centre, Wageningen, Netherlands.
- Lin, Justin Yifu (1998) *How Did China Feed Itself in the Past? How Will China Feed Itself in the Future?* [CIMMYT Economic Programme, Second Distinguished Economist Lecture], CIMMYT (International Maize and Wheat Improvement Center), Mexico DF, Mexico.
- Long, N. (2001) *Development Sociology: Actor Perspectives*, Routledge, London, UK.
- Ma Yan and Haski, P. (2003) *Le Journal de Ma Yan: la Vie Quotidienne d'une Écolière Chinoise*, Ramsay, Paris, France.
- Mezirow, J. and Associates (2000) *Learning as Transformation: Critical Perspectives on a Theory in Progress*, Jossey-Bass, San Francisco, USA.
- O'Hara, P. (2006) 'Shaping the key to fit the lock: participatory action research and community forestry in the Philippines' in Tyler, S.R. (ed.), *Communities, Livelihoods and Natural Resources: Action Research and Policy Change in Asia*, pp. 253–276, Intermediate Technology Publications, London, UK; International Development Research Centre, Ottawa, Canada.
- Ostrom, E. (1999) 'Social capital: a fad or a fundamental concept?' in Dasgupta, P. and I. Serageldin, I. (eds), *Social Capital: a Multi-faceted Perspective*, pp. 172–214, World Bank, Washington DC, USA.
- Peng Zebin and Chen Zehui (1993) 'Current status of maize hybrid breeding and its strategies in China' in *Proceedings of the Fifth Asia Regional Maize Workshop, 15–21 March 1993, Hanoi, Vietnam*, CIMMYT (International Maize and Wheat Improvement Center), Mexico DF, Mexico.
- RAF (Rural Advancement Fund) (2004) *Comprehensive Survey Report on Farmers' Professional Associations in China*, Institute for Rural Development, Beijing, China.
- Rivera, W. and Alex, G. (eds) (2004) *Demand-driven Approaches to Agricultural Extension: Case Studies of International Initiatives*, World Bank, Washington DC, USA.
- Röling, N. (2002) 'Beyond the aggregation of individual preferences: moving from multiple to distributed cognition in resource dilemmas' in Leeuwis, C. and Pyburn, R. (eds), *Wheelbarrows Full of Frogs: Social Learning in Rural Resource Management*, pp. 25–47, Koninklijke Van Gorcum, Assen, Netherlands.
- Rondot, P. and Collion, M.H. (eds) (2001) *Agricultural Producer Organizations: Their Contribution to Rural Capacity Building and Poverty Reduction*, World Bank, Washington DC, USA.
- Scott, J.C. (1998) *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*, Yale University Press, New Haven, Connecticut, USA.
- SEARICE (South-east Asia Regional Initiatives for Community Empowerment) (2007) *Valuing Participatory Plant Breeding: a Review of Tools and Methods*, SEARICE, Manila, Philippines.
- Song Yiching (1998) 'New' Seeds in 'Old' China: Impact Study of CIMMYT's Collaborative Programme on Maize Breeding in South-west China [PhD thesis], Wageningen University, Wageningen, Netherlands.
- ____ (2003) 'Linking the formal and informal systems for crop development and biodiversity enhancement' in *Conservation and Sustainable Use*

- of Agricultural Biodiversity: a Sourcebook*, pp. 376–381, CIP-UPWARD, Los Baños, Philippines.
- Song Yiching and Jiggins, J. (2003) 'Women and maize breeding: the development of new seed systems in a marginal area of south-west China' in Howard, P.L. (ed.), *Women and Plant-Gender Relations in Biodiversity Management and Conservation*, pp. 273–288, Zed Books, London and New York.
- Song Yiching and Vernooy, R. (2003) 'Participatory maize and livelihood improvement in south-west China' in *Agricultural Research and Extension Network Newsletter* 48 (July): 8
- Song Yiching, Zhang Linxiu, Vernooy, R. (2006) 'Empowering women farmers and strengthening the local seed system: action research in Guangxi, China' in Vernooy, R. (ed.), *Social and Gender Analysis in Natural Resource Management: Learning Studies and Lessons from Asia*, pp. 129–154, Sage, New Delhi, India; International Development Research Centre, Ottawa, Canada.
- Song Yiching, Zhang Shihuang, Huang Kaijian, Qin Lanqiu, Pan Qunying and Vernooy, R. (2006) 'Participatory plant breeding in Guangxi, south-west China' in Almekinders, C. and Hardon, J. (eds), *Bringing Farmers Back into Breeding: Experiences with Participatory Plant Breeding and Challenges for Institutionalisation*, Agromisa Special 5, pp. 80–86, Agromisa, Wageningen, Netherlands, available from: www.idrc.ca/uploads/user-S/11798591651Bringing_farmers_back.pdf [accessed 1 June 2009].
- Stone, B. (1990) 'Evolution and diffusion of agricultural technology in China' in Kotler, N.G. (ed.), *Sharing Innovation: Global Perspectives on Food, Agriculture and Rural Development* [proceedings of a colloquium organized by the Smithsonian Institution], pp. 35–93, Smithsonian Institution, Washington DC, USA.
- Tan Xianyong (2006) *Research on China's Agricultural Micro-economic Organizational System: Rural Development and Institutional Innovation*, China Agricultural Press, Beijing, China [in Chinese].
- United Nations (1993) *Convention on Biological Diversity*. United Nations, New York, USA, available from: www.cbd.int/doc/legal/cbd-un-en.pdf [accessed 2 July 2009].
- UPOV (Union for the Protection of new Varieties of Plants) (1991) *International Convention for the Protection of New Varieties of Plants*, UPOV, Geneva, Switzerland, available from: <http://www.upov.int/en/publications/conventions/1991/content.htm> [accessed 2 July 2009].
- Van den Ban, A.W. (1994–1997) 'Possible roles of farmers' organizations' in *Bangladesh Journal of Extension Education* 9 special issue, pp.139–145, available from: library.wur.nl/wasp/bestanden/LUWPUBRD_00359026_A502_001.pdf [accessed 3 July 2009].
- Van der Veen, R. (2000) 'Learning natural resource management' in Loewinsohn, M., Berdegué, J. and Guijt, I. (eds), *Deepening the Basis of Rural Resource Management: Proceedings of a Workshop 16–18 February 2000*, pp. 15–22, International Service for National Agricultural Research, the Hague, Netherlands; RIMISP, Santiago de Chile, Chile.
- Vernooy, R. (2003) *Seeds that Give: Participatory Plant Breeding*, International Development Research Centre, Ottawa, Canada, available from: www.idrc.ca/seeds/ev-30294-201-1-DO_TOPIC.html [accessed 2 June 2009].

- ____ (2005) 'Whose varieties are they? Clarifying questions of recognition, access and benefit sharing related to the development of new varieties through participatory plant breeding' [background paper, unpublished], International Development Research Centre, Ottawa, Canada.
- Vernooy, R. and McDougall, C. (2003) 'Principles for good practice in participatory research: reflecting on lessons from the field' in Pound, B., Snapp, S., McDougall, C. and Braun, A. (eds), *Managing Natural Resources for Sustainable Livelihoods: Uniting Science and Participation*, pp. 113-141, Earthscan, London; International Development Research Centre, Ottawa.
- Vernooy, R., Li Xiaoyun, Xu Xiuli, Lu Min and Qi Gubo (eds) (2008) *Learning from the Field: Innovating China's Higher Education System*, Cambridge University Press, New Delhi, India; International Development Research Centre, Ottawa, Canada; available from: www.idrc.ca/en/ev-122332-201-1-DO_TOPIC.html [accessed 24 June 2009].
- Vernooy R., with Shrestha, P., Cecarrelli, S., Ríos, H., Song Y. and Humphries, S. (2009) 'Towards new roles, responsibilities and rules: the case of participatory plant breeding' in Cecarrelli, S., Guimaraes, E. and Weltzien-Rattunde, E. (eds), *Plant Breeding and Farmer Participation*, Food and Agriculture Organization of the United Nations, Rome, Italy [in press].
- Vernooy, R. and Song, Y. (2003) 'Celebrating diversity' in *ILEIA Magazine* 19(3): 36.
- ____ (2004) 'New approaches to supporting the agricultural biodiversity important for sustainable rural livelihoods' in *International Journal of Agricultural Sustainability* 2(1): 55-66.
- Vernooy, R., Song Y., Li Jingsong (2007) 'Local agricultural innovation in China: ensuring a fair share of rights and benefits for farming communities' in *Asia Tech Pacific Monitor* 24(2): 27-33.
- Wang Xiufen (2007) *Research about Peasant Household Livelihood Vulnerability – Based on Changgang Community in Guangxi* [MSc dissertation], China Agricultural University, Beijing, China [in Chinese].
- Wennink, B. and Heemskerk, W. (eds) (2006) *Farmers' Organizations and Agricultural Innovation: Case Studies from Benin, Rwanda and Tanzania*, Royal Tropical Institute (KIT) Publishers, Amsterdam, Netherlands.
- World Bank (2007) *Enhancing Agricultural Innovation: How to go Beyond the Strengthening of Research Systems*, World Bank, Washington DC, USA.
- WTO (World Trade Organization) (1994) *Agreement on Trade-related Aspects of Intellectual Property Rights: Article 27.3b*, WTO, Geneva, Switzerland, available from: www.wto.org/english/docs_e/legal_e/27-trips.pdf [accessed 11 June 2009].
- Wu Licai (2004) 'An explanation of farmers' cooperation rationality' in *Journal of Huazhong Normal University (Humanities and Social Sciences)* 1: 5-7.
- Xu Zhigang, Hu Ruifa, and Huang Jikun (2003) 'Input and use of agricultural extension funds', in Chen Xiwen (ed.) *The Use and Management of Funds that Support Agriculture — System reform research in China*, Taiyuan: Shanxi Economy Press, pp. 139-163, [in Chinese].
- Yan Yangchu (1935) *The mission of the Rural Campaign*, Chinese National Association of the Mass Education, Beijing [in Chinese].
- Yan Yangchu (1935) *The Meaning of Mass Education*, Chinese National Association of the Mass Education, Beijing [in Chinese].

- Yang Huan (2007) *A study on the Cooperation among Farmers in Agriculture at the Community Level: Insights from Wumin County, Guangxi* [MSc thesis], China Agricultural University, Beijing, China [in Chinese].
- Yang Huan, Vernooy, R., Zuo Ting, Qi Gubo, Xu Xiuli and Li Chanjuan (2008) *A Review of Literature and Policies Related to Farmer Organizations in China* [unpublished], China Agricultural University and Center for Chinese Agricultural Policy, Beijing, China.
- Zhang Li (2008) *Into a New Orbit: Changing China's Higher Education System – in Person*, China Agricultural University Press, Beijing, China.
- ____ (2009) *How Knowledge Sharing Happened in an Innovation Process: a Case Study of Participatory Plant Breeding and Public Extension Reform from Guangxi* [PhD thesis], China Agricultural University, Beijing, China.
- Zhang Li, Qi Gubo, Vernooy, R., with Long Zhipu and Jingsong Li (2010) 'Mainstreaming CBNRM in Chinese higher education' in Vernooy, R. (ed.) *Collaborative Learning in Practice – Examples from Natural Resource Management in Asia*, pp. 95–150, Cambridge University Press, New Delhi, India; International Development Research Centre, Ottawa, Canada [in press].
- Zhang Linxiu, Huang Jikun and Rozelle, S. (2007) *Farmers' Professional Associations in Rural China: State Dominated or New State–Society Partnerships?* Center for China Agricultural Policy/Chinese Academy of Sciences, Beijing, China.
- Zhang Shihuang (1995) 'Some suggestions for maize genetic base broadening by a systematic utilisation of exotic germplasm and landraces' [draft working paper, unpublished], Chinese Academy of Agricultural Science, Beijing.
- ____ (2003) 'Foreword' in Vernooy, R. *Seeds that Give: Participatory Plant Breeding*, China Agricultural Press, Beijing, China [in Chinese].
- ____ (2004) Opening speech at the maize breeding and genetic biodiversity workshop, held by the Chinese Academy of Agricultural Sciences and CIMMYT (International Maize and Wheat Improvement Center), Beijing, China.
- Zhang Shihuang and Xinhai Li (2000) 'Genetic variation of inbred lines of maize detected by SSR Markers' in *Chinese Agricultural Science* 33(2):1–9 [in Chinese].

This page intentionally left blank

Index

- access
to genetic resources 10, 49, 59, 61–3
to markets 5, 30, 66–70, 96, 99
to seed varieties 24, 42, 59, 63, 72–3
adaptation 7, 52, 54, 56, 81, 89
age 6, 29, 37, 69, 95, 121
agrarian 9, 35, 40–1, 69
agreements 56, 61–2
see also trade agreements
agricultural
biodiversity 35, 48
diversity 5, 63, 114
extension 29, 63, 85–8, 93–8, 108–9, 116
innovation 66–7, 89, 100
production 69–70, 81–2, 85, 94–6, 100, 116
see also ATE; CAAS; CCAP; Ministry of Agriculture
agricultural research 2, 19–20, 25, 85, 102, 113
see also formal
agro-biodiversity 5–7, 48, 57–8, 62, 97, 115
agro-ecological 5–6, 8, 29, 53
agronomic 2, 24, 54, 119
animal feed 9, 13–4, 29, 32
arable land 7, 39–40, 74
ATE (agricultural technology extension) 86–7, 93, 98

banks 70, 78
see also gene
barriers 58, 62, 65
Beijing 1–3, 14, 58, 79–80, 88, 102
benefit sharing 59–61
see mutual help
biodiversity 2–6, 10, 13–5, 24–6, 43, 60–1
conservation 62, 86, 108–9, 113–4
see also agricultural; agro-biodiversity; genetic
biological 5–7, 48, 59–60, 62, 109
see also CBD
blight *see* epidemics
breeders 21, 51–8, 62–3, 97, 100, 115
see also maize; plant
breeding 3–5, 21–2, 51–8, 63, 95, 115
institutes 8, 50
see also cross-breeding; formal; hybrid; maize; plant; PPB
bridging 10, 26, 68, 97, 110, 120

CAAS (Chinese Academy of Agricultural Sciences) 10–1, 16, 19–20, 50–2, 58, 91
capacity building 10, 49, 61, 80, 91–6, 104
capital 68, 70, 82–3, 95–6, 100, 116
see also financial
cash crop 39, 69, 72, 86
cassava 39, 71–4, 103, 106
CBD (Convention on Biological Diversity) 60–2
CCAP (Centre for Chinese Agricultural Policy) 2, 58, 66, 75, 86–9, 117–8
led team 7–8, 50, 92–4, 99–100, 104–6, 109
CDCs (community development committees) 70, 99–100, 102
CDF (community development fund) 77–8, 99, 108
change agents 92, 109–10, 115, 118
chemical 24, 76, 82, 86–7
Chinese
Government 2, 11, 19, 66, 85, 119
maize 13, 21–2
see also CAAS; CCAP

- choice 4, 7, 66, 76, 82–3, 87, 101
 CIMMYT (International Maize and Wheat Improvement Centre) 7–8, 25–6, 52–4, 58, 64
 cities 1–2, 9, 35–7, 41, 49, 95
 climatic 13–4, 30, 48, 114
 coastal 6, 16
 collection 16–7, 25, 63, 71
 commercialization 9, 25, 29, 43–4, 72, 114
 committee *see* CDCs
 community-based 11, 44–5, 99, 102
see also CDCs; CDF; PCD
 competition 25, 62, 86, 114
 conflicts 2, 26, 59, 67, 86
 conservation 6, 29, 47–50, 57–61, 86, 108
see also biodiversity
 consumption 8, 15, 30–2, 66, 72–3, 76–8
 conventional 4–5, 48, 53, 85, 88–9, 119
 cooperative 2, 13, 26, 49, 73, 113
see also farmer; informal
 coping strategies 38, 40–1, 43, 70–1, 113
 corn belt 14, 19, 21
 costs 24, 41, 68, 73–4, 86–7
 credit 5, 9, 66–7, 70, 77–8, 86
 ‘creolization’ 42, 52
 crisis 35, 85–8
 crop improvement 10, 15, 47, 58, 63–5, 108, 114
 crops *see* cash crop; food; maize; sustainable
 Crops Research Institute 10, 49
 cross-breeding 8, 15, 43, 55–6
see hybrid
 cultivars 9, 15, 21, 42–3
 cultural 7, 15–6, 72–4, 82, 102, 116
 cycle 8, 38, 42, 51, 54, 90
 decentralization 2, 6, 88, 119
 decision makers 1, 3, 62, 115–6, 119
 demand-driven 87, 91–2, 107
 de-tasselling 43, 51
 diffusion 2, 7, 47, 119
 disease 21, 54
 dissemination 21–2, 26, 42, 56, 81, 86
 distribution 7, 10, 39, 69, 78, 94
 diversity 8–10, 13–4, 17, 31, 38, 121
 fairs 10, 57, 97, 115
see also agricultural; biodiversity; biological; CBD; genetic; maize
 double-cross hybrids 13, 15, 18, 21–3
 drought 17, 54, 95–6
 Duan county 36, 55–6, 70–1, 88, 101, 107
 dynamic process 10, 43, 47, 67, 90, 114
 economic
 development 22, 49, 60, 90
 growth 1, 35, 62
 education 9, 39, 77, 82, 87, 95–6
 departments 20, 93, 113
 provision 2, 69, 119
 employment 39, 41, 91
 empowerment 26, 49, 91, 101
 environmental 3–5, 7–8, 42, 56, 86, 98
 protection 10, 49, 56
 epidemics 5, 21
 erosion *see* genetic
 evolution 5, 9, 13, 24, 42, 65
 exchanges 25, 98, 106, 109, 117
 exotic 16, 21, 25–6, 52, 113
 experimental 4, 48, 77, 117
 expertise 9, 43–4, 63, 109, 117–8
 sharing 5, 97, 100, 104, 114
see also women’s
 extension
 agents 3–6, 10, 32, 115–6, 118
 services 9, 29, 48, 57, 67–8
 stations 2, 8, 50, 114
 system 10, 69–72, 81, 85–110, 116–7
see also agricultural; ATE; participatory
 facilitators 4, 91, 97, 99–101, 104, 110
 farmer cooperation 10, 65–83

- farmers'
- knowledge 3, 5, 9–10, 43–4, 49–51
 - livelihoods 30, 35, 49, 57, 91–5, 101
 - organizations 60, 66–71, 81–3, 91, 96–9, 116
 - see also* Guangxi province; women farmers
- farming systems 2, 40, 44, 65
- see also* organic farming
- feedback 48, 58, 87, 93, 110, 118
- feminization 1, 8, 40–4, 95
- fertilizers 75–6, 81–2, 86
- financial 66, 70, 75, 86, 103
- capital 82–3, 96, 116
- fishing 6–7, 48, 60, 86, 93, 104–5
- flat lands 8–9, 14, 30
- flood 8, 13, 30, 40, 70, 95
- food
- crops 13–4, 16, 72
 - production 1, 19, 85
 - security 7–9, 13–5, 19, 24–6, 49, 109, 113
- forestry 5–6, 20, 66, 86, 93
- formal
- agricultural research 8–10, 13, 47
 - breeding 13, 21–5, 43, 50–4, 63, 115
 - seed system 13, 25–6, 42, 49, 114
- fund 4, 48, 70–1, 86–9, 99–103, 117
- see also* CDF; government
- gender 2, 5–7, 9–10, 38, 41, 119
- analysis 49, 104
- gene banks 17, 51, 57, 63
- genetic
- base 7, 10, 17–25, 47–9, 52–4, 57
 - biodiversity 3, 7, 47, 50
 - diversity 25, 30, 44, 49, 108–9
 - erosion 13, 17, 48, 114
 - resources 25, 48–9, 58–64, 97, 114
 - see also* access
- germplasm 13, 16–7, 21–2, 25, 57–8, 113
- see also* maize
- globalization 9, 48, 59
- GMRI (Guangxi Maize Research Institute) 18, 50–8, 75–8, 88–91, 107–10
- government
- officials 6, 93–4, 104, 109–10
 - funding 86–7
 - support 10, 20, 25, 41–2, 67, 72
 - see also* Chinese
- grain 8, 14–9, 32, 40–3, 54, 86
- grants 99–100
- Green Revolution 19, 67
- Guangxi province
- farmers 13, 25, 47, 65–6, 99, 114
 - research team 7, 33–5, 51, 70, 102
 - see also* GMRI
- Guinuo 2006 55–6, 58, 71, 78
- Guizhou province 8, 14, 16, 25, 41, 50
- harvest 1, 52–4, 78–9, 96
- health 2, 48, 76, 119
- Hengxian county 36, 70–1, 75
- herbs 103, 106
- heterosis 15, 18, 25
- high yield 19, 21, 24, 54, 62, 106
- holistic approach 6, 62, 89, 110
- household
- incomes 36–39, 69
 - types 40–2, 53, 65, 73–5
- husbandry 9, 69–70
- hybrid
- breeding 19, 21, 25, 51, 114
 - maize 17, 19, 21, 25, 78
 - varieties 13–4, 17–21, 24–5, 31, 49, 51
 - see also* double-cross hybrids; Guinuo 2006; single-cross hybrids; Tuxpeño 1
- inbred lines 15, 17–8, 21–2
- incentives 26, 58, 62, 72, 87, 92–3
- incomes 9, 35–9, 77–8, 95–6, 104, 108
- see also* household
- indigenous 10, 16, 42–4, 49, 60–1, 97
- infertile 17, 95

- informal
 - cooperation 71–2
 - systems 10, 42, 50, 57, 98
- institutes *see* breeding; Crops Research Institute; GMRI; research
- irrigation 8, 14, 66, 71–6, 86, 95
- knowledge sharing 5, 63, 67, 92–7, 110, 118
 - see also* farmers'; traditional
- kohlrabi 71, 75–6
- labour 9, 35–43, 53, 69, 73–4, 82
- land 5, 8–9, 14, 37–8, 41, 103
 - see also* arable land; flat lands
- landholdings 29–30, 39, 95
- landraces 2, 13–7, 21–4, 43–4, 49–57, 115
 - see also* maize
- landscape 5–6, 115
- laws 10, 59–62, 113
 - see* legal
- leadership 41, 79–80, 82, 104, 107–9, 117
- learning 4–6, 9, 29, 89–91, 104–5, 113
 - by doing 10, 90, 115, 121
- legal 47–9, 56–63, 65, 115
- linking 3, 26, 49–50, 68
- livelihoods 1–2, 25, 110–1, 118
 - strategies 9, 29–44
 - see also* farmers'; rural
- livestock 37–8, 69, 86, 93, 95
- loans 70, 78, 96, 99–100
- Long'An county 36, 56, 70, 88, 101, 106–7
- machinery 73–5, 86
- maize
 - breeders 9, 15, 43, 91, 104
 - breeding 17, 22–6, 47, 63, 99, 114
 - crop 17–8
 - diversity 25–6
 - germplasm 7, 16–7, 25–6, 47
 - improvement 15, 26, 50, 64
 - landraces 8, 16, 21, 29–30
 - producers 29, 44, 48
- see also* Chinese; CIMMYT; GMRI; hybrid; waxy maize
- marketing 15, 29, 68–71, 86, 91, 103
 - see also* seed
- markets 10, 13, 35, 65–70, 81–2, 116
 - see also* access
- Mashan county 31–6, 56, 71, 77–80, 94–5, 105–6
- medicinal 15, 60
- Mexico 25, 54–5, 63, 115
- microfinance 78, 99
- migration 9, 35–7, 41
- Ministry of Agriculture 19–20, 50–7, 63–6, 88, 92–4, 115–7
- modern varieties 4, 7, 43, 47–8
- monitoring and evaluation 6, 77, 86, 92–3
- mountains 13–4, 30, 94, 105, 114
- mutual help 73–4, 81–3, 108, 113, 116
- Nanning 3, 49, 51, 57, 75–6, 98
- natural resource 15, 43, 82, 90
 - management 2–4, 6–7, 66, 102, 113
- networks 7, 10, 59, 65–83, 109, 116
- NGOs (nongovernmental organizations) 6, 67, 87–8
- non-farming 9, 37–8, 41
- OPV (open pollinated varieties) 17, 23, 42, 54–7, 115
- off-farm 39, 69, 73, 82, 91
- on-station 3–4, 48, 51–3, 57, 108
- organic farming 75–7, 81–2
- PAR (participatory action research) 35–9, 43–4, 70–1, 90–2, 109–10, 117–21
- participation 5–8, 26, 52–8, 67, 87, 107
- participatory
 - approach 63, 89, 92, 107
 - extension 87, 94, 98, 101, 106, 109
 - see also* PAR; PPB; PVS
- partners 26, 49, 61–6, 93, 100–4, 114
 - see also* PCD

- patents 60–2
 PCD (Partners for Community Development) 75–6
 per capita 7, 35–6, 39–40, 96
 pesticides 4, 48, 76, 82, 86
 planning 4, 38–40, 57, 63, 92, 115
 plant
 breeders 9, 47–53, 59, 80, 101, 106–7
 breeding 15, 19, 26, 42–4, 48–50, 108–9
 see also PPB
 ploughing 73–4, 96
 policy
 makers 6, 19, 42, 58–60, 103–4, 115–18
 reform 11, 104, 110, 116–7, 119
 see also CCAP
 political 1, 6–7, 47–9, 66, 102, 118–20
 pollination 15, 43
 see also OPV
 population 7–8, 25, 39, 53–6, 69, 109
 poverty 1, 8, 29, 49, 91, 119
 alleviation 9, 25, 109
 power 1, 72, 118–9
 PPB (participatory plant breeding) 8–10, 32, 47–63, 78, 97–100, 118–9
 experiments 52, 57–8, 108, 114, 119
 price 8, 68, 76–8
 private sector 19, 26, 62, 86, 88, 114
 producers 10, 47–8, 62, 82, 114, 116
 production *see* agricultural; food;
 maize; seed
 profit 25, 60, 76, 82
 protection 58–63, 66, 86, 115
 see also environmental
 PVS (participatory variety selection) 50–3, 57–8, 71
 quality
 control 76, 86, 99
 seed 9, 16, 25, 29, 44
 rain 8, 30, 94–5
 reforms 8, 43, 59, 92, 117
 see also policy
 regulations 10, 48, 59–62, 86, 93, 100
 remote areas 24, 43, 59, 66, 69
 research
 and development 6, 8–10, 13–26, 47–63, 85, 117
 institutes 19–20, 85, 88–9, 107–8, 116
 see also agricultural research; Crops Research Institute; formal; GMRI
 resource *see* genetic; natural resource
 rice 16, 19, 29, 39–43, 57, 71–80
 rights 7–8, 58–63, 115
 see also TRIPS
 risk 8, 68, 81, 87
 roads 1, 8, 30, 66, 78
 rural
 development 10–1, 58, 65–6, 85–8, 102–5, 113–21
 livelihoods 15, 35, 48–9, 113–4
 sales 76–7, 82
 season 5, 52–6, 74–6, 81, 95
 seed
 marketing 26, 49, 55–8, 114–5
 production 9–10, 25, 29, 44, 78–82, 106
 selection 1, 43–4, 115
 see also access; quality; seed systems; viable seed
 seed systems 7–10, 13, 25–6, 42, 48–50, 114
 see also formal
 selection 9, 15, 21, 42–3, 53–7, 77–8
 see also PVS; seed; variety
 single-cross hybrids 15, 21, 23
 skills 9, 15, 39–43, 56–9, 75–9, 102–7
 see knowledge
 soil 8, 30–1, 86, 103
 species 5, 8, 15, 25, 48, 97
 stakeholders 50, 57, 66–7, 89–99, 104–10, 121
 station 5, 8, 53–4, 108
 see also extension; on-station
 storage 1, 42, 75
 stress tolerance 5, 17, 24–5, 42–3
 subsidies 2, 119
 subsistence 8, 24, 30, 35–8

- sugar cane 72–4
- suppliers 10, 81, 88
- sustainable 24, 57, 76, 92, 102, 115
 - crop 7, 48, 97
 - development 9, 81, 87, 109, 117
- sweet potatoes 19, 31, 39
- synergy 1–11
- taste 16, 42, 54–6, 76, 81
- technical 15, 47–9, 65, 81, 91, 98
 - information 69, 72, 79
 - support 56, 75, 109
- technology
 - development 7, 22, 47, 68, 89, 106–8
 - transfer 62, 87
 - see also* ATE
- temperate zones 14, 25
- tolerance 17, 24–5, 96
- top-down approach 4, 48, 57, 85–91, 107, 115–6
- townships 37, 92, 95, 104, 117
- tractor *see* ploughing
- trade agreements 49, 60–2
 - see also* TRIPS; WTO
- traditional 8–9, 13, 38–43, 98, 100, 110
 - knowledge 25, 51, 59–62, 81–2, 113–5, 118–20
 - variety 15, 24, 30–1, 72, 105–7
- training 71–8, 80–1, 86–7, 94–101, 104–7, 116
- transportation 68–70, 76, 96
- trial/study villages 36–7, 50–4, 69
- TRIPS (Trade-Related aspects of Intellectual Property Rights) 60–2
- tropical 14, 18, 20, 25
- Tuxpeño (1) 24, 43, 52, 55
- urban 1, 38, 76
- United States 18–9, 21, 60–1
- valleys 9, 13, 18, 31
- variety
 - development 7, 47
 - improvement 25, 48, 58, 99
 - release 4, 10, 48
 - selection 8, 50–1, 54, 71
 - see also* access; hybrid; modern varieties; OPV; PVS; traditional
- vegetable 16, 31, 97
- viable seed 10, 42, 47, 66, 114
- villages *see* trial/ study villages; Wentan village
- vulnerable 5, 13, 25, 94–5, 113
- wages 2, 37, 119
- water 6–8, 30, 66, 73, 86, 93–5
- waxy maize 8, 16–7, 30–2, 43, 55–6
- weather *see* climatic
- Wentan village 39–41, 47–55, 72–5
- wheat 7, 19, 29
 - see also* CIMMYT
- women farmers 2–3, 7–8, 25–9, 42–4, 57, 78
 - groups 47–51, 81, 108–10, 114–5
 - see* feminization
- women's expertise 1–3, 42, 119
- WTO (World Trade Organization) 49, 59, 61–2, 68
- Wuming county 36, 39–40, 70–2, 88, 101, 106–7
- yields 21–5, 42, 54, 76, 81, 109
 - see also* high yield
- Yunnan province 14–6, 25, 41, 50, 77, 99