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## For Food Security, China Tries an Alternative to Industrial Agriculture

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### In Brief:

China's industrial growth has challenged the economic might of the United States, but the country's advances have not occurred evenly. They have come at the expense of rural development, particularly in regions characterized by unfavorable natural conditions and fragile ecosystems. Although China has attained a high degree of grain sufficiency (about 95 percent) and remains a net food exporter, there are signs of enduring serious problems. Poverty combined with food insecurity and malnutrition continues to affect around 150 million Chinese people, according to recent estimates based on the World Bank poverty line of U.S.\$1.25. This has exacerbated the widening gap between the wealthy coastal areas, supported by industrial development, and the impoverished peasants of the northwest and southwest who rely on subsistence production. In addition, agricultural income is generally declining and represents a lower percentage of rural household income; many farmers are losing interest in farming, with women and older people becoming the main agricultural cultivators.

Participatory research conducted in southwest China has resulted in concrete strategies to deal with these challenges. Farmers, led by women, have organized effective local organizations for technology development, seed management, and market linkages, with innovative support from the staff of public research and extension agencies. Collaborative field experiments to improve crop varieties—an approach known as participatory plant breeding—local biodiversity fairs, organic farming practices, new market channels, and new forms of research and policy support are contributing to improved farmer livelihoods and to a more dynamic and equitable process of rural development. Modernizing rural development using traditional and local knowledge stands in stark contrast to the shift to industrialized agriculture in China's coastal regions. Both approaches will be needed if China is to address the challenges of food security, well-being, sustainable natural resource management, and biodiversity conservation.

### Key Concepts:

- China's agricultural development in recent decades has contributed to the country's increase in food security and reduction in poverty. However, the country continues to face persistent rural poverty in fragile agroecological regions, increasing socioeconomic inequality, feminization and aging of the agricultural workforce, environmental degradation, and erosion of biodiversity.
- Smallholder farmers are losing agricultural biodiversity and related traditional knowledge and local practices. This genetic erosion is threatening the livelihood and security of the poor and the country's long-term agricultural sustainability and food security.
- Privatization of seed production has led to a focus on hybrids and other modern varieties and an almost total neglect of other types of crops, including traditional and underutilized varieties. Most hybrid varieties cannot adapt to the conditions in remote mountainous areas, including to increasingly variable weather conditions and longer-term climate change dynamics.
- Farmers, led by women, have organized new local organizations for technology development, seed management, and market linkages. They use an approach known as participatory plant breeding, which unites professional

breeders and farmer breeders to improve crops and maintain biodiversity, blending the best of scientific and traditional knowledge and expertise.

- Green and certified organic agriculture have developed rapidly in China, with financial and technical support of government agencies. Domestic and foreign markets for organic produce are growing. Larger-scale conversion to green and organic agriculture requires considerable time and additional organizational, technical, and marketing support.

China's economic growth in recent years has been extraordinary but uneven. Vulnerable groups, such as smallholder farmers and their communities, are most affected by this unbalanced development, which is expressed in terms of widening income gaps between urban and rural regions, unequal government support to industry and agriculture, a focus on the East Coast and neglect of remote western rural areas, and the prioritization of economic development over protection of the environment. This is leading to enormous challenges, such as enduring extreme rural poverty and increasing socioeconomic inequality, feminization and aging of the agricultural workforce, severe environmental degradation, and serious erosion of biodiversity.<sup>1</sup> Ensuring China's food security has recently been added to these concerns. Food insecurity persists in a number of provinces, mostly in western and central China: 130 million people are believed to be food insecure or undernourished. Most of these people live in the mountainous regions of the northwest and southwest, which are characterized by fragile ecological conditions and underdeveloped infrastructure and services. According to a recent study, about 150 million people continue to live under the poverty line of U.S.\$1.25 per day. That number goes up to 474 million if the line is set at U.S.\$2 per day.<sup>2</sup>

### Uneven and Unequal Change

At the heart of food insecurity are several problems. Due to the process of rapid modernization, China has lost about 8.3 million hectares of arable land, 6.5 percent of the country's total arable area, largely in the most fertile coastal regions, where urbanization and industrialization have flourished. Access to water—and its quality, use, and distribution—are all mounting problems that, over time, may become even more serious than issues related to land. Supply-side-related problems are not the only challenges facing Chinese agriculture. Since the 1990s, rising incomes, especially in cities, have led to significant increases in the consumption of nonstaple foods, such as meat, fish, fruits, eggs, and dairy products. Given that the number of higher-income earners is expected to increase rapidly, demand for nonstaples will also expand, increasing pressure on the national food supply. Production of nonstaple foods has been rising in response to increased demand, for example, between 1996 and 2007, meat production went up by 50 percent, egg production by 30 percent, and milk production by 200 percent.<sup>3</sup> However, increased demand and the resulting increase in production have been accompanied by various problems, including environmental pollution and unsafe foods, for example, tainted milk, which caused the death of babies and children, a global outcry, as well as a huge setback to development of the domestic dairy industry.

Since it initiated reforms in 1978, China has been widely recognized for its major achievements in reducing *extreme* poverty. However, severe poverty remains high in absolute numbers. Small farmers in the remote upland areas of southwest and northwest China, with an average of less than 0.2 hectares of land, are among the poorest of the poor. They are also the most affected by food insecurity. Although they hold land-use rights, in most cases the land is of such low quality that it is not possible to achieve subsistence levels of production. Many poor farmers have to purchase additional food, but they have been hit hard by increased food prices since the reforms.

A major consequence of the reforms has been an overall increase in out-migration from rural to urban areas, especially from poorer areas. Men are the majority of the migrants, while fewer women are moving, resulting in the increasing feminization of agriculture in the last decade, most notably in the poor western and southwestern areas.<sup>4</sup> More and more women are being left alone at home, and they constitute 70–80 percent of the agricultural labor force in most rural provinces.<sup>5</sup> They are mainly middle-aged women with limited education. However, women's increasing role in rural life is seldom noted by the key decision makers, mostly living in towns and cities, who are responsible for rural development issues, including the areas of 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, for example, in the development of new crop varieties and alternative agronomic practices. The result has been an agricultural policy that often fails to address the needs of farmers in some of the most deprived areas.

### Neglected by Conventional Crop Research

Conventional crop research in China is well organized and has produced very good results, leading to a major decrease in food insecurity and poverty. But it has been carried out mainly under favorable growing conditions, following a

development path of high-input and commercialized agriculture. The past 15 years have seen spectacular results in China's agricultural heartland from the use of improved crop varieties and agricultural inputs—such as inorganic fertilizers, machinery, and tools—that have been supported by lower agricultural taxes, input and output subsidies, price supports, and market and infrastructure development. However, less arable regions, including the mountainous areas of Guangxi, Yunnan, and Guizhou in the southwest, have not been served well. This is partly because of the prevailing assumptions of plant breeders, in turn supported by decision makers in agricultural development circles, 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 still found in the southwest) must be replaced by high-yielding varieties under all circumstances to ensure national food security.

Agricultural biodiversity, farmers' diverse livelihoods, and farmers' contributions to crop conservation and improvement have been largely ignored. Privatization of seed production has led to a focus on hybrids and other modern varieties, with almost total neglect of traditional varieties and underutilized crops. Unfortunately, most hybrid varieties cannot adapt to the conditions in remote mountainous areas, including to increasingly variable weather conditions (e.g., droughts, floods), as experienced in Guangxi and other southwestern provinces. They are also susceptible to diseases and pests. Farmers in these regions have not been able to adopt hybrids and continue to rely on local varieties, though the area under cultivation is decreasing in many communities.<sup>6</sup>

### Genetic Erosion in China

Maize, one of China's most important grains, 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 for both food and feed, but farmers in the main maize-growing areas have to rely on only about 200 hybrid varieties.<sup>10</sup> Although the national maize germplasm collection contains about 16,000 varieties, the use of much of this material in breeding programs is limited. In 1995, only five hybrid varieties were grown on 22.6 percent of the total maize acreage, and more than 38 percent of the national maize crop by area is made up of five inbred lines. If disease breaks out, the impact would be catastrophic, similar to other cropping situations that have suffered from reliance on only a few varieties.<sup>11</sup>

But not only maize is affected by genetic erosion. In the last ten years, crop landraces in the whole country have decreased rapidly. For example, a recent survey in Guangxi, Yunnan, and Guizhou in the southwest revealed that, although about 90 percent of respondent households were cultivating maize landraces in 1998, this proportion decreased to 73 percent in 2003 and 56 percent in 2008. Farmers are turning more and more to hybrids and buying seeds, increasing their dependence on high-input cropping systems (hybrids often do not do well without sufficient doses of chemical inputs; hybrids also require the purchase of new seeds year after year). This is mainly the result of spreading market forces backed by government policies and interventions, on the one hand, and the lack of government support for local practices, on the other hand, leaving less and less space and options for the development of farmers' own seeds systems. Recent research suggests that, although farmers appreciate the advantages of hybrids to some extent, such as the high yields under favorable conditions, they remain concerned about the risks.<sup>12</sup>

### Creating Synergies

To address these multiple challenges affecting rural China, in 1999 a novel initiative was started by several groups of women farmers, a number of rural villages, two plant-breeding organizations, and the Center for Chinese Agricultural Policy (CCAP), the country's leading public agricultural policy research organization. Research began in Guangxi Province, located in the southwest and a risk-prone area. In the mountains, which cover much of the province, farmers planted maize in minute pockets of soil on steep 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 limited. Maize is produced for consumption. It is a traditional staple crop in the area, where there is a diversity of maize landraces, including, for example, waxy maize. A second research area consisted of relatively better-off communities in the valleys and flat areas, where people tend to be a bit better educated and have livelihoods that are more integrated with the market economy. Maize used to be a traditional staple food, but it is now used more for pig feed. Pig farming is the main source of income for most villagers.

CCAP's senior researcher Yiching Song developed the initiative, which launched an ambitious agenda that included crop rotation and organic fertilizers. Led by Song, who obtained her doctorate in rural development from Wageningen University in the Netherlands, the team used participatory research to create synergies between the worlds of farmers and breeders, searching for innovative ways of using the best of traditional and modern knowledge and practices. The main aim was to establish cooperative and complementary relations between the formal seed system and farmers' systems. Cooperation was necessary in order to empower farmers, mainly women farmers. At the heart of the efforts is an approach known as participatory plant breeding, in which professional breeders and farmer breeders join forces to improve crops, blending scientific and traditional knowledge.<sup>7</sup>

The work of the research team, including the farmers, built on local women farmers' maize-breeding experience, developed over many years. At the same time, the team sought the expertise of formally trained plant breeders. Crop improvements were made through a number of crossing techniques and variety selection processes, which involved detasseling, mass selection, and line selection by farmers with support from breeders. Breeders went on to use more complex methods in the fields of the Guangxi Maize Research Institute (GMRI) in Nanning. So far, these trials have led to higher-yielding varieties that are at the same time more resilient to biotic and abiotic stresses, such as pests, diseases, and drought. More than 80 varieties have been used in the trials. Based on ten years of experimentation, four farmer-preferred varieties have been selected and released in the research villages. They have also spread beyond these villages. In 2008, similar work started in the neighboring provinces of Yunnan and Guizhou.

To share the benefits of the new crop products, the research team encouraged farmers and plant breeders to establish a formal agreement 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 entrench the practice. It represents novel policymaking and is being followed with interest by both the Ministry of Agriculture and the Ministry of Environmental Protection. It is a concrete example of giving meaning to international agreements such as the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture.

The initiative is also exploring new efforts at marketing local crops. Two organic or green farming associations, established by local farmers but supported by the research team, are becoming more and more well-known in Hengxian County in southeast Guangxi. Various forms of green and certified organic agriculture in China have been developing rapidly. In many places, these forms of farming do build on historically developed farming systems that never relied heavily on industrial inputs; in other places, including in the more favorable regions, such as central and coastal China, the new forms have developed as a radical shift from Green Revolution practices. Government support, financial and technical, has been important in most cases, but there are also examples of mostly farmer-led change. Public research organizations played an important role in the start-up and development phases of supporting farmers technically and administratively, including with the establishment of internationally recognized certification schemes.<sup>8</sup> The earliest examples of conversion to organic farming date to the beginning of the 1990s. By 2005, more than half a million hectares were dedicated to certified products, with over a thousand companies involved. Since then, the areas under production, the total production, as well as the number of crops produced have expanded all over China (including for tea and bamboo). In 2002, organic vegetables started to become available in some of the major supermarkets in large cities. Both domestic and foreign demand continue to rise.

The first organic products from Guangxi, rice and kohlrabi—which are being produced without the use of industrial inputs—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 produce directly from the two organic associations, which offer only slightly higher prices than for conventional produce. This restaurant, the first of its kind in the province's capital, is quickly gaining popularity.

The two organic associations, based in the villages of Chentang and Sancha, were established in 2005, a year after the conversion to organic farming was initiated in a move away from industrialized forms of farming, which were becoming increasingly costly and risky. Motivated to take a different approach to farming, farmers began to reorganize their work through more cooperation, relying on local resources (such as organic fertilizers and natural pesticides) and a collective spirit of crop management and experimentation. Starting with only ten 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, supporting poverty alleviation and grassroots development.

In 2006, PCD staff began working with team members from CCAP and GRMI to improve local crop varieties. They received technical training and also support to improve the organizational processes, from production to marketing. The organic associations organize regular communications among their members to improve farming skills and give them a deeper understanding of the advantages of organic farming. 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. As farmers

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 their members, encouraging the farmers to experiment to determine the best proportions of materials and the most effective amount of organic fertilizer to use.<sup>9</sup>

The growth of the organic 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 associations, without receiving any payment. Their voluntary efforts are not sustainable in the long run, as they must also earn enough money to support their families. The associations' income, which comes from annual member fees 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 effort is a problem. 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 the basic techniques and skills of organic farming. How to professionalize the associations is becoming an issue, although this challenge can be viewed in a positive light: it indicates that the associations are serving an important function.

## The Road Ahead

A decade's experience illustrates the successes and challenges of linking community-based research with policy- and law-making processes by engaging decision makers in rural development policy at local, provincial, and national levels. While pushing forward rapid transformation of the Chinese economy, many of the country's policymakers, researchers, and rural development agents have neglected important aspects of rural development, such as the traditional knowledge base and local genetic resources. 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, from both government and the private sector. Concerns about conservation of biodiversity and improving rural livelihoods have mostly been sidelined. Farming in southwest China is experiencing a transformation, in certain areas resulting in crises. Agricultural income is generally declining and represents a decreasing percentage of rural household income. Many farmers are losing interest in farming. Both the feminization and aging of the agricultural workforce are evident and increasing; women and older people have become the key agricultural cultivators. Seeds and seed management and improvement are central to sustainable farming but have increasingly become a bottleneck.

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 they still maintain 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. A dynamic and viable seed-production system is crucial for maintaining maize (and food) production, continuing the process of crop improvement, and developing local adaptations to environmental changes. 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. Lack of useful information about new technology and markets is one of the key constraints on agricultural production. Organized farmers have established new links with extension services to solve the problems they face in these arenas.

As Yiching Song, in a recent interview (December 2011), concludes,

Our work in Guangxi tells us that we need to work together with scientists from many disciplines, and with multiple stakeholders from multiple levels. 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. It takes a long time, but it is possible.

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