EXPLORING THE POTENTIAL FOR CROP DEVELOPMENT AND BIODIVERSITY ENHANCEMENT: FOSTERING SYNERGY BETWEEN THE FORMAL AND THE FARMERS' SEED SYSTEMS IN CHINA

Yiching Song

Project Leader and Senior Research Fellow, Centre for Chinese Agricultural Policy,
Chinese Academy of Science
Building 917, Datun Rd, Anwai, Beijing 100101, China
Tel+ 86-10-64856535, Fax+ 86-10-64856533
E-mail: Yiching.Song@alg.vlk.wau.nl or yiching@163bj.com

1. Brief description of the project

The Chinese Seed Systems Project started in January 2000 in Southwest China. It is co-funded by IDRC (International Development Research Centre, Canada) and Ford Foundation, and is carried out by the Centre for Chinese Agricultural Policy (CCAP) of the China Academy of Science (CAS), in collaboration with the International Maize and Wheat Improvement Centre (CIMMYT) and with academic supervision from Wageningen Agricultural University (WAU), The Netherlands.

This Participatory Plant Breeding (PPB) project is a follow-up to an impact study carried out from 1994 to1998 by CIMMYT to assess the impact of CIMMYT's maize germplasm on poor farmers in Southwest China. The study addressed the processes of technology development and diffusion by both the formal and the farmers' seed systems and the impact of the introduced germplasm at different levels.

One of the key findings of the impact study was the systematic separation and conflicting operation of the formal and the farmers' seed systems, which resulted in poor adoption of formally bred "Modern Varieties" (MVs), an increasingly narrow genetic base for breeding and a decrease in genetic biodiversity in farmers' fields. Therefore, the current project aims to identify possibilities, mechanisms and arrangements for developing more effective linkages and mutually beneficial partnerships between the two systems so as to enhance crop development and *in-situ*/on-farm management of genetic resources, and to strengthen farmers' capacities to manage agrobiodiversity in the specific context of China.

2. Context and assessment of the central problem

Maize is now the most important feed crop and the third most important food crop in China. It is the main staple food crop for the rural poor in the remote upland areas in the Southwest, which is an agroecologically diverse area and the centre of maize genetic diversity in China. It is believed that Southwest China is one of the original areas of maize cultivation in the world. For instance, waxy maize is thought to have originated from that area (Liu 1991, Zhang 1995). Farmers in Southwest China have cultivated and relied on maize for their

survival for generations. The majority of farmers in the upland marginal areas are still cultivating improved Open Pollen Varieties (OPVs) and landraces. Farmers there still maintain a higher level of maize varietal and genetic diversity than in the rest of the country (Huang 2000, Zhang et al 2000).

It is well known that the Chinese Government has followed a modern technology-oriented approach and has relied predominantly on its formal seed system. The development and distribution of MVs, mainly hybrids, for the three main staples, i.e. rice, wheat and maize, has been the core task and the first priority for the formal system to achieve the overall goal of national food security. Since the early 1970s, some 30% of Chinese food security is attributable to development and rigorous promotion of improved planting materials, especially hybrid wheat, rice and maize (Lin 1998, Fan & Pardey 1997). Hybrid maize is now grown on around 80% of the total maize-production area in China. Nevertheless, these hybrids are mainly used in the uniform and high-potential areas of the Northern Plain, the "corn belt" of China. Farmers in the remote and harsh areas in the uplands of the Southwest are more or less marginalised by the modern technology development process.

This situation became worse after a market economy was introduced. As a result of the privatisation and commercialisation process, the formal seed system became increasingly involved in profit-driven competition. Hybrid breeding and hybrid seed production drew more attention and efforts then ever before. In the marginalised areas, however, farmers' seed systems continue to play a major role in meeting farmers' heterogeneous needs in OPV seed supply, while maintaining diversity for the interests and sustainable livelihoods of all farmers. The previous impact study revealed that, in the study area, more than 80% of the seed supply is from farmers' own seed systems (Song 1998).

A cooperative and complementary relationship between the formal seed system and farmers' systems, rather than the current separated and conflicting situation, is urgently needed for addressing the challenges in food security and biodiversity. It is needed, moreover, to empower farmers, who are in this case mainly women, to become active partners in plant breeding, on-farm biodiversity management and seed marketing. This formed the central problem and the core reason for starting the current PPB project in Southwest China.

3. Preparation and networking

3.1. Establishment of multidisciplinary research team

Based on the research results of the previous impact study, the Chinese Government, i.e. CCAP, Chinese Academy of Agricultural Science (CAAS) and the Ministry of Agriculture (MoA), and the international organisations, i.e. CIMMYT and WAU, as well as the rural communities in the study area had shown great interest in a follow-up project to explore possible institutional and technological conditions / arrangements for an effective and efficient collaboration of the formal and informal seed systems through a process of

participatory technology development (PTD).

The following institutions and groups, with different disciplinary backgrounds and operating at different levels, formed into a PPB team, with each member contributing its own part to the project. Researchers (i.e. plant breeders and social scientists), farmers, extensionists, public seed company managers and policymakers combined their knowledge and skills in a complementary and mutually reinforcing way within the PPB team (see Figure 1).

CCAP, as the leading agricultural policy research institute in China, is the institution that hosts the project and provides guidance with regard to research design, implementation and use of the research results.

Institute of Crop Science (ICS) is the leading institution for maize crop research and improvement in the system of the Chinese Academy of Agricultural Science (CAAS). It works on technological issues and related policy issues in maize improvement and genetic biodiversity management.

The ***International Wheat and Maize Improvement Centre (CIMMYT)*** is a collaborating institution that provides guidance in research methodology and methods, mainly in economic and genetic diversity aspects. CIMMYT provide assistance with regard to socio-economic and technical analysis, policy and the technical implications of the project. In addition, it provides some maize germplasm for the project, e.g. appropriate populations for the improvement of the Tuxpeno varieties identified as farmers' preference during the previous study, and for broadening the local genetic base.

Wageningen Agricultural University (WAU) is a collaborating institution that assists in the theoretical framework and research methodologies such as Agricultural Knowledge and Information Systems (AKIS) and a tool it developed for studying it: Rapid Appraisal of Agricultural Knowledge Systems (RAAKS), as well as PTD, specifically in Participatory Plant Breeding (PPB) and Participatory Varietal Selection (PVS).

The following local institutions and communities, from both the formal and the informal systems, are playing crucial roles in field implementation of the work:

Guangxi Maize Research Institute (GMRI), a subordinate institution of CCRI in the CAAS system, collaborates in the formal plant breeding work directly with the collaborating villages and other related local organisations.

Five farmer plant breeding villages, Wenteng, Zhichen, Niantan, Zurong and Huaguang, represent farmers' seed systems collaborating with formal-sector plant breeders, extensionists and other stakeholders in the project activities. Wenteng and Zhichen villages are cases where women farmers are maize breeders in the informal system. The two villages are cases found and studied during the previous impact study. The women farmer

breeders there had expressed an interest in continuing the participatory research and they were involved in designing the current project proposal as core project team researchers from the beginning. These two villages also serve as the in-depth case studies in the current project for time series comparison and other research purposes. The other three villages, Niantan, Zurong and Huaguang, were identified and involved during the exploratory phase, based on their own interests and other criteria decided through discussion among the villagers and the project team. The five villages are from two major maize ecological systems and represent different socio-economic contexts in Southwest China (see Table 1).

Five township extension stations (from four counties) were identified by the project team as main research partners to link the formal and farmers' seed systems at grassroots level. They play a crucial role in collaboration with farmers in PPB/PVS experiments and other project activities (see Section 3.3.2 for further information).

Laizhou Academy of Agricultural Science (LAAS), a farmers' agricultural research organisation in Shangdong Province, North China, is the first agricultural research institution initiated and organised by farmers in China. It has developed a series of improved maize varieties that have been widely adopted by farmers all over the country. Laizhou's maize varieties cover an estimated 30% of the total maize growing area in China. It serves as the case study and potential partner for farmer research / breeding and organisation in the current project period. The case is under study now, and more information concerning its initiatives, organisation, operation, approaches and breeding activities is being obtained. Deeper involvement of LAAS as a research partner in the project is planned for the next phase.

3.2. Identification of main actors and establishment of working networks

The main actors and key informants in the two seed systems in the technology development and dissemination process were identified by the project team as farmers (mainly women), breeders, seed companies, extensionists and policymakers at different levels, i.e. global, national, provincial, county, village and farm household. The project has been facilitating interaction, communication and collaboration among the different actors, and the PPB/PVS field experimentation provides a platform for a joint learning process for all.

In the past one and half years, the project has established an effective working network at both global and local level. Local level here means the entire national agricultural research system including national, provincial, county, township, village and farm household levels. It has involved multiple disciplines including plant breeding, biodiversity, seed production and distribution, socio-economics and policy studies. Many stakeholders and different institutions at different levels in the two systems have been involved, and some significant direct linkages have been established in the process.

Global level. The Chinese Seed Systems Project has benefited greatly from advice regarding theoretical framework and PTD methodologies from WAU and CIMMYT. The

project was originally designed to be compared with the Oaxaca Project, which is a collaborative project between CIMMYT and INIFAP, the Mexican national agricultural research institute. The comparison is being carried out with respect to farmers' responses to and their "creolisation" of exotic modern varieties. The current project is following more or less the same research model as the Oaxaca Project, especially in PPB and PVS field experiment design, in order to ensure comparability.

The project is one of the PPB/PVS cases in the CGIAR Systemwide Program on Participatory Research and Gender Analysis (PRGA) for technology development and institutional innovation in research orientation and methodology. Advice and comments from several advisors associated with PRGA have been invaluable for the design and implementation of the project. The project leader was invited to present the participatory research approach in the III International Seminar of the PRGA entitled "Uniting Science and Participation in Research" in Nairobi, Kenya, in November 2000. Exchange of ideas and experiences with other PPB and PVS case researchers during the Seminar, e.g. with those from PPB projects of the International Rice Research Institute (IRRI) working in India and the International Centre for Tropical Agriculture (CIAT) working in Latin America and Africa, were quite helpful for the field implementation in China, especially with respect to the methodologies for research and enhancing local organisation.

Local level. The Chinese Seed Systems Project has involved CCAP, CCRI from national level, GMRI from provincial level, four counties, and five township extension stations and five villages from grassroots level as direct research partners, and MoA, Guangxi Agricultural Department and the provincial and county seed companies as indirect collaborators. Interaction and communication among these actors have been enhanced significantly through project activities such as joint discussion, mutual field visits, field days etc. Some direct feedback linkages between farmers, breeders, extensionists, public seed company managers and policymakers have been established to a certain degree.

3.3. Grassroots network building and enhancement

Before and during project implementation, the project team increasingly realised that the local network is very crucial for a sustainable knowledge exchange between farmers and scientists and among farmers, as well as for building farmers' capacities and empowerment in crop improvement and biodiversity management. This is a big challenge in the context of rural China, where there is no non-governmental or farmer organisation in its true sense. Given our objectives and the local reality, the project team decided to start with two existing networks at grassroots level, i.e. women farmer groups in the informal system and existing grassroots extension stations in the formal system.

3.3.1. Identification and strengthening of women farmer groups

Women are the main cultivators and farm managers because of the male out-migration from the rural areas, especially from the poorer and more remote areas, in the last two decades in China. Feminisation of agriculture is a common trend now, but its policy

implications and the institutional support needed by women are far less recognised by policymakers (Song & Jiggins 2000).

The previous and current project research revealed that, lacking institutional support, some women farmers have organised themselves and support each other. Some informal and loosely organised groups of women farmers exist and function in the villages. In most cases, they form on a voluntary basis for micro-credit borrowing, knowledge/skill/information exchange, labour sharing etc. The project is intended to increase these women's capabilities and bargaining power by enhancing their group/organisation and involving them in the participatory research process. This should increase their access to training, technology, market information etc. Moreover, these women groups could become show models to draw the attention of policymakers to the roles of women farmers in agriculture and plant breeding and to the constraints they face.

The project has tried to enhance these women farmer groups by providing them PRA (Participatory Rural Appraisal) training and encouraging their intensive participation in the PRA of their communities and in group design and implementation of the PPB field experiments. So far, the women groups have been identified and strengthened in all the five PPB/PVS villages. They differ from each other in terms of the original group's purpose and capacities, determined by their environmental and socio-economic conditions. However, they are all very enthusiastic and play a dominant role in the project, especially in the PPB and PVS field experimentation.

3.3.2. Strengthening the existing formal extension system at grassroots level

In order to facilitate the exchange between farmer and formal knowledge and to strengthen the linkages between the two seed systems, the formal grassroots extension system (including the township extension stations and their village farmer technicians) was identified as another local network to strengthen and work with. The public extension system is experiencing the transition from a planned economy to a market economy, and from serving only the state to serving the farmers as well as the state. The township extension stations are operating under very difficult conditions and are facing financial constraints. Yet, they are the only available and accessible formal technical assistance for farmers, they have formally trained personnel and almost all of them are local people who are from farming communities. Those local "experts" are familiar with the local farming systems and more enthusiastic towards a participatory approach to working with farmers than are other outside professionals. The project has allocated some resources for those stations as grassroots formal partners, and linked them to the women farmer groups through the PPB/PVS experiment activities. So far, a satisfactory collaboration among the women farmers, township extensionists and village technicians has been established in all five villages According to the mid-term review and participatory evaluation, all partners, and especially the farmers, appreciate the PTD approach and the collaboration. Nevertheless, it has also been realised that much more effort will be needed to further strengthen, sustain and institutionalise such farmer-preferred and mutually beneficial collaboration and networks.

4. Field implementation

4.1. General objective

The general objective of the project is to diagnose the feasibility of and explore possible conditions for the institutional and technological arrangements needed for collaboration between the formal and farmers' seed systems through participatory plant breeding, and to assess the impact of PPB on crop improvement, biodiversity enhancement and farmer empowerment in the specific context of China.

4.2. Two main components and specific objectives

The participatory research project has two major parallel and interwoven components, each with its own specific focus:

1. The technological component works on technological issues of PPB, seed selection and genetic resource management, in order to develop and evaluate participatory methods and methodologies for improving maize to meet farmers' diverse needs in heterogeneous environments, and to enhance on-farm maize genetic biodiversity.
2. The social science component works on social and institutional issues of PPB and PVS. It focuses on characterising the formal and farmers' seed systems, eliciting farmers' knowledge, and exploring appropriate methods and mechanisms to enhance local/farmers organisation and to empower farmers.

4.3. Three research phases, main methods used and achievements so far

The research is divided into three major phases, working on different specific objectives. Although there are interdisciplinary areas and overlaps, each phase has its own focus and main methods. The three phases complement each other and, together, contribute to multidisciplinary and comprehensive research results (see Table 2). Gender aspects have been considered and gender analysis has been included in all three research phases, with specific attention to the needs and interests of women farmers, who are the main cultivators and seed selectors in the area.

4.3.1. Diagnostic and exploratory phase

The diagnostic and exploratory phase seeks: a) to characterise the formal and farmers' systems, their different goals, needs and socio-economic environments; b) to elicit farmers' preferences, indigenous practices and knowledge in plant breeding, seed selection and maintaining landraces; c) to identify existing landraces and other "creolised"[1] local varieties, their characteristics and importance with respect to farmers' preferences and genetic biodiversity; d) to know the impact of and linkages between the formally introduced germplasm and the identified "creolised" local varieties, farmers' practices and

[1] In this context, 'creolisation' refers to farmers' adaptation and improvement of introduced cultivars.

knowledge; and e) to build up and enhance local organisations for farmers' empowerment and sustainable collaboration with the formal system.

The main methods used are: identification of main stakeholders, mapping the actor networks, semi-structured interviews of main actors, farmer focus-group discussions, and semi-structured in-depth interviews of farmer and formal plant breeders.

As initial activities in the exploratory phase, interviews following up on the previous impact study were carried out with the farmers in the two in-depth case-study villages first and then in the other three villages (see Section 3.1). Discussions by farmer groups among themselves and with the formal plant breeders and other professionals took place in the villages and addressed the key research questions and the design of the project activities. The project team interviewed leading maize breeders and policymakers at national and provincial levels. The philosophy/theory behind their breeding objectives and other factors influencing their decisions with respect to their strategies of plant breeding and plant genetic resources management were discussed and investigated. The team also interviewed public seed company managers and officials at the state, provincial and county levels. The current situation of maize seed production and marketing and the roles and operation of public seed companies and farmers were discussed and investigated. The newly approved "Seed Law"[2] and the related changes and challenges confronting the seed companies and other potential competitors (e.g. private sector and farmers) led to heated discussions during the interviews.

During the first half of the first project year, a total of 32 professionals in the formal sector, policymakers, breeders, seed company managers, extension agents at different levels, and 28 farmers in the two in-depth case-study villages were involved in interviews and joint discussions. Baseline data on two comparative villages, Zhichen and Wenteng, and one breeding institution, the Guangxi Maize Research Institute, were collected. At the end of the first year, eight villages were studied. Of these, three were selected by the team through discussion with the village farmers as additional PPB/PVS villages, making a total of five collaborating villages. Semi-structured in-depth interviews were then conducted in all five villages and at GMRI. Ten farmers from each village and ten formal plant breeders from GMRI, 60 individuals in total, were interviewed.

PRA training and studies were conducted in the collaborating villages. The team identified women farmer groups in the villages and village agricultural technicians and extensionists from the local township extension stations as the main participants as well as the managers of the research at grassroots level.

[2] A new "Seed Law" was approved by the People's Congress on 8 July 2000 and commenced implementation on 1 December 2000. It allows more freedom and competition in the sector than the old "Seed Law" approved in 1989. For instance, farmers are allowed to enter the seed market and deal with OPV seed subject to certain conditions.

4.3.2. PPB and PVS field experiment phase

Given the specific context in China, the PPB field experiments were designed as pilot research using both a scientist-led and a farmer-led approach, with different research focuses in each trial for comparison. The priorities of the PPB pilot project are to look at the standards and methods of both farmers and breeders, with three objectives: 1) to bring the best farmer knowledge and the best scientific knowledge together in realising the overall goal of crop improvement and biodiversity enhancement, 2) to establish direct communication and feed-back between the two systems and enhance local capability, equity and gender balance, and 3) to compare different breeding approaches, i.e. PPB, PVS, conventional formal and farmer traditional, through trials (see Table 3).

The main methods used are comparative field trials, field visits and field days, in-depth case studies and participant observation.

As a result of a series of discussions among farmers and formal plant breeders jointly and separately, it was decided that the PPB and PVS field experiments would target four types of varieties, i.e. exotic populations (CIMMYT populations), farmer "creolised" varieties, farmer maintained landraces and formally conserved landraces. More than 20 varieties were identified as target varieties for PPB and PVS on-station and on-farm trails. The characteristics of the four types of varieties and purpose of the trials are as follows:

- *Exotic populations* (CIMMYT populations). Six populations, i.e., Tuxpeno 961, 962, 963, 964, 965 and 966, introduced by CAAS from CIMMYT in 1996, were identified as starting points for improving OPVs. They were planted for field experimentation and regional adaptation selection in Guangxi Maize Research Institute (GMRI) in the first cropping season[3] of 2000 During the pre-harvest season, the first field day was facilitated by the team with participation of farmers (80% of them were women) from the five villages, formal-sector plant breeders, extensionists and public seed company managers. Based on the results of the field trials, joint discussions and voting, two varieties (961 and 963) were selected by both formal plant breeders and farmers, and agreed by other participants, for inclusion in farmer-led PVS trials in farmers' fields in the following cropping season.

- *Farmer "creolised" varieties.* These are materials delivered by formal breeders and then improved and locally adapted by farmers. One popular variety, Tuxpeno 1, which came from CIMMYT in the early 1980s and was effectively diffused through farmers' systems in Southwest China and then "creolised" by farmers (see Wenteng case study in the previous impact study, Song 1998), was included in the on-station trial for the purposes of analysis, breeding and comparison, to be followed by farmer-led PVS trials.

[3] There are two maize cropping seasons per year in the research area: the first lasts from February until the end of June, the second one is from July to November.

- *Farmer maintained landraces.* Eight landraces currently used by farmers in the trial villages were collected and included in the on-station trails for purposes of analysis, breeding and comparison, to be followed by farmer-led PVS and PPB trials.

- *Formally conserved landraces.* During the first field day in GMRI, farmers selected four such landraces from on-station trials[4] for farmer-led PPB trials in the two in-depth case-study villages, to be crossed by farmers with the landraces they are currently using. This has been taking place during the first and second cropping seasons of 2001.

Based on the baseline data, the varieties collected and the discussions among farmers and formal-sector breeders, field trials with the four types of varieties were established in the second cropping season of the first project year, starting with GMRI and the two in-depth case-study villages. In the following cropping season, i.e. in the second year of the project, the trials were scaled up to include all five villages. Each trial site has its own focus for PPB and PVS comparison. The decision making about the trials and the division of labour between farmers and breeders differ depending on the type of trial (see Table 4).

Farmers and formal plant breeders discussed and decided on morpho-phenological and other characteristics of the tested varieties to be recorded. Together, they designed a trial schedule for collecting and recording the relevant data during the trials. Farmers' preferences regarding these trial varieties in particular and and maize varieties in general are elicited during PTD process, e.g. in the course of discussions during trial design, PPB/PVS field experimentation and mutual field visits. The farmers (predominantly women) from the five villages, extensionists, formal-sector breeders and other relevant professionals are invited together to evaluate and "vote" on the tested varieties in both the farmers' fields and on station before each harvest. The assessment made during the field trials, field visits and field days by the farmers and the formal-sector breeders about the germplasm and their preferences for different crop characteristics are assessed and analysed by the team according to profession, gender, type of households etc to know the differences and changes over time. These data are now being processed.

4.3.3. Participatory evaluation phase

PPB seeks to overcome the limitations of conventional plant breeding by improving the crop characteristics through farmers' participation, according to farmers' preferences and using farmers' indigenous knowledge and practices, while enhancing genetic diversity and empowering farmers. Different indicators of the above aspects suggested and decided by both farmers and scientists will be used to assess the impact. The participatory evaluation phase focuses on farmers' assessment of the impact of different PPB and PVS approaches

[4] This was a project by GMRI conducted from 1995 to 1997. It was a conventional formal breeding project. The original objective of the project was to test and analyse the genetic features of these land races for population improvement. In the project, 100 land races were tested together with four standard testers, i.e. M17, 330, Bass (Reid) and Lancaster.

and their strengths and limitations compared with conventional plant breeding and farmers' traditional seed selection in the specific context of China.

Besides the data collected in each cropping season through interviews, field visits, field days, mid-term review and evaluation etc, a final evaluation will be conducted in the last cropping season of the project, which is tentatively scheduled for 2003. The methods of field day, farmer survey and in-depth case study will be used for collecting the data. The project researchers, including the farmers, will make a comparative analysis of the data from the seasonal impact assessments and the final evaluation and then compare this with the baseline data obtained during the first project phase.

Field day: As mentioned above, at each harvest during the project period, formal-sector breeders and other professionals, including farmers from the trial villages and other areas, are invited to evaluate and "vote" on the materials resulting from the farmers' field trials and the on-station trials. Both farmers and formal-sector breeders suggest, discuss and agree on relevant indicators to assess the impacts of PPB and PVS on crop characteristics, productivity and genetic diversity.

Farmer survey and in-depth case study: Other indicators concerning attitudinal change, influence on formal system, local capacity building, farmer empowerment, equity enhancement etc are decided through an intensive farmer-scientist communication and discussion process. This includes focus-group discussion, i.e., with women farmers, men farmers, formal-sector breeders, and extensionists, and joint discussion of all the groups. Then, the team will collect relevant data through a survey of 200 farm households, including trial, non-trial, adopting and non-adopting, woman-led and man-led households, in the trial villages during the last harvesting season of the project. In-depth case studies of the two initial PPB/PVS trial villages and GMRI are being conducted to assess the impact at community and institution levels during the process.

5. Institutionalisation, confronting challenges and future directions

5.1. Institutionalisation

Participatory Research and Gender Analysis (PRGA) is the project's guiding approach. It is a completely new perspective in the context of China. By following this approach, the project intends to change the traditional concepts, attitudes and behaviour of working for farmers into working with farmers and to espouse gender analysis in the process. It is extremely important but very challenging. In the long-existing predominant policy model of "transfer of technology" and the corresponding institutional system in China, it is commonly assumed that farmers are simply farmers, that they know nothing about technology and that they are just passive receivers.

Participatory approaches (PTD, PPB, PVS etc) are also totally new in China, and the project itself is new and has a pilot character. It is a learning process for the project research

team, too. Yet, we fully understand that recognition of farmers' initiatives and farmers' involvement in the process of technology design, improvement and diffusion should be institutionalised so as to bring about an equal, effective and sustainable collaboration of the two seed systems. Based on this understanding, the project has developed some strategies and lobbying activities to influence the policymaking process and to ensure policy support for PTD at various levels.

First of all, in the design of our project, we have strategically arranged to involve the highly relevant institutions that lead and influence policy, i.e. CCAP, CAS, CCRI, CAAS and GMRI, and their policymakers at national and regional levels, as direct partners and researchers in the project. The involvement of those institutions and individuals from a variety of disciplines at different levels in the system should directly influence the policymaking process related to all aspects of maize technology development and biodiversity management.

Secondly, the project enhances interaction, communication and collaboration among different stakeholders in the two seed systems, which will provide a more complete and convincing picture to policymakers with a view to institutionalising the approach. Some concrete lobbying activities include presenting the project in policy fora; dialogue and discussion through interviews with policymakers; and joint discussions and activities of farmers, formal-sector professionals and policymakers during field visits and field days. PTD and PPB training for the project team and collaborators was given at the beginning of the project at national and regional level. PRA training was given in GMRI and in all trial villages.

5.2. Confronting challenges

There has already been some impressive impact in terms of attitudinal change and even policy consideration on certain aspects and levels, e.g. the breeding plan and policy of GMRI and the genetic biodiversity management policy of CCRI. However, gaining acceptance of the PTD concept and activities by the whole formal system and making an impact on the system is a slow and very difficult process. To make things worse, the increasing trend to a market economy and the commercialisation and privatisation of public institutions is making the process even slower and more difficult. Meanwhile, we are faced with the growing phenomenon of feminisation of agriculture and, at same time, the reality that the public research and extension systems in China have been "designed for men" and are predominantly male-staffed. To them, 'farmers are farmers', and gender analysis is irrelevant. On the other hand, there is the difficulty that, when village men return from the town on leave from their work, it is they who attend the extension meetings and training sessions, even though they are no longer active farmers.

There is an urgent need for supportive policies and a conducive institutional system for espousing Participatory Research and Gender Analysis in China.

5.3. Future directions

During project implementation, encountering the above-mentioned challenges, we increasingly realised the importance of and urgent need for further efforts and commitment in scaling up and institutionalising the PRGA initiatives and successful experiences in the project in order to spread their benefits more widely and make the process sustainable.

During and after the field days in early June 2001, the research team discussed intensively with the village farmers, local extensionists and project managers from IDRC and Ford Foundation concerning the project activities. These discussions gave the team a thorough overview of the project in the past one and half years. In view of the project's current impacts and goals, IDRC and Ford Foundation have made a preliminary decision to support a further phase of the project, for another two years (2002 and 2003). It was agreed that pushing for attitudinal change and influencing policymaking and institutionalisation would be our working direction and priorities in the next project phase.

Some concrete activities and long-term arrangements in the current phase are already leading to these goals. First of all, we are putting more effort and commitment into training, which is considered crucial for attitudinal and conceptual change, capacity building and scaling up impact. PRA and PTD training for the research team, especially for the local formal-sector breeders and grassroots extensionists and the key farmer breeders, are taking place in August and November 2001, respectively. Training in gender analysis will be conducted after the above two training events. Meanwhile, further training in social concepts and participatory research methodology for the key researchers, mainly those with backgrounds in plant breeding and other natural sciences, has been arranged. A key researcher, a leading breeder in GMRI, is scheduled to attend a training course "Socio-economic Aspects of Plant Breeding and Seed Production" at the International Agricultural Centre in Wageningen in 2001, and several others are being considered for acceptance into such courses. At the same time, the project leader has been invited by the College of Rural Development, China Agricultural University, to design and given a PTD course there, starting in October 2001.

In addition, we are making every effort to "sell" our project, especially to the policymakers in China. We think it is time to scale up so as to enlarge our impact and influence policymaking. The project, its progress, results and impact were presented at CCAP and CRRI in Beijing in June 2001. Furthermore, arrangements have been made that the project will be presented during an international workshop on Asian maize development and production coordinated by CIMMYT and CCAP in March 2002 in Beijing. Main stakeholders, such as research / breeding institutions, seed companies, extension agencies and key policymakers, from both the public and the private sector and from international, national and subnational levels will attend the workshop. We hope the project will add a new aspect to complete the whole picture of maize development. Last but not least, we are putting further efforts into networking. The project has joined the National Network for Participatory Research coordinated by the Centre for Integrated Agricultural Development

(CIAD) at the China Agricultural University. We now have more interaction and communication with other participatory research projects in China. And we feel that the networking is extremely helpful for sharing experiences and information and for empowering ourselves to do better research for development.

References

Fan & Pardey. 1997. Research productivity and output growth in Chinese agriculture. *Journal of Development Economics*

Huang K. 2000. Analysis on the development of hybrid breeding in Guangxi and its relationship with the genetic base and heterotic patterns. *Journal of Guangxi Agricultural Science*, November 2000.

Lin JY. 1991. The household responsibility system reform and the adoption of hybrid rice in China. *Journal of Development Economics* 36: 353-372.

Lin JY. 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, D.F., Mexico.

Song Y & Jiggins J. 2000. Feminisation of agriculture and related issues: two cases study in marginal rural area in China. Paper presented at the European Conference on Agricultural and Rural Development in China (ECARDC VI), Leiden, 5–7 January 2000.

Song Y. 1998. *New" seed in "old" China: impact study of CIMMYT's collaborative programme on maize breeding in Southwest China.* Published doctoral dissertation, Wageningen, Wageningen Agricultural University.

Zhang Shihuang. 1995. Some suggestions for maize genetic base broadening by a systematic utilisation of exotic germplasm and landraces. Draft working paper, Chinese Academy of Agriculture Science.

Zhang S, Yuan L et al. 2000. Research on maize genetic diversity and heterotic patterns for breeding. *China Agricultural Science* 33, ISSN 0578-1752. Beijing.

Table 1: Information on PPB / PVS villages involved in the Project

Villages: / Items:	Wenteng	Zhichen	Niantan	Zuron	Huageng
Elevation	52	660		580	620
Average annual precipitation(mm)	1860	1734	1800	1820	1860
Predominant soil type	Red soil	Red soil			
Agroecological conditions	Open / forest, hilly area	Drought-prone and submerged rocky mountainous	Drought-prone	Open, flat valley area	Drought-prone and submerged rocky mountainous
Economic situation	Better-off	Very poor	Poor	Better-off	Very poor
Distance from market (km)	2	10	6	3	12
Population	3620	2146	810	4425	2566
Inhabitants' average level of education (yrs)	7	4	6	7	5
Total labour force	2839	1500	450	2200	1560
Total migrants	519	975	220	570	
Females among the migrants	140	235	66	120	
Average per capita income (*yuan*)*	2216	800	900	1200	7800
Proportion of female-headed households (%)	80	83	70	78	82
Average per capita land holding	1.62	0.94	0.8	0.79	0.95
Main cropping system	Maize + bean / groundnut	Maize + sweet potato / bean	Maize + bean / sweet potato	Maize + bean / sweet potato	Maize + sweet potato / bean
Average maize yields (t/ha)	2.8	1.37	1.5	2.4	1.42
Proportion of maize area irrigated (%)	62	0	5	20	0
Proportion of maize production area using chemical fertiliser (%)	80	15	60	80	15
Proportion of households using chemical fertiliser in maize production (%)	100	31	80	98	35

Proportion of households using purchased (hybrid) seed in maize production (%)	85	0	15	70	5
Number of varieties used	3	5	5	4	5
Proportion hybrid growing area (%)	60	0	10	45	3
Proportion of households engaged in commercial maize production (%)	70	10	40	70	15
Staple food crops (by rank)	Rice, maize	Maize, sweet potato	Rice, maize	Maize, rice	Maize, sweet potato

* 1 Y*uan* =0. 12 US$

Table 2: Research arrangement and main schedule in Phase I

Items				2000						2001					
Phases	**Activities**	**Main actors**	**Partners & locations**	**Jan Feb**	**Mar Apr**	**MayJun**	**Jul Aug**	**Sep Oct**	**Nov Dec**	**Jan Feb**	**Mar Apr**	**MayJun**	**Jul Aug**	**Sep Oct**	**Nov Dec**
Diagnos-tic and social research phase	System actor network mapping; initial interviews of actors	Researchers	Professionals and farmers in both systems												
	Baseline data collection	Researchers													
	Semi-structured in-depth interviews	Researchers	Breeders in GMRI; farmers in 2 villages												
PPB / PVS field-trial phase	Selecting trial sites and targeting variety identification	Researchers, breeders and farmers	Villages and GMRI												
	PPB / PVS trials on CIMMYT pop's	Breeders and farmers	GMRI and villages												
	Farmer-"creolised" variety trials	Farmers and breeders	Villages and GMRI												
	PVS trial on formally conserved landraces	Breeders and farmers	GMRI and villages												
	PPB trials on farmer-maintained landraces	Farmers and breeders	Villages and GMRI												
Partici-patory	Field visits	Breeders, and farmers	GMRI and villages												

	evalua-tion phase	Field days	Breeders, farmers and researchers	Farmers and professionals on-farm and on station during harvesting													
		Farmer survey	Researchers	Selected farmers in 5 villages													

Table 3: Comparison of field trials differing in breeding approach and focus

Items	GMRI Trial 1	GMRI Trial 2	Wenteng Trial	Zhichen Trial 1	Zhichen Trial 2	Zhuron Trial	Niantan Trial	Huaguang Trial
Breeding approach	Conventional scientific breeding	Formal-led PPB	Women farmer-led PVS	Farmer-led PVS	Farmer-led PPB	Farmer-led PVS	Women farmer-led PPB	Traditional farmer selection
Organisational form	Centralised Working through top-down system	Decentralised Working with some farmers	Decentralised Working with women farmers	Decentralised Working with farmers	Decentralised Mainly by farmers	Decentralised Working with farmers	Decentralised Mainly by women farmers	Decentralised Totally by farmers
Germplasm in trials	Populations 961,966	Populations 961-966, Tuxpeno 1 formal +farmers' landraces etc	Pop 961,963	Populations 961,963	F wax , L wax	Populations 961,963	F white, L white	Populations 961,963
Technological objectives	Increased productivity	Increased productivity Enhanced biodiversity Local adaptation of germplasm Increased farmer- preferred traits	Local adaptation of germplasm for OPV improvement	Local adaptation of germplasm for OPV improvement	Enhanced biodiversity Crop improvement	Local adaptation of exotic germplasm for OPV improvement	Enhanced biodiversity Crop improvement	Local adaptation of exotic germplasm
Social/institutional objectives	Trial comparison	Better understanding of farmers' system	Build farmers' skills	Build farmers' skills	Build farmers' skills though	Build farmers' skills	Build farmers' skills	Trial comparison

		Build farmers' skills Increase farmers' participation	Enhance farmers' seed system Empower women	Enhance farmers' seed system Empower women	PPB Test PPB	Enhance farmers' seed system Empower women	Enhance farmers' seed system Empower women	
ACHIEVEMENTS								
Varieties released/selected	GX single 22	GX Wax 2006, pop 961, 963	Improved Tuxpeno and Pop 963	Locally improved pop 961	Gushan Improved Wax	Locally improved Pop 961	Improved local white	Locally improved Pop 961
Seed production and diffusion	Formal	Formal and farmer's system	Farmers' system	Farmers' system	Farmers' system	Farmers' system	Farmers' system	Farmers' system

Table 4: Decision-making and division of labor among farmers, breeders and researchers in different trial models (by ranking)

Items	**GMRI Trial 1**	**GMRI Trial 2**	**Wenteng Trial**	**Zhichen Trial 1**	**Zhichen Trial 2**	**Zhuron Trial**	**Niantan Trial**	**Huaguang Trial**
Breeding approach	Conventional scientific breeding	Formal-led PPB	Women farmer-led PVS	Farmer-led PVS	Farmer-led PPB	Farmer-led PVS	Farmer-led PPB	Traditional farmer selection
Main decisions-makers:								
• Setting breeding goals	B, R	B, F, R	F, B, R	F, B, R	F, B, R	F, B, R	F, B, R	F, R
• Defining plant type for PPB / PVS trials	B	B, F	F, B	F, B	F, B	F, B	F, B	F
• Defining breeding / selection materials	B	B, F	F, B	F, B	F, B	F, B	F, B	F
• Defining breeding / selection methods	B	B, F	F, B	F, B	F, B	F, B	F, B	F
• Setting selection criteria	B	B, F	F, B	F, B	F, B	F, B	F, B	F
• Selecting parent materials and making crosses	B	B, F	F, B	F, B	F, B	F, B	F, B	F
Main implementers:								
• Selecting land for trials	B	B	F	F	F, B	F	F, B	F
• Adaptive testing on-station and in farmers' fields	B	B, F	F, B	F, B	F, B	F, B	F, B	F
• Evaluating experimental varieties	B	B, F	F, B	F, B	F, B	F, B	F, B	F
• Producing seed	B	B	F	F	F	F	F	F
	B	B, F	F	F	F	F	F	F

• Releasing + popularising new Vs								

F = Farmers B = Breeders R = Project Researchers Vs = Varieties