

Contribution of action researching to institutional innovation: a case study of access and benefit sharing (ABS) mechanisms in the participatory plant breeding (PPB) in Southwest China

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Abstract: This article investigates the contribution of action research to systemic institutional innovation, through a case study of access and benefit sharing (ABS) mechanisms developed in the context of a participatory plant breeding programme in Southwest China. The processes of purposeful change are examined as critical events, in eight episodes. Evidence is presented in these episodes of the role of action research in fostering conducive interaction between local innovation and regime level change. The analysis elaborates the value of action research in supporting multi-level institutional evolution and networked governance of seed systems. The importance is highlighted of regime actors in boundary spanning during these processes. The article concludes that although ABS legislation in China is not yet adequately formulated, ABS can still be addressed in local practice in terms of procedural approaches, such as ABS contracts and market-based geographical indications because the legal basis for these mechanisms already exists.

Keywords: action research; institutional innovation; access and benefit sharing; ABS; participatory plant breeding; PPB; Southwest China.

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1 Introduction

For thousands of years, producing, saving and maintaining a healthy seed system has been one of farmers' main concerns. In most developing countries, seed became the subject of agricultural policy and regulation only during the green revolution, i.e., from the 1960s onward. Seed became seen as an important vehicle for the dissemination of the technology embedded in the seed itself and the technology that accompanied the new genes such as chemical fertilisers and plant protection chemicals (Louwaars, 2002). The growing pace of the agricultural revolution encouraged the emergence of government agencies to supply and support regulated seed provision for commercial farming. However, over the past 30 years, governments have progressively left the seed business to private enterprise, under an increasingly globalised seed regulatory framework. The meaning of seed, variety and their production changed decisively with the expansion of intellectual property (IP) regimes to agriculture (Phillips and Onwuekwe, 2007), from a 'common heritage' to exclusively protected property. Farmers' rights over seed, in terms of saving, exchanging and selling seeds from their harvest, have been restricted and in

consequence their contribution to on-farm breeding, varietal selection and seed production has been weakened.

On the other hand, when it became evident that the green revolution and modern varieties preferentially benefited farmers in relatively favourable and uniform agro-ecological and socio-economical conditions, the impact on poor people in developing countries was questioned. The differential effects on food prices and labour in many cases did not improve the living conditions of the poorest in those societies (Evenson and Gollin, 2003). In these areas, the diversity of traditional crop varieties has remained one of the few options that farmers have to meet their livelihood needs (Sawadogo et al., 2005). Research over the last two decades has provided substantial evidence that significant crop genetic diversity continues to be maintained in farmers' fields in the form of traditional varieties (FAO, 2010; Jarvis et al., 2011).

The continuing *in situ* conservation of plant genetic resources (PGRs) seemingly will depend on the farmer and the farming community retaining the knowledge, institutions (defined here as systems of formal and informal rules) and capacity to evaluate the benefits that agro-biodiversity has for them. The importance of strengthening local institutions to enable farmers to take a greater role in the management of their resources for combined livelihood and conservation purposes has been emphasised (Jarvis et al., 2011). Since the 1980s, participatory plant breeding (PPB) has been developed as a complementary strategy in modern crop improvement. By bringing farmers and breeders together for seed development and varietal selection small scale farmers in the areas neglected by commercial interests receive the benefits of varieties well-adapted to their variable, marginal or complex cropping environments, livelihood needs, and local market demand. PPB potentially combines breeding purposes with agro-biodiversity enhancement within specific agro-ecological landscapes; PPB practices also foster the integration of farmers' and breeders' skills and knowledge. However, the practitioners and products of PPB have encountered everywhere a series of socio-political and institutional barriers, not least in relation to variety registration and the sharing of the benefits of PPB seed (Ashby, 2009).

The expansion of IP protection over seed, in the form for instance of plant breeders' rights (PBRs) and patents on traits and varieties, has increased the institutional constraints. Farmers' access to on-farm saved seed is becoming more restricted and their actual and potential contribution to long-term PGRs maintenance and improvement is undervalued by the emergent regime. Although access and benefit sharing (ABS) issues increasingly have been discussed at the international level, and there is strong insistence that the countries, communities and farmers that grant access to their PGRs should share the benefits that other commercial users derive from these resources (De Jonge, 2011), there remain numerous institutional uncertainties at the national and local levels.

The uncertainties derive in part from the provisions of different conventions. The convention on biological diversity (CBD) for instance declares that states have sovereign rights over PGRs and introduces a compensation mechanism, as the first example of an ABS model, which requires that developing countries be compensated for the contribution of their biological resources (CBD, 1992). The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) frames ABS in terms of rights (ITPGRFA, 2001); it asserts among other clauses farmers' rights to save, exchange, and

sell farm saved seed, regulated by national legislation. Farmers who contribute to PGRs maintenance and improvement are becoming subject also to national ABS legislation that ignores or integrates the international frameworks to varying degrees (Ghijssen, 2009). Commercial seed businesses for their part have benefited principally from the implementation of IP protection and the evolution of PBRs under the successive International Union for the Protection of New Varieties of Plants (UPOV, 1991) conventions. In UPOV 1991 Act, the scope for protection has been expanded from 'traded reproductive material (in UPOV 1978 Act)' to all materials, including the harvested product and the end product; on the other hand, farmer-saved seeds in UPOV 1991 come within the scope of PBRs (Ghijssen, 1998).

As the institutional map becomes more complex, and to varying degree contradictory, countries are searching for appropriate mechanisms through which to balance competing interests, and the rights of plant breeders and farmers. The existing modalities include a variety of practices ranging from open seed exchange without or with some upfront payment (usually in the form of a price paid by a buyer), to a formal agreement with or without any benefit sharing arrangement (Nijar, 2011); the range of mechanisms is making it more, rather than less difficult to frame appropriate legislation that satisfies the interests of all parties. China for instance became a member of the CBD in 1993, signed the 1978 version of UPOV on joining the World Trade Organisation in 1999, and is preparing to join ITPGRFA. Preparation of ABS legislation was initiated in 1995; it is still under negotiation among the different sectors and interests concerned in seed improvement and provision (Qin, 2009).

This study is based on a PPB programme in maize in Guangxi, the Southwest China, as the context through which to probe the space for institutional innovation in relation to farmers' access to improved seed, maintaining farmers' roles in PGRs conservation, and the development of benefit-sharing mechanisms. The analysis teases out the evidence, presented in eight episodes, for conducive interactions between local institutional innovation and regime change. The chosen research practice, action research (AR), is positioned as the vehicle for multi-actor learning that mediates the tensions that arise from the multi-level change processes.

2 Conceptual framework

2.1 A multi-level perspective on system innovation

System innovation concepts provide a framework for analysing technological, ecological and institutional change, that increasingly are applied to agricultural development processes (Hall et al., 2003; Morriss et al., 2006). The system innovation literature (e.g., Ison, 2008; Knickel et al., 2009) and historical analyses of socio-technical regimes (Rip and Kemp, 1998) that emerge in relation to local level innovations (e.g., Geels and Schot, 2007), provide many useful insights but the processes by which multi-level interaction actually occurs are rarely well-covered. There has been relatively little attention paid to how changes in the interaction between niche and regime levels, which often brings tension and conflict, can be made conducive to achieving the desired institutional outcome.

The multi-level perspective on system innovation distinguishes analytical and heuristic concepts in order to understand system innovations through the frame of a

hierarchy of institutional settings at landscape, regime, and niche levels. The macro-level of landscape is taken to consist of slow-changing external relations that provide gradients for pathways of change. The landscape can be described in terms of the external structure of relationships or the embedding context for the interactions of actors between and within the hierarchy of levels. The meso-level of socio-technical regimes, that is, a society's rule set embedded in formalised knowledge, practices, procedures, norms, regulations and organisational arrangements, accounts for relative stability in the application of technology and 'lock in' to historical pathways of development. The rules enable and constrain activities within social relationships and micro-level niches. The micro-level of niches (as protected experimental spaces) accounts for the generation, testing and development of innovation (Geels, 2002). Novel configurations require a protected space (Rip, 2002) in which a network of actors enact change by working closely together under specially designed conditions to develop, test and disseminate desired changes (Van der Ploeg et al., 2004).

During an innovation process new links are formed among actors and their material world that changes the articulation between what happens within the protected space (niche) and at regime level. Historical choices, current policies and legislation, and dominant technological infrastructures and the interests that depend on them, shape the development of novel configurations. At the same time, the creation of novelties can have profound effects at regime and landscape levels (Roep and Wiskerke, 2004; Hoogma et al., 2002). If a regime is confronted by novelties with the necessity of change, tensions emerge and the dominant linkages in the configuration may begin to 'loosen up' (Geels, 2002). The institutional rule set evolves through dealing with those tensions and introducing new elements in the articulation of levels.

2.2 Action research

AR is a participatory process of investigation concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a worldview that values the knowledge, skills and capacities of multiple actors. It brings together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people (Reason and Bradbury, 2006), oriented to system development and the improvement of knowing and knowledge (Chisholm, 2001). Emphasis is placed in its practice on collaborative production of knowledge generated inter-subjectively in and through shared actions (Kesby, 2007; Kindon et al., 2007). AR thus is in principle and practice an apt research approach to system innovation.

In this study, we in our role as PPB practitioners and researchers stand back from our own practice and examine the role and contribution of AR in developing a novel ABS mechanisms and relationships.

3 Methodology

3.1 Data generation

The core stakeholders in the study initially were farmers from twelve PPB trial villages in Guangxi, four breeders from Guangxi Maize Research Institute (GMRI), one

breeder from the Chinese Academy of Agricultural Sciences (CAAS), and three policy researchers from the Centre for Chinese Agricultural Policy (CCAP). The network subsequently was expanded as a result of the AR co-learning process to include policy makers from the Chinese Ministry of Agriculture (MoA) and Ministry of Environmental Protection (MoEP), and PPB and ABS experts from institutes outside China.

The prominent interests expressed through the programme can be defined as farmers' interests, breeders' interests and researchers' interests. Farmers' interests have been articulated as improving their livelihood through breeding and seed production. Breeders' interests have been expressed as breeding for a new target group (smallholder farmers), utilising local PGRs in farmers' fields in breeding, and developing farmers' knowledge on conservation and breeding. Researchers' interests were to bridge the gap between breeders and farmers, enhance exchange of knowledge and PGRs and supporting the institutionalisation of a fair ABS agreement. The facilitation of dialogue and action among these interests has been conducted by CCAP researchers and GMRI/CAAS breeders. The former targeted the institutional aspects, and the latter focused on technical issues in breeding.

Data were gathered through a range of activities that were designed and re-designed in successive AR cycles:

At the niche level, a series of institutional experiments on PPB-related ABS issues have been executed – which has never been attempted before in China – in which 'experiment' was understood as an early stage of an ongoing process of institutional development, in which 'proof of the ABS concept' was explored. The institutional experiments on ABS have been tested in three ways, each building on cycles of AR:

- a PPB breeding activity from 2000 onward, targeting the improvement of maize landraces and farmers' varieties, locally-adapted hybrid development, and building farmers' capacity
- b community-based production of PPB varieties, from 2005 onward, to provide a market-based reward for PPB farmers
- c from 2008 onward, the development of ABS contracts between the maize breeding institute (GMRI) and 12 farming communities; the first was signed in 2010.

The contracts provide formal support to farmers' on-farm PGRs conservation and improvement (including landraces, improved farmers' varieties, and hybrids).

At regime level, the stakeholders, guided and facilitated by the PPB programme, have entered into dialogue with key actors positioned in higher level institutions responsible for breeding, seed production and ABS within the Chinese national context. Twelve policy workshops and round table discussions have been held at provincial, regional (including Southwest provinces), national and international levels since 2000, with the direct and indirect involvement of policy makers from the MoA and MoEP, researchers and breeders from the CAAS and the GMRI, and ABS colleagues from other countries. These meetings have taken up different aspects of regime change, including public breeding policy, agro-biodiversity conservation, smallholder farmers' livelihood improvement, and the details of ABS mechanisms. The meetings have created networked participation in a platform for discussing – and to an extent negotiating – niche-regime interactions, through which additional regime level innovations have been proposed and considered.

Events and decisions at niche and regime levels were recorded during the meetings described above, and also during annual project meetings and mutual field visits that took place as part of the programme's participatory process. The field visits include activities like on-farm varietal selection and *in situ* conservation. Through this process, of iterative dialogue, planning, action, observation, and joint reflection, ideas have been exchanged and discussed among CCAP researchers, GMRI and CAAS breeders, and PPB farmers who have a long-term engagement in the programme's activities.

Events, decisions and processes were recorded throughout by means of:

- 1 The documentation of observed research practices, and the participant observations made by the field researchers.
- 2 Joint identification of key episodes, distilled during reflection meetings in the successive AR cycles in the field and at the level of the PPB programme. The episodes were further discussed with farmers and policy stakeholders in the workshops at provincial (i.e., Guangxi) and Beijing levels.
- 3 Planning and design of further actions, on the basis of the co-learning built around each episode.

3.2 Data analysis

Innovation histories based on important events (here a series of related events are treated as 'episodes') allow analysis of the dynamics of innovation processes (Spielman et al., 2009; Klerkx et al., 2010). In order to provide a basis for analysis of the interactions between niche and regime levels, the study traced the timeline of the generation of novelty from 2000 through 2010, documented critical events, interactions and relationships in each of the eight episodes, and identified strategic shifts in action and institutions that resulted in consequence. The structure of innovation history in the analysis focuses on 'events' – what is happening, 'strategic shifts' – why they are critical, and 'process' – the role of AR in building new relationships between niche and regime level actors, information, issues and 'the rule set'.

4 Critical events driving the articulation between levels

4.1 Episode 1: Formal breeders realise farmers' expertise in seed selection and breeding and accept farmers as valuable partners

At the end of the 1990s, an assessment of the impact of International Maize and Wheat Improvement Centre (CIMMYT)-released maize varieties on poor farmers in Southwest China (Song, 1998) observed the systematic separation of the formal seed system and farmers' seed system. Formally bred and released modern varieties were shown to have poor adaptation in the remote mountainous regions of the Southwest and to be only marginally adopted by the farmers in these regions. On the other hand, although the Southwest was known to be the centre of maize genetic diversity in China and landraces were intensively distributed in local communities (Yao et al., 2007), the assessment documented for the first time the local diversity of landraces conserved in communities, with more than 80% of farmers' seed being supplied by their own seed systems

(Song, 1998). CCAP researchers felt on the basis of this study that it was urgent to utilise local varieties (i.e., farmer improved open pollinated varieties (OPVs) and landraces) more effectively in formal breeding in order to adapt formally released varieties to local conditions. A pioneering PPB project, funded by the International Development Research Centre (IDRC) and the Ford Foundation, was initiated in 2000 with facilitation provided by the sociologists and the policy researchers of CCAP in Beijing. The project started in Guangxi with the active collaboration of maize breeders from GMRI (the provincial public breeding institute) and CAAS (the national public breeding institute). Project researchers invited the breeders to farmers' fields to discover for themselves farmers' skills, knowledge and expertise in managing genetic diversity. Later on farmers were invited to bring their varieties to the institute and to share their experience of seed selection. During the exchange visit the breeders discovered that the farmers had conserved and improved *Tuxpeño 1*, a maize OPV released much earlier by CIMMYT, and that one farmer, known as Aunt Pan from *Wentan* village, had improved a locally important variety that had become widely popular in the surrounding local communities. Breeders from the provincial and national formal breeding institutes started to accept that farmers could be supported to become valuable partners in seed development and improvement. With the assistance of the project researchers they returned to *Wentan* village and invited Aunt Pan to join the PPB research team to continue improving *Tuxpeño 1*. From 2000 to 2004, gradually, the project became a programme (funded in part from Chinese sources), expanding from one village to five and from individual farmers to farmer groups. For both breeders and farmers, PPB became an entry point to explore and identify technological and institutional options to bridge farmers' seed system and the formal seed system, integrate scientific knowledge and farmers' knowledge in breeding and conservation, and to build mutual respect and understanding among farmers and public breeders.

4.2 Episode 2: Whose varieties are they?¹ Challenges encountered in registration of PPB varieties

In 2003, with the support of the PPB team, GMRI breeders entered the first PPB variety, *Xin Mo 1* (an OPV), into the formal testing procedure for value of the variety for cultivation and use (VCU). There are two levels of VCU testing in China, at both the national and the provincial levels. *Xin Mo 1* was entered into the national testing procedure and in the Northern provinces it did not perform as well as in the trial villages of Guangxi; it finally failed the VCU test. The PPB team reflected on the challenges to the registration of PPB products. They decided that henceforth OPVs would be released only in the trial villages and their neighbouring communities. Another variety, a hybrid waxy maize, *Guinuo 2006*, that had passed VCU tests successfully in the trial village, was officially released in 2003 at regional level by registration through the GMRI. One of the parental lines of *Guinuo 2006* was collected from the trial village and later on farmers participated in adaptation trials of this line. The commercialisation of *Guinuo 2006* by the GMRI-owned seed company subsequently generated significant financial benefit for the breeders because it soon became one of the most popular waxy varieties on regional seed markets.

By the start of 2011, four OPVs had been bred but not released because they cannot meet the requirements of the national VCU tests and the hybrid *Guinuo 2006* is the only variety that has been registered. In 2004 the research team started to explore the space for

recognising PPB varieties through other mechanisms than the national VCU procedures. They invited provincial and national policy makers and formal breeders to a policy dialogues to discuss registration and release issues for PPB varieties. The issue of how to recognise farmers' contribution and create incentives for PPB farmers emerged as an important part of the dialogue. During the meeting the farmers and breeders who had joined in PPB activities, themselves concluded that the current seed regulation left little space for farmer improved varieties because VCU testing admits to the market only those varieties that show 'clear improvement' (especially in the yield) in all its testing regions compared to existing varieties. The performance of PPB varieties, selected from and for low-input conditions, cannot easily be assessed under favourable conditions. On the other hand, given the generally weak awareness of farmers' rights and contribution to PGRs conservation, both in the field and in policy circles, the meeting participants agreed that farmers could not easily be granted benefits as potential (joint) breeders even if a PPB variety could be registered. Moreover, the mandates of public breeding institutes have been changing since the opening up of the seed market in 2001; most currently combine breeding, seed multiplication, and seed marketing. The CAAS breeder at the meeting gained the support of the other participants for his view that, in order to support farmers' breeding activities within PPB, it had become necessary to clarify and separate the public interest and commercial roles of these institutes, and ensure that their commercial enterprises compete in the market place on equal terms with private commercial seed enterprises.

4.3 Episode 3: Reaching an agreement on sharing benefits at community level

From 2004 onwards *Guinuo 2006* rapidly penetrated the commercial market. Farmers who had participated in the adaptation testing of *Guinuo 2006* had appreciated with pride its potential commercial value but they also subsequently became aware of the costs to themselves of purchasing the seed, i.e., for accessing it from the commercial market. The PPB team started to realise that it was unfair that the farmers who had contributed to seed development should now have to pay for using it. In order to help farmers save on the seed cost and as a way to re-direct benefits to PPB farmers, the PPB team initiated the community-based seed production of *Guinuo 2006* in the trial villages. Unlike OPVs for which farmers can produce seed individually and independently, hybrid seed production needs more intensive technical support, such as provision of parental seeds and development of isolation skills during the flowering stage. Since *Guinuo 2006* has been registered and protected, community-based seed production requires prior agreement among GMRI breeders, the GMRI-owned seed company and the seed production villages. The PPB team invited all the stakeholders together for a discussion of the feasibility of reaching an agreement in support of community-based seed production. There was general welcome for the idea and the negotiations resulted in an agreement to share the economic and financial benefits, i.e., the breeding institute and the seed company would supply the commercial market while allowing PPB farmers to supply the seed for local niche markets. On the breeders' side, this agreement was based on their desire to continue to build relationships of mutual trust. 'We have collaborated with those PPB farmers for a long time, we trust them as friends; and we would like to grant them small scale seed production in their communities' (Huang, K., PPB breeder from GMRI, July 2005). In 2005, two of the trial villages located in remote mountainous areas were

selected for seed production; these locations were chosen because the breeders wanted to reduce the chances that the parental lines of the hybrid variety, which remained protected by their PBR, would be stolen by rival commercial interests.

4.4 *Episode 4: Recognising the potential value of landraces for formal breeding*

From the beginning of the collaboration in PPB breeders both in CAAS and GMRI reported that the genetic base of maize hybrids was becoming dangerously narrow and they realised the importance of landraces conserved on-farm as a potential source of valuable new breeding material. Because the PPB team has provided breeders the opportunity to visit and work with farmers in identifying and collecting farmers' PGRs, the breeders have become increasingly aware of the existing and potential connections between their breeding activity and the plant materials conserved by farmers. In 2008 the PPB team concentrated on on-farm landrace conservation and on extending PPB activity to new communities in Guangxi and into two additional provinces, Yunnan and Guizhou. The new communities were located in the more remote regions of the Southwest than the original PPB villages and the farmers in these villages were shown in a survey to conserve an even larger range of PGRs. In collaboration with the MoA's 'Agricultural System Construction' programme (a national public research system reform initiative that started about the same time), the PPB team and their new provincial collaborators and community leaders, intensified their work on PGRs conservation and utilisation.

During a field visit to the villages of *Luocheng* and *Yizhou* the breeders' awareness and appreciation of farmers' expertise in *in situ* conservation greatly increased when they discovered that some of the local varieties developed and maintained by the farmers showed better performance and adaptation to the conditions in the farmers' fields. The farmers in *Luocheng* and *Yizhou* readily agreed to become a PPB and conservation site. At the same time, the local landraces collected through the initial and follow-up field visits have been trialled on station and their properties investigated in the laboratory, thereby becoming integrated into the routine work of the institutes. In 2009, during another policy dialogue, the CAAS breeders presented the initial findings of simple-sequence repeat (SSR) analysis of 170 landraces and OPVs collected from farmers' fields in the three provinces. Based on the findings, the researchers and policy makers realised that formal breeding programmes were not taking full advantage of the utilisation of local PGRs, that the collaboration between farmers and breeders needed to be strengthened, that more emphasis should be put on *in situ* conservation, and that mechanisms needed to be developed to provide incentives for farmers to collaborate with the breeders and to continue to conserve local PGRs. It was proposed by the CAAS breeders that the farmers receive what they called a subsidy whenever PGRs was collected from them and whenever farmers participated in selection and breeding work together with the breeders. However this proposal has not yet been taken into account by the policy makers, as it requires negotiations with and among a number of sectors, such as the financial sector; the initiation of such negotiations is beyond the authority of the agricultural sector.

4.5 *Episode 5: Recognising the tensions between local ABS practice and regulatory frameworks*

In order to better understand the generic problem of the emergent tensions between local ABS practices and national regulatory frameworks the IDRC organised in Beijing in 2009 an international exchange of the ABS experience in four countries, China, Jordan, Peru, and Nepal. The meeting comprised a workshop in Beijing and a field visit to PPB/PGRs villages in Guangxi. The close links between ABS issues and national legislation, crop policy, and stakeholders' interests became a focus of discussion at the workshop. Chinese officials working on ABS legislation, from the ministries MoA and MoEP participated in the discussion. They introduced the slow progress with implementation of the CBD and development of ABS legislation in China. The PPB team presented the PPB-related ABS practice in Guangxi and the community-based seed production of *Guinuo 2006*, defined by the team as an ABS experiment at the niche level. They stressed that the further development of the emergent practice required a series of new institutional arrangements, such as procedures for registering a joint PBR, a joint plant breeders right transfer agreement and mechanisms for payment for use of protected varieties, the introduction of a 'commercial line' restriction for non-commercial seed production, and for quality control of farmer-produced seed. Other ABS initiatives within China were presented, and the reflection on the potential for action and the existing regulatory framework was shared among researchers. Chinese participants also learned from the other countries' experience that both public research institutes and local non-governmental organisations play important roles in addressing ABS for smallholder farmers.

The subsequent policy dialogues organised in the AR process continued to raise challenging issues. In China, ultimately the state has sovereign rights over all PGRs and private ownership and PGRs property rights have been vaguely defined, i.e., in law it remains the case that no individual can claim ownership over PGRs. Breeders can receive 100 Yuan (i.e., US\$15) for each variety collected for a gene bank, but there is no payment for farmers if seeds are collected from their fields. To compensate farmers for their contribution, CAAS breeders suggested refunding those farmers for the costs of maintaining the designated PGRs in their fields, to the value of 0.3%–0.5% of any commercial profit a commercial seed company might derive from that material. Subsequently, the GMRI breeders endorsed this idea, but when they discussed the proposition within their provincial institutes the institutes' commercial branches that are responsible for seed production and marketing, objected because this proposal would not bring commercial benefit to the seed company. This episode exposed the opinions and interests of each stakeholder and brought into the tensions within GMRI. The officials concluded that China lacked a common ABS framework at the national level and that this was creating uncertainty for emergent local practices.

4.6 *Episode 6: Overcoming problems in mainstreaming PPB – creating incentives for breeders*

During the field visit linked to the ABS workshop, the PPB experiment in Guangxi attracted the attention and interest of other PPB practitioners, such as Dr. Ceccarelli, an internationally acclaimed PPB practical breeder from the International Centre for Agricultural Research in the Dry Areas (ICARDA). He suggested improvements to how the field experiments were designed and implemented. It was a critical moment for the PPB team because they were at the point of offering a follow-up training for PPB breeders in China. The team recognised the potential and importance of his expertise and invited him to join local breeders during the training, held in January 2010 in Guangxi. Ceccarelli demonstrated and discussed how PPB activity and results can be documented and generate high quality scientific papers. The credibility of the outside expert provided the other participants a stimulus to discuss how to improve their PPB work as a rigorous scientific activity: ‘Before this training, I understood PPB is more related to farmer-led field experiment, aiming at improving farmers’ livelihood and their capacity building. From this training, I reflect that there is also an institute-led PPB experiment, which can be designed in a more scientific manner’ (Zhang, S., CAAS breeder, January 2010). The concept of evolutionary breeding was introduced in support of building the scientific rationale for farmer participation in on-site selection and breeding. The scientific excitement created during the training provided incentives for institute breeders to commit to breeding-oriented experiments with farmers, and the scientific data generation and publication on the basis of PPB, and provided them with the confidence that PPB is a scientifically-recognised and rigorous professional activity.

4.7 *Episode 7: Developing ambitions to create incentives for farmers in relation to agro-biodiversity enhancement*

In order to map the distributional changes in maize varieties in farmers’ fields over the past ten years, a CCAP researcher conducted a survey in 2009 that recorded farmers’ adoption of hybrids and the persistence on landraces in the three Southwest provinces, Guangxi, Yunnan and Guizhou (Li et al., 2012). Analysis of the results showed that there had been a rapid loss of landraces. Some landraces even in the PPB trial villages had disappeared; if there is no one to plant those varieties, there is a lack of seed; if there is no seed, there is no exchange and no further access and the actual and potential public good value of the local PGRs is lost for ever. On average the percentage of the growing area planted to landraces has declined from 77% in 1998 to 21% in 2008 (ibid.). In Guangxi a single hybrid variety, *ZD 619*, covered 44.9% of the maize area in the survey region by 2008 (ibid.). Such findings astonished both farmers and breeders and in consequence the team re-defined its priority, i.e., to develop and test effective incentives for *in situ* conservation and PPB breeding. Given the recognition by researchers, professional breeders and officials in the policy dialogues that legislation on biodiversity, farmers’ rights and ABS lag behind in China, the team realised the urgency of creating workable mechanisms at the niche practice level.

4.8 Episode 8: Making an ABS agreement among PPB stakeholders

The team scoped possible mechanisms for ABS through a series of policy dialogues and round table discussions with policy makers and officials, breeders, institute managers and farmers. Two property regimes for PGRs, i.e., as common property and exclusive property (based on PBRs), and the implications of each for how farmers might benefit from them were discussed. The researchers showed how under a common property regime, farmers as resource stewards can benefit from public subsidy while under a PBR regime, farmers can benefit from the royalty on new varieties if they are recognised as contributing to the breeding of the registered variety. It emerged in the discussions that according to the current plant variety protection (PVP) regulation (1997) in China, farmers can be recognised as the joint breeders through a contracting arrangement. However, such an agreement is difficult to achieve in practice because the development of the public breeders' commercial interests has created a competing stake in PGRs between farmers and the public institutes, and farmers' rights can rarely be claimed through PVP law. Meanwhile, the passing of the *Science and Technology Progress Law* in 2008, which was sponsored by the Ministry of Science and Technology, allows the products of public investment in breeding to be privatised by the public institute, in the form of exclusive IP right. During the 2nd Regional Inter-governmental ABS conference held in Nanjing in April 2010, members of the Association of Southeast Asian Nations (ASEAN) exchanged their experience with IP rights implementation, ABS legislation, and how to balance farmers' right and PBR within their national seed regulatory frameworks.

At a policy dialogue organised in Beijing following the ASEAN meeting (which was attended by one of the team's researchers) the participants were inspired by a presentation of an ABS contract model that has been developed in Taiwan. This requires recognition by name of any farmer contribution, and an enforceable fair benefit arrangement agreed by all the named parties, before a license for seed release is granted. It provides an alternative to arrangements based on exclusive rights, and compels the balancing of interests among stakeholders in the public sector, commercial sector and farming communities. Of particular interest to mainland China's policy makers was the model's reliance on procedural law because this approach to law-making is already well-established in the institutions governing commerce. Given that contracts are well established in commercial practice and are enforceable in law, CCAP researchers started to negotiate an ABS contract together with its stakeholders. In order to distinguish two potential purposes for a contract, i.e., to encourage *in situ* conservation (for breeding and agro-biodiversity enhancement) on the one hand, and to share fairly the commercial benefit from market exploitation on the other, two types of contract were developed in parallel. The former addressed the urgent need for PGRs maintenance; the latter addressed the fair sharing of benefits from commercialisation with both farmers and institute breeders protected by PBRs. These two contracts were signed by three public research institutes (including one policy institute and two breeding institutes) and 12 farming communities, in Guangxi in June 2010.

In July 2010, the team reported the contract process to the officials of the ministries MoEP and MoA, and discussed the feasibility of scaling out the practice at national level. MoEP officials proposed to integrate the PPB team's case experience into the national ABS discussion. MoA officials realised the necessity for setting up a national PGRs and landrace registration system as the basic step required for international recognition of national ABS law. They also suggested geographical indication (GI) protection as an alternative form of protection for PPB products. Although experience with GIs in China is limited so far, GIs already have opened new markets for traditional agricultural products and have been used as a form of collective IP by all those who produce that product in a given area (Nagarajan, 2007; Ilbert and Petit, 2009). Since the early 1990s, China has developed three modalities of GI protection for raw agricultural products and the final product, respectively under the supervision of the State Administration for Industry and Commerce, the General Administration of Quality Supervision Inspection and Quarantine, and the Ministry of Agriculture (Wang, 2009). All three modalities already allow recognition of and reward for farmers' contributions. If the seed of PPB varieties and its products can be protected by the GI system, farmers in the Southwest will have a strong opportunity to enter into the market and share the benefit from their conservation, production, and value-adding efforts.

5 Analysis and discussion

5.1 Niche-regime interactions foster institutional innovation

The eight episodes show a series of adjustments that arose in the AR process as the team and broader circles of stakeholders engaged in joint learning. Each shift is revealed an outcome of niche-regime interactions that have been called into existence as a result of the PPB team's efforts. Institutional innovation in the end is dependent on the extent to which these interactions build enduring relationships, networks of interest and procedural or other arrangements. The implication is that institutional innovation is a highly unpredictable process (Klerkx et al., 2010). Some shifts bring tensions openly into discussion, others initiate new spaces for change. Table 1 compares the eight episodes in terms of niche-regime interaction, strategic shifts, the role played by AR, and the institutional change achieved.

Positive interactions bring opportunities and widen the space for further innovation, while negative interactions may cause conflict and tensions between niche level practices and regimes, as can be seen in episodes 2, 5 and 7 in which diagnosis of the challenges for PPB varieties and agro-biodiversity respectively was seen as confronting to dominant interests and existing power configurations. Table 1 also shows how the emerging practices and discourse continually shifted the focus of AR. Armitage et al. (2007a) argue that an emergent outcome may represent an important innovation under conditions of change, uncertainty, and complexity. Table 1 further reveals how learning at one level or among one set of stakeholders was progressively shared with others, allowing actors to plan and design new actions and address emerging issues and options. Sometimes the planned activity is adjusted to accommodate a new situation, e.g., the design of the PPB training carried out in episode 6 was initiated during the field visit carried out in episode 5.

Table 1 Highlights of eight episodes in a participatory maize breeding project in Southwest China, in relation to ‘niche-regime interaction’, ‘strategic shift’, ‘role of AR’ and ‘institutional change’ of each

Episode (year)	Critical events (niche-regime interaction happens)	Strategic shifts	Role of action research	Institutional change achieved (as results and outcomes)
1 (2000)	Formal breeders begin to realise farmers’ expertise on breeding and recognise farmers as valuable partners	PPB started with farmer improved varieties in Guangxi	Networking farmers and breeders in breeding, facilitating mutual understanding and respect relationship between farmers and breeders	Farmer-breeder collaboration in PPB; trust building during PPB
2 (2003)	PPB varieties face challenges in seed regulation: OPV failed VCU testing, hybrid was registered by breeders; farmers are excluded from PBR and market incentive; the commercial role of public institute was realised	Reflecting on registration challenges and taking ABS issues into consideration	Defining institutional challenges of PPB products, organising reflection and bringing negative situation into discussion	Emerging mis-matches between PPB varieties and seed regulations
3 (2005)	Farmers are excluded from commercial market of <i>Guinuo</i> 2006, the project proposed to refund PPB farmers through community-based seed production, breeders and seed company allowing PPB farmers supply the seed for local niche market	Reaching an agreement of sharing benefit at community level through seed production	Facilitating interaction and negotiation on seed production, balancing the request from both breeders and farmers (i.e., balancing PBR and FR) and enhancing the collaboration during seed production	Agreement on seed production and put into practice from 2005 onwards
4 (2008)	Formal breeders realised the narrowed genetic base in hybrid breeding and the potential value of landraces in future breeding, a collaboration with national programme on PGRs conservation and utilisation in three Southwest (SW) provinces started, formal breeding institutes become more aware of genetic diversity existing in SW	Recognising the potential value of landraces for formal breeding, and scaling out PPB to SW region	Introducing farmer conserved PGRs to formal breeding institutes; and enhancing trust-building and knowledge sharing during PGRs collection	Strengthening the importance of in situ conservation in the Southwest

Notes: ABS = access and benefit sharing, CAAS = Chinese Academy of Agricultural Sciences,

FR = farmer’s rights, IDRC = International Development Research Centre,

OPV = open-pollinating variety, PBR = plant breeder’s rights, PGRs = plant genetic resources,

PPB = participatory plant breeding, VCU = value for cultivation and use.

Source: Authors’ compilation

Table 1 Highlights of eight episodes in a participatory maize breeding project in Southwest China, in relation to ‘niche-regime interaction’, ‘strategic shift’, ‘role of AR’ and ‘institutional change’ of each (continued)

<i>Episode (year)</i>	<i>Critical events (niche-regime interaction happens)</i>	<i>Strategic shifts</i>	<i>Role of action research</i>	<i>Institutional change achieved (as results and outcomes)</i>
5 (2009)	IDRC experience exchange and policy dialogue on ABS; discussing PPB-ABS issues/practices within Chinese context and defining the alternatives for the project	CAAS breeders propose the refund for farmers, objected by GMRI breeder	Bringing PPB-ABS practice/issues into policy discussion, and vice versa	Gap between ABS practice and national legislation
6 (2010)	Mainstreaming PPB through a training, PPB methods shift into breeders’ daily work through creating incentives for breeders	PPB experiment becomes more systematic and scientific-oriented	Bringing outside expert into the project, in order to make PPB more convincing for breeders; creating incentives for institute breeders, in terms of scientific experiment and publications	Mainstreaming PPB method in public breeding institute in the Southwest provinces
7 (2010)	Reflecting on the loss of agro-biodiversity in SW, the team seeks for incentives for farmers; sharing the survey findings with national and SW-provincial institutes to increase their awareness on PGRs conservation	Developing ambitions to create the incentives for farmers on agro-biodiversity enhancement	Conducting survey and sharing the findings with PPB team and breeding institutes, facilitating the reflection on PGRs maintenance	Seeking for incentives for farmers’ in situ conservation
8 (2010)	Searching for feasible options to balance PBR and FR within regulatory framework; making ABS agreement among PPB stakeholders, combining both landrace maintenance and hybrid breeding	Inspired by ABS contract model of Taiwan, ABS contract has been signed by breeders and farmers.	Defining ABS alternatives within national context, facilitating stakeholders making agreement on ABS contract, bridging local practice and policy forum into dialogue	ABS contract

Notes: ABS = access and benefit sharing, CAAS = Chinese Academy of Agricultural Sciences, FR = farmer’s rights, IDRC = International Development Research Centre, OPV = open-pollinating variety, PBR = plant breeder’s rights, PGRs = plant genetic resources, PPB = participatory plant breeding, VCU = value for cultivation and use.
Source: Authors’ compilation

Seen as a whole, the processes covered in this article can be seen as both bounded by well-defined concerns, yet sufficiently open for new elements and actors to enter as new information and knowledge is introduced and networking creates new relationships among those hitherto widely separated from each other. By creating space and time for new meaning and practices to emerge among actors positioned at different levels, around concrete experiments, the learning at niche level is enabled to penetrate the regime level (Steyaert and Jiggins, 2007).

Table 1 in addition allows analysis of AR as an evolving process that integrates practice and reflection, re-design and planning, and accommodates contrasting perspectives and draws in actors from different levels. For instance, episodes 1, 3 and 8 are more practice-oriented, in which PPB, community-based seed production and the ABS contract have been initiated and achieved. Episodes 2, 5 and 7 are more reflection-oriented, in which the team defines the constraints to ABS and PGRs maintenance, and seeks alternative spaces in the regime which might be induced to support the emergent niche-level innovations. In episode 4 we see that change in the AR's focus was not driven by farmers at the grassroots' level but was based on the concerns expressed by regime-level stakeholders about the potential value of landraces. The shifts illustrated in episode 6 are related to building the capacity and scientific understanding of formal breeders with regard to PPB. The eight episodes together encompass institutional innovation as the result of creating new ways for niche and regime level actors to interact and build mutually useful relationships, driven by critical moments that have led either to strategic changes in practice or to an expansion of what is taken into account in formulating appropriate frameworks in China for PPB, seed registration and release, ABS, and PGRs. Some strategic shifts have happened gradually and slowly, while others were caused by a sudden change or surprise opportunity (e.g., episode 6, initiated by a field visit).

Within each episode, action researchers play different roles, such as network broker (Wenger, 1998, 2000; Klerkx et al., 2010) in episodes 1, 3, 5, 8, discovering the boundaries of the issues at stake together with the stakeholders (Steyaert and Jiggins, 2007), or by bringing in new elements or knowledge and broadening the horizon of practice as in episodes 2, 7, 8, and by creating capacity for adaptive management and situated learning from experiments (Steyaert and Jiggins, 2007) in episodes 3, 4, 6, 7, 8. Sometimes, proposals that are considered and then rejected, or actions that fail to deliver their intended promise, none the less help define the issues in a situation that is complex. Under such condition, the slow implementation of a sound proposal is mainly related to the different (and sometimes conflicting) interests of the stakeholders. For example in episode 5, the proposal to refund farmers' efforts to maintain resources was rejected by the GMRI-owned seed company, thereby bringing into open discourse the conflicting interests of the public interest and commercial branches of GMRI. Although both CCAP and GMRI/CAAS researchers tried to be neutral in their facilitating processes, the neutrality of the action researchers could still be questioned, as CCAP researchers also pursued local advocacy, and GMRI/CAAS breeders have clear interests in breeding.

A number of institutional changes (i.e., changes at the regime level) has resulted from the niche-regime interaction, such as the development of a framework and procedures for PPB collaboration and the contractual agreement on seed production and ABS and PGRs. In other instances, the interaction did not lead directly to institutional change but rather

made visible or even created tensions and ‘mis-matches’ in the articulation of interests and institutional arrangements, in turn building pressure for further change.

5.2 AR and ‘adaptive co-management’

AR provides a general approach for developing the institutional governance of systemic relationships in which the research team usually has primary responsibility for proposing designs and facilitating the process. The specific roles of researchers in AR include designing and facilitating meetings, collecting and feeding back information, monitoring and helping manage the overall network development process, and creating ways for members to learn from the process (Chisholm, 2001). In such a way, AR plays an important role in mediating learning processes and relationships among people, and between people and their material world. In this study, CCAP researchers acted as the main facilitators driven by the motivation to create among PPB stakeholders an understanding of and capacity to deliver a workable ABS mechanism. AR in this case, as shown in the eight episodes, created a platform for mutual understanding, knowledge creation and social learning. The feedback provided to stakeholders by means of the distillation and joint consideration of each of the eight episodes through time clearly served to support the enlargement of the space for action and the participants’ commitment to shared learning as the basis of institutional adaptation (Leeuwis, 2004).

The findings presented here indicate that in this case AR enabled processes and outcomes that parallel those reported in the adaptive co-management literature (for instance, in Armitage et al., 2007b). The key features of adaptive co-management include a focus on learning-by-doing, integration of knowledge systems, collaboration and power sharing among community, regional, and national levels, and management flexibility (Olsson et al., 2004). Adaptive co-management seeks to provide evolving and place-specific governance that responds to feedback (both social and ecological) and places coupled social-ecological systems on sustainable trajectories (Dietz et al., 2003). The PPB-related ABS exploration for instance can be seen as a form of adaptive co-management evolving in a dynamic and non-linear fashion over the eight episodes.

Adaptive co-management calls for transitions in governance ‘at all levels’ that involve state, public sector, private and civil society actors. According to Berkes (2007), flexible, multi-level institutions and cross-level learning networks are important for building adaptive capacity in a world characterised by rapid rates of change and abrupt transformations. Transitions in governance rarely happen by themselves and everywhere seem to demand careful facilitation as new relationships of trust are created and well-informed negotiation among stakeholders. The experiences reported in the eight episodes further show that because the outcome – workable ABS mechanisms – cannot be defined in advance, debate, uncertainty, and difficult choices, struggles and the risk of serious disappointment, are all part of the process (Meadowcroft et al., 2005).

5.3 Networked (regime) actors in AR

The research process analysed here influenced the relationship among farmers, breeders, policy makers and outside experts, through structuring a learning network and supporting all actors to enter into new spaces for discussion. Beginning from a simple professional collaboration between researchers, breeders and farmers around seed breeding and varietal selection, based on their complementary knowledge and experience, as mutual

understanding and trust accumulated, new issues emerged and were explored together, and these challenged everyone's accepted boundaries of understanding and action. Meanwhile, new issues arose from the actions taken and new elements and actors entered into the discourse as higher level officials and other policy makers, as well as outside experts contributed new information and considerations. The existing boundaries of knowledge began to open up and discussions became both broadened and deepened. The programme's objectives have been expanded: from breeding, to biodiversity conservation, to fair ABS for smallholder farmers. The latter can be seen as the expansion and the development of the former, in ways that do not exclude the breeding objectives. The network itself became 'knowledgeable' and increasingly empowered to act on the basis of the members' shared understanding of each other's values and interests, representing a form of 'distributed cognition' (Röling, 2002).

The position of the researchers was especially important in these processes. They had sufficient PPB expertise to be accepted as colleagues by the breeders; they had sufficient social and academic standing to be accepted as credible and legitimate authorities by provincial and central officials; and yet they also, by their long term presence in the field, and the respect and value they gave to farmers' knowledge and skills, were accepted as trusted and comfortable partners of the communities they worked in. Such boundary spanning actors have been identified in other settings as essential to regime change (Wenger, 1998, 2000; Klerkx et al., 2010). When there are tensions between niche and regime, or agent and structure, the boundary spanner plays an important role in mediating relationships at the interface. In this study the CCAP researchers created opportunities to link niche level practice directly with policy actors and to mobilise a boundary-spanning network in relation to policy and regulation. The breeders from CAAS and GMRI similarly each began to link niche practice and outputs within their technical and scientific fields with the related regime context.

5.4 Institutional change in relation to ABS

This paper has discussed ABS issues within the context of PPB, where farmers and breeders interact in relation to the breeding activity and on-farm PGRs maintenance. From 2005 to 2010, a number of institutional changes in relation to ABS have been accomplished through and as a result of the interaction. These are an informal mechanism in the form of an agreement on seed production, a formal mechanism in the form of a legally enforceable contract, new procedures for and commitments to local level capacity building in relation to PPB, ABS, and PGRs conservation, identification of new options (such as GI and procedural law), and influence on the still evolving policy environment. In China, rights-based approaches to seed management, and ABS legislation, are still under negotiation among diverse interests and sectors. At the practice level, change in the incentive structures has been shown to be effective in bringing about institutional innovation (Williamson, 2000; Slangen et al., 2008), and this experience is being closely followed by Chinese policy makers. The major constraints to PPB-related ABS exist in the seed regime in relation to VCU and DUS (distinctiveness, uniformity and stability) testing, exclusive IP protection, and the vacuum in national legislation with respect to ABS. Given there is no body of national ABS law in place, niche level practices have been created that offer a range of practical options for policy makers to consider. In particular, since the role of contract law has already been well established in commercial

practice and the contracts are enforceable in law, this study's policy dialogue participants have expressed strong interest in pursuing ABS through the procedural law governing contracts, learning from the experience of the draft model law in Taiwan. However, the wider application of this option depends on a willingness to allow farmers' organisations to become registered as legal entities. Another kind of procedural approach to ABS is already achievable, under the three modalities described in this paper for registering GIs. All three modalities already allow recognition of and reward for farmers' contributions to the development of raw agricultural materials and food products. GIs are expected therefore to provide additional windows of opportunity in the near future for sharing the market benefits of PPB products.

6 Conclusions

This paper demonstrates the contribution of AR to building conducive interactions between niche practice and regime. The value of AR in fostering institutional innovation has been shown by detailed study of the processes of change with respect to PPB-related ABS mechanisms. The analysis of eight critical events uncover the strategic shifts that have occurred in a research practice that has evolved as shared learning accumulated among niche- and regime-level actors. Each episode details the twists and turns in the iteration between practice and reflection, through which stakeholders jointly discover the issues and make new accommodations. The results offer legislators and policy-makers in China in the ongoing formulation of ABS policy and law a number of tested options for sharing access and benefits in seed breeding, varietal selection and PGRs conservation. These novelties, emerging from PPB practice in a programme niche that has attracted international, national, provincial and community level support, offer ways for China to balance interests while respecting its obligations under international law and accommodating competitive market pressures.

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Notes

- 1 This question was first asked by Ronnie Vernooy in his 2003 global review of PPB experiences supported by the International Development Research Centre of Canada, entitled 'Seeds that give: participatory plant breeding'. The review led to a background paper by the same author (2005), 'Whose varieties are they?' Clarifying questions of recognition, access, and benefit sharing related to the development of new varieties through participatory plant breeding. The paper was the basis of the research project (2006–2008) in which the China project was one of the six case studies, allowing the China team to systematically research the policy and legal questions related to variety release of PPB varieties.