Participatory plant breeding background/overview

Introduction

In the context of the limits to formal breeding and the threats to farmers' seed systems and their role in agricultural biodiversity conservation and use, PPB emerged as a way to overcome some of these limitations and to bring farmers back into the breeding process as active participants. There is a comprehensive literature by practitioners providing detailed overviews of participatory plant breeding (for example, Witcombe et al., 1996; Sperling and Ashby, 1999; Sperling et al., 2001; Bellon and Morris, 2002.; Vernooy, 2003; Thijssen et al., 2008; Ceccarelli et al., 2009; Badstue et al., 2012; Kraaijvanger et al., 2016; Weltzien and Christinck, 2017).

Simply put, PPB is a form of participatory crop improvement[5] "based on the principle that farmers participate as equal partners alongside agricultural scientists, fairly sharing their knowledge, expertise and seeds. The results of such collaboration include not only more effective crop management practices, but also strengthening of farmers' capacity to experiment, learn and adapt" (Steinke et al., 2016:63). The essential core of PPB that we are adopting in this paper is collaboration between farmers and formal breeders through various stages of the breeding process. Breeding plots are located in farmers' fields, sometimes with parallel plots on agricultural research stations, with farmers actively involved in selection and testing for agronomic and quality traits tailored to their specific requirements (Shelton and Tracy, 2016:2).

The definition of PPB we are using excludes selection and enhancement activities by farmers without a partnership with formal sector breeders. These practices are very central to sustainability of farmer activities but are excluded from this particular study because: i) we are looking at ways in which farmers and breeders collaborate on practical projects; ii) there is very limited documentation of such practices, despite their widespread reality; iii) including any and all farmer practices on selection and enhancement essentially means reviewing smallholder farmer practices everywhere across the world which obviously is too large a project. PPB has developed over the past three decades or so as a particular form of collaboration and should be reviewed in light of the intentions of its practitioners over this time.

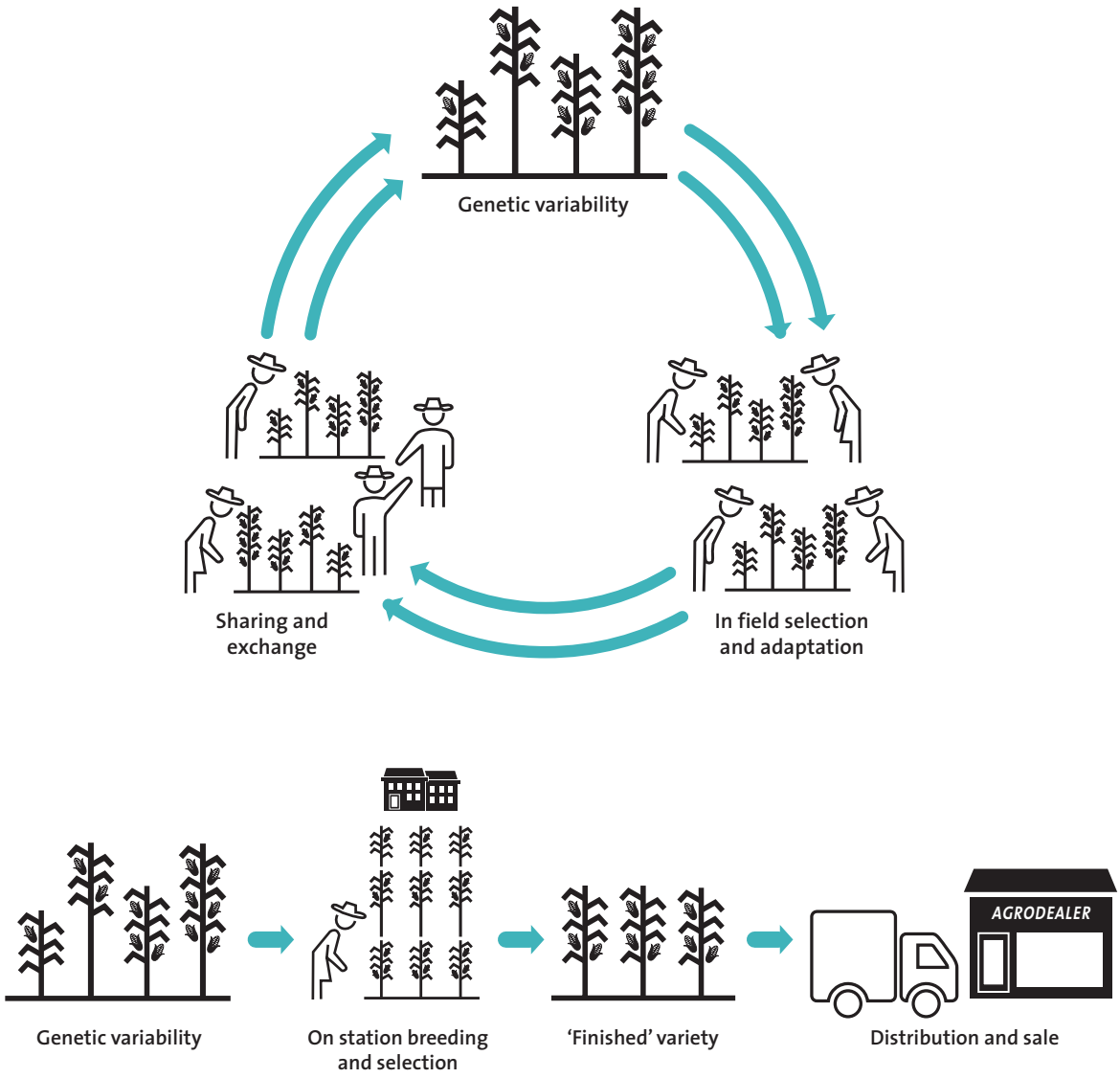
PPB is the active participation of farmers in some or all of the set of sequenced breeding programme activities discussed in more detail later in the report: priority setting, genetic materials acquisition and selection, crossing (not always), selection at early stages (many segregating lines) and late stages (a small number of nearly finished lines), in situ experimentation/testing, and production and sharing of genetic materials and knowledge. The general intention amongst practitioners is not for PPB to be a substitute for station-based research or scientist-managed on-farm trials; rather it is considered a complementary breeding process (Hardon et al., 2005; Aguilar-Espinoza, 2007; Ceccarelli et al., 2009). For many formal sector breeders, the objective of participatory plant breeding is to facilitate quicker and more extensive uptake of new cropping technologies (Morris and Bellon, 2004). "Although farmer participation is often advocated for reasons of equity, there are sound scientific and practical reasons for farmer involvement, too, as it can increase the efficiency and the effectiveness of the breeding programme" (Wakjira et al., 2008:188).

Three main objectives are common to most PPB programmes:

i) Improvements to genetic materials to suit farmer and user needs (product);
ii) Farmer access to a greater diversity of genetic materials, adapted to the local context (product);
iii) Farmer empowerment – technical and

5. Steinke et al. (2016) define participatory crop improvement as a broader term incorporating PPB, PVS and crowdsourcing of field trials as a more recent technique. Also see de Boef and Ogliari (2008).

Figure 1: Cyclical vs linear processes



organisational skills for maintaining and developing materials under their control, on-farm management, and local creativity/innovation (process).

Table 1 shows the differences between conventional and participatory breeding. It indicates there is more to participatory breeding than simply being a more effective or efficient way to do plant breeding. Perhaps it upsets the notion that PPB is simply complementary to conventional breeding programmes, because it proposes a different structuring of priorities, objectives and processes. Systematic crop improvement will be more embedded in farmers' daily lives and will be shaped by the context. It will be more cyclical, with materials constantly feeding into new rounds of production, selection, adaptation and use. This is in contrast with conventional breeding, which generally seeks a finished, distinct product for commercialisation in a discontinuous or detached process (Figure 1). In conventional breeding, farmers may be involved in PVS but on its own this cannot qualify as PPB, since there are many other dimensions in which the process may remain centralised and controlled from outside. This is not to say conventional breeding fails to take farmer concerns into account. After all, farmers are the market for seed companies. But these priorities are defined from outside, and rarely with any direct discussion with farmers.

There are variations of PPB, including grassroots breeding (Sthapit and Ramanatha Rao, 2007), briefly touched on later in the discussion about conservation and maintenance of agricultural biodiversity.

Table 1: Conventional vs participatory plant breeding

	Conventional	Participatory
Crop improvement	Linear with a distinct finished product as the output, disposal of unwanted germplasm	Cyclical with materials continuously feeding into living adaptive processes in the field, germplasm enters into the production system throughout the process
Priority setting	Private sector, breeders, industrial users	Farmers and breeders, at times other users
Sources of germplasm	Farmers via national gene banks, CGIAR institutions, private collections	Farmers directly, national gene banks, CGIAR institutions
Institutional locus	Private companies, ARIs/universities	Farmer organisations, ARIs/ universities, NGOs
Operational structure	Centralised	Decentralised
Selection and testing	Breeders, at times including farmers in PVS towards the end of the process	Farmers and breeders
Location of field trials	On-station	In farmer fields and on-station
Product	Officially released varieties	Improved materials for own use, sometimes officially released varieties
Characteristics	Few traits, yield maximisation, genetically homogenous, broad adaptability	Bundle of traits, diverse characteristics, genetically heterogeneous, local adaptation
Extension	Private, public	Public, farmer-to-farmer

Evolutionary plant breeding (CENESTA, 2013; Rahmanian et al., 2014) is another recent variation, which builds on farmer practices of mass selection and related methods, such as grid selection and field gene banks (Almekinders and Louwaars, 1999:37). It is a less controlled process. Populations with large genetic variability are deployed in the hands of farmers and the plants gradually evolve and adapt to climate and management changes, producing a 'living gene bank' in farmers' fields, which is a constant source of genetic variability. Farmers then select desired materials from this pool to multiply as single lines.

The process is a combination of farmer and natural selection. Mixtures are used that may include landraces, new lines and commercial varieties. Populations are made by varieties of the same or different crops. The process tends to give more stable yields over time than uniform crops, and they are generally more resilient to drought, pests and diseases. Evolutionary plant breeding is considered to be a dynamic and inexpensive strategy to quickly enhance adaptation of crops to climate changes (CENESTA, 2013).

Participation

Critique of participation

The concept of participation has its fair share of critics. Rahnema (1993) links participation as a concept to the US-led development model in the period after the Second World War. The objective of participation is "to involve patients in their own care" once they have been defined as patients through development discourses on poverty. In this view, participation prepares the frontiers for absorption into commodity relations in a number of ways. It can dampen and divert resistance to development. "Peacefully negotiated forms of participation can take the heat out of many situations where development policies create tension and resistance on the part of their victims" (Rahnema, 1992:118).

Participation enables the presence of an external authority. Needs are created (see Illich, 1993) and then participation is introduced to ensure support for the same needs and services (for example, specialised breeding). Participation, networking and co-operation can be used technocratically to increase knowledge of the 'field reality' for purposes not defined by farmers living those realities. They can lead to "more refined and deceitful means of action and persuasion" (Rahnema, 1992:124). Non-professional, grassroots-oriented intermediaries replace the alien authority of the outsider with a 'co-actor' (Rahnema, 1992:123). Participation can go hand in hand with the privatisation of services, for example, agricultural extension and R&D. Participation may also be used to reduce the costs of development by transferring costs to farmers and the poor. Restricted forms of participation may facilitate greater productivity at low cost, the benefits of which may be extracted from the participants if the process is controlled externally (Rahnema, 1992:117).

Rahnema refers to the more critical strand of participation thought, including dialogical interaction, conscientisation and participatory action research as 'popular participation'. She says this strand proposes to reorient development to start from existing local knowledge, empowering the voiceless and powerless, and offering new alternatives to failed development approaches. Rahnema critiques this approach, too, saying that, although it has had a few positive impacts, overall it has not produced an alternative to the development paradigm. "Any attempt to realise a mix of the two knowledges, represented by local and outside persons interacting with each other, is ... a conceptually reductionist and patchwork type of exercise" (Rahnema, 1992:122). She questions empowerment as a concept: if some people consider it necessary for other people to be empowered, they assume that those people do not have the appropriate power, and that they themselves have a formula of power to which these others must be initiated (Rahnema, 1992:123).

Rahnema puts her own faith in "informal networks of resistance which ordinary people put up" (1992:123), arguing that many activists for the participatory approach have

ended up contributing to the devaluing of these traditional and vernacular forms of power, by imposing ideological frameworks and definitions of the aims of struggle (Rahnema, 1992:124). This argument suggests these informal networks are forever local and do not interact with the 'outside' world. Rahnema essentially argues against any development intervention at all.

What are we to make of this challenge? It has a lot of force and resonance with the reality of development as we see it in Africa. Rahnema negatively assesses participation as a method for realising radical political change, since it is tied into a particular development system and relations of power. In a related conversation, Eric Holt-Gimenez and Annie Shattuck from Food First divide contemporary food system politics into a corporate regime that includes strong neoliberal and weak reformist elements, and food movements that include progressive and radical strands. Within the food movements, progressives are doers and seek practical solutions, based on agroecology and food justice. Radicals emphasise structure and political control over food systems and direct their energy at changing regime structures and creating politically enabling conditions for more equitable and sustainable food systems. Progressive projects can be very energetic,

creative and diverse, but can also be locally focused and issue- rather than system-driven. Strategically, Holt-Gimenez and Shattuck propose that, if the progressive strand is drawn to the reformist strand in the corporate regime, it can break the back of food movements. Rather than pushing for forms of collaboration with the (reformist) corporate food regime, food movements should aim to build co-operation between the progressive and radical strands within the movements (Holt-Gimenez and Shattuck, 2011).

We should not think that, merely because breeders work in formal institutions and are technical experts, they are automatically part of the corporate food regime. If we acknowledge that breeders can be part of the food movement (for example, breeders and small seed enterprises that participate in the Open Source Seed Initiative), the discussion with breeders is, then, within the food movement and relates to how practical, technical work and radical work aimed at systematic changes relate to one another. As Holt-Gimenez and Shattuck suggest, the strategic decision for food movements is then to assess whether such forms of collaboration could result in splitting the food movement by drawing farmers into formal sector seed projects that may entrench formal sector power and authority over farmers and blunt the edge of resistance, or whether it can be considered an instance of shifting public support towards diversified agro-ecological production systems. Such a shift is one of seven transition pathways from corporate-industrial agriculture to agro-ecology identified by IPES Food (2016). This scoping report is intended to assist the food movement in reflecting on this question.

Types of participation

The progressive or radical effect of participatory activities will depend, at least in part, on the types of participation and forms of co-operation. Jones et al. (2014) propose a distinction between outcomes and types of participation. They identify manipulative, instrumental and empowering outcomes (Jones et al., 2014:98).

In manipulative processes, participants may not feel they are being forced into doing something, while being led to take actions inspired or directed by centres outside their control. "More often than not, people are asked or dragged into partaking in operations of no interest to them, in the very name of participation" (Rahnema, 1992:116). In a project in Mexico and Cuba, there were questions about whether farmers should be paid to grow experimental plots. Those in favour of this approach eventually withdrew from the programme (Rios Labrada, 2005). This is a sign that farmers were being drawn into something they did not have intrinsic interest in doing, and it certainly was not something they had prioritised for its own value to them. For the purposes of this paper, we will rule out manipulation as part of the definition of participation. We are interested in investigating participatory approaches, where farmers are actively involved in making and implementing decisions on issues they have prioritised, and in which resources are made available to assist them to do this.

Instrumental outcomes indicate the product outcomes of a participatory process, the objectives of the programme in tangible terms, such as an enhanced/improved variety. We should distinguish between instrumental outcomes and instrumental processes. Instrumental or product outcomes will be an element of any PPB programme. These outcomes are the tangible benefits to farmers of doing crop improvement. Instrumental and empowering outcomes are not mutually exclusive and, in fact, should go together: for example, producing enhanced varieties can and should occur hand in hand with strengthening farmer agency. On the other hand, farmers may be

Table 2: Political orientations and modes of participation

Political category	Mode of participation	Description
Neoliberal corporate food regime	Contractual	Scientists contract with farmers to provide land or services.
Reformist corporate food regime	Consultative	Interactions take place, but these are dominated by technocratic authority, with solutions developed separately from 'participants'.
Progressive food movement	Collaborative/collegial Farmer-led	There is continuous interaction between researchers and farmers, with farmer input and action at various stages.
Radical food movement	Farmer-led	Projects have limited external resources and depend on autonomous grassroots agency; researchers can assist with knowledge, information and networks.

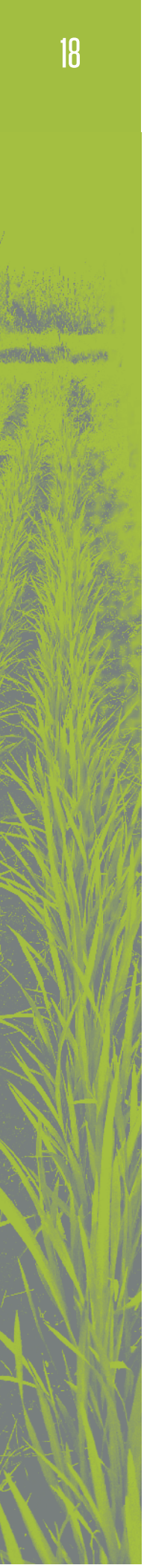
used instrumentally in processes of trait and varietal identification, varietal testing, and work with technicians, if they have no involvement in other aspects of the programme.

Empowerment is defined as changes in innovation processes that shift the balance of power between farmers and researchers in favour of the former. This is a process outcome. There are debates about the meaning of empowerment, at what level it takes place, and where it materialises on a continuum from individual to collective empowerment. For example, an over-emphasis on individual achievement in mainstream development focuses on individual agency, which may not be sufficient to dislodge structural power differentials (Jones et al., 2014:93).

Biggs (1989) identifies four modes of participation: Contractual, consultative, collaborative and collegial. To this we will add 'farmer-led' as a distinct category. Jones et al. (2014) suggest that modes of participation should not be viewed as mutually exclusive and it may not be fruitful to assign normative status to the various modes, that is, that one is better than another. For example, "in many cases that involve high levels of scientific or technical expertise, communication and control of problem analysis and project goals do not immediately lend themselves to a shift from outside experts to participant communities, so that consultative participation may be the most appropriate process to achieve desired outcomes" (Jones et al., 2014:94). These processes are also dynamic and ongoing, so engagements and interactions can deepen over time.

However, a rough mapping between Holt-Gimenez and Shattuck's political orientations and Biggs' modes of participation (Table 2) can enable us to consider the systemic effects of particular modes and choices. For example, if a contractual or consultative mode of participation is repeated over a number of years without moving into a different mode, this can signify a particular political orientation. We would certainly argue that there is a need to move along the continuum of modes of participation over time towards greater active and direct involvement of farmers and other users, with the ultimate goal of self-organised farmer associations driving processes of plant breeding/crop improvement. There may be various steps and starting points to get there, but this is the longer-term objective. If this is not the long-term objective of organisations, then this provides an indicator of political orientation. As such, we do implicitly attach differential values to the different modes of participation.

In the contractual mode, scientists contract with farmers to provide land or services. This is very similar to contract farming and can align as a methodology with a neoliberal corporate outlook, where farmer involvement is reduced to a financial relationship. This is not to say that every breeder who ever



contracts a farmer to plant and manage trials, for example, is adopting a neoliberal outlook. But the mode of participation is amenable to neoliberal co-optation, which means co-optation by forces of exploitation and appropriation. Simply using farmers' fields for trials against payment of rent (as happens in many conventional breeding programmes) is not PPB, since farmers do not participate in selection of breeding material (Ceccarelli, 2009:68–71).

In the consultative mode, researchers in the formal system seek information from farmers and others and then develop solutions separately. Farmers and others have little or no direct influence on the project and no decision-making power to direct the project in one way or another (Vernooy 2003:17). As Jones et al. (2014) indicate, this may be an entry point into farmer participation, but over time this would need to deepen into more active forms of participation, otherwise it can become a means to legitimise plans developed separately from farmers.

In the collaborative mode, there is some degree of task sharing between farmers and researchers, with continuous interaction between them. The emphasis is on farmer participation as a 'monitoring' function to assist with planning research. Research-minded farmers/custodian farmers are sought and relationships built with them. Methodologies are usually context specific and strict stages of research are not followed. Results are used to assist to direct activities in the formal system (Biggs, 1989:7–8). The extent of involvement of researchers will depend in part on the objectives of the specific research. Participation of researchers may increase, for example if farmers are working with more than one variety at a time, because this needs experimental design, in which farmers could make planting errors, if unassisted. Researcher contributions will also depend on the amount and type of data to be collected (Witcombe et al., 1996:3).

Sperling makes a distinction between 'formal-led' and 'farmer-led' PPB. In 'formal-led PPB', farmers join in breeding experiments initiated by formal breeding programmes. Researchers invite farmers to participate. Researchers may have an obligation or priority objective to feed information back to the formal research sector, with scientific standards of replicability and validity of results to be met. Such processes have strong linkages to formal variety release and seed production systems (Sperling et al., 2001:440). Contractual and consultative modes of participation will be formal-led, as will most collaborative projects, given the difficulties of farmers initiating co-operation with the formal sector, and given the specialised technical knowledge breeders bring (Witcombe et al. 1996:5).

The collegial mode of participation is on one end of Biggs' continuum. This suggests the continuum is designed from the perspective of the breeder. Collegiality refers to the (theoretical) relationship of open sharing and exchange of information and knowledge between academics at a university. It is about how researchers engage with farmers, actively encouraging the informal R&D system in rural areas. The aim is to increase the ability of informal systems to do research and to request information and services from the formal system. Research-minded farmers have the major say in running the sites. Formal researchers provide technical and organisational backstopping (Biggs, 1989:8). Without initiatives coming directly from farmers themselves, this is as far as researchers will be able to go with participation. It is a way of introducing knowledge and topics to farmers for further work. It is most likely to be successful if researchers have a history of interaction with the farmers. In this sense, consultative and collaborative modes of participation can be entry points into potentially longer-term relationships through which collegial relationships can develop. If an objective of a programme is farmer empowerment, collaborative or collegial processes will be required (Hellin et al., 2008).

Following Sperling et al. (2001), we have added a farmer-led mode of participation as an approach arising from organised farmers themselves. In 'farmer-led PPB' researchers are guided by farmers from the outset, and seek to support farmers' own systems of breeding, varietal selection and seed maintenance. Within the framework of our bounding definition of PPB (involving researchers and farmers in collaboration) researchers/extension services facilitate

a process in which farmers establish the breeding/crop improvement objectives. Farmers bear the main responsibility and often costs of conducting the experiments, selecting materials for seed multiplication and dissemination of materials. The objective is to provide varieties or populations suited to the local context, and broader applicability beyond the site is not the primary aim. There is no obligation to feed information back for extrapolation, or to generate products, such as varieties for formal release and seed systems (Sperling et al., 2001:440–441). Ceccarelli (2009a:200) refers to decentralised breeding and says "transferring a breeding programme to outside a research station almost always implies losing some degree of control of a number of steps and operations".

Farmer-led PPB is demand driven, so farmers will approach researchers. There are obstacles to this, such as farmer access to the right people to speak to. Extension services and non-government organisations (NGOs) usually operate as the link between farmers and researchers. However, in most of Africa, for example, there is limited availability of extension services and appropriate methodologies. These often use top down, 'transfer of technology' approaches, introducing technologies developed elsewhere. Note that even in farmer-led PPB, formal sector researchers are involved. As indicated above, this is a defining characteristic of PPB, which distinguishes it from farmers' activities in selecting and enhancing seed on their own, without any external support.

Farmer's roles in PPB in practice cover a wide range of activities (Sperling et al., 2001). These include technical leadership, including substantial technical contributions to the practical breeding process, such as matching specific varieties to specific environmental niches and uses, or varietal performance over time and in different locations. Community specialists may lead and manage the breeding work itself, especially minor crops, in remote areas, or where there is a limited presence of formal R&D. Farmers also play an essential role in social organisational leadership, with farmer associations, co-operatives and other networks forming the organisational base for PPB activities and sharing. Farmer organisations assist with representative sites for on farm testing, seed multiplication and distribution.

Assessing the impact of participation can be a challenge. Farmers may have multiple reasons to be involved with researchers and practitioners, which are not necessarily directly aimed at improving knowledge and skills. For example, participation may be driven by incentives, such as free seed, fertiliser or access to credit. Other perceived

benefits could be contact with outsiders, for example, access to knowledge and social status. As such, external and cognitive inputs need to be reduced to a minimum, as they might lead to dependency. Process inputs may ideally be restricted to facilitation (Kraaijvanger et al., 2016:39).

There may be different degrees of participation in different phases of a PPB project, for example, start-up and priority setting may be initially driven by external researchers to identify interest amongst farmers and get them on board. Later stages, such as varietal testing, peer learning and diffusion of new varieties, may be much more farmer driven. Practical knowledge shared by technicians with farmers can form the basis for later farmer peer-to-peer learning and sharing (Jones et al., 2014:98). Therefore, we can understand participation as a process, which may start off in a relatively contained way and then expand and be deepened over time.

Historical background to PPB and current projects

PPB grew from critiques that began in the 1950s of the ineffectiveness of development projects to bring useful new technologies to new areas. These critiques emerged in a context where technical expertise was separated from farmers, and farmers were converted into passive (or at least choice-restricted) recipients of interventions and technologies, which were not always appropriate to their needs and conditions.

A counter-trend emerged in the 1970s, to bring farmers back into agricultural development activities and experimentation, for example, farming systems research and farmer-to-farmer models. The theory is that farmers are more likely to adopt technologies when they are actively involved in developing them (Shelton and Tracy, 2016:2). PPB in practice was part of this counter-movement. It originated "as part of a movement promoting the concept of participatory research, in response to criticisms of the failure of post-green-revolution, experiment-station-based research to address the needs of poor farmers in developing countries" (Ceccarelli et al., 2009:viii).

Some public researchers at the CGIAR institutions began to experiment with more participatory approaches, for instance the International Potato Centre in Peru, the International Center for Tropical Agriculture (CIAT) and IRRI in the 1970s (Shelton and Tracy, 2016:2). These efforts stood in contrast to the dominant model in the CGIAR, which was a top-down 'transfer of technology' model going via the national research system and extension workers to farmers, in a one-way process. This is also termed a 'central source' model (Biggs, 1990).

By the late 1990s, a range of participatory research projects by CGIAR institutes, national research centres and NGOs showed success, including PVS in plant breeding. This is farmer selection of advanced breeding lines in their fields, and evidence was produced that showed this process was superior to on-station selection of varieties for formal certification. PVS and PPB terms were first used at a workshop in 1995, sponsored by Canada's International Development

Research Centre (IDRC) (Shelton and Tracy, 2016:3).

Based on the success of participatory projects, in 1996 CGIAR launched a system-wide initiative called the Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation (PRGA), co-sponsored by CIAT, which served as the convening centre, and by CIMMYT, the International Center for Agricultural Research in the Dry Areas (ICARDA), and IRRI. PRGA program activities were funded by the IDRC, Ford Foundation, and the governments of Canada, Italy, the Netherlands, New Zealand, Norway, and Switzerland (McGuire et al., 2003). In 2000, a recommendation was made to the CGIAR Technical Advisory Committee "that PPB become an integral part of each CGIAR centre's plant breeding program" (Vernooy, 2003:55).

IDRC's Biodiversity Program supported a number of PPB projects globally in the 1990s and the early 2000s (Vernooy, 2003). Other early donors included Ford Foundation, development co-operation agencies from Switzerland, Germany and Norway, the Netherlands, and various other governments. More recently, a number of other organisations are also providing funds for PPB work, ranging from the McKnight Foundation to AGRA and the United States Agency for International Development (USAID). Since 2000, a wide range of PPB projects have been recorded globally. According to Salvatore Ceccarelli, one of the pioneers of PPB who has worked extensively in West Asia and North Africa, in 2009 there were about 80 known PPB programmes worldwide (Ceccarelli et al., 2009:vii).

There are a significant number of published studies on PPB and PVS at national and regional levels. In the Americas we found studies from Honduras, Nicaragua, Mexico, Costa Rica, Cuba, Bolivia, Brazil, Ecuador, Peru, the Andean region and the US. In Europe there are studies from Italy, Portugal and Germany. In Asia there is documented research from India, Bangladesh, Bhutan, Lao PDR, China, Nepal, the Philippines, Indonesia, Vietnam, Cambodia and South East Asia as a region. In the Middle East and North Africa there are some regional studies as well as specific country studies in Iran, Syria and Morocco. In South and East Africa there is recorded work in Zimbabwe, South Africa, Zambia, Malawi, Ethiopia, Uganda, Kenya and Rwanda. In West Africa there are cases from Sierra Leone, Benin, Burkina Faso, Cameroon, Mali and Ghana. Crops include maize, wheat, sorghum, barley, rice, quinoa, teff, cassava, potatoes, beans, cowpea and tomatoes. Undoubtedly these case studies do not cover all the work that is being done on PPB and related fields globally or in Africa. However, even a selection offers a basis to start looking at the processes of PPB and to draw out some of the lessons.

Some current multi-country and multi-regional programmes include:

- USC Canada (charity) Seeds of Survival programme[6] in 13 countries: Burkina Faso, Ethiopia and Mali in Africa; Bangladesh, Nepal and Timor Leste in Asia; Bolivia, Canada, Cuba, Guatemala, Honduras and Nicaragua in the Americas, with a mix of biodiversity conservation, PVS and PPB;
- Oxfam-Novib (charity) Sowing Diversity, Harvesting Security (SD=HS)[7] in Peru, Zimbabwe, Vietnam, Lao PDR and Myanmar, with a mix of biodiversity conservation and enhancement;
- Bioversity International (CGIAR institution) Seed for Needs initiative[8], which started in Ethiopia in 2009, and now has sites in 15

6. http://www.usc-canada.org/what-we-do/seeds-of-survival/
7. https://www.sdhsprogram.org/
8. https://www.bioversityinternational.org/seeds-for-needs/

countries: India, Cambodia, Laos and Papua New Guinea in Asia; Colombia, Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua in the Americas; and Ethiopia, Kenya, Tanzania, Rwanda and Uganda in Africa.

USC Canada Seeds of Survival

This programme seeks to build and support collaborative relationships between farmers, scientists, governments and local NGO workers, on the basis of farmers' time-tested local knowledge and practices. Local partner organisations implement the programme. The programme has its origins in work started in 1989 in Ethiopia by Maleku Worede – then director of the national gene bank – and Canadian researcher and activist Pat Mooney, on rescue, multiplication and return of seed to farmers. The project expanded to other countries from the 1990s, and incorporates conservation, exchange and use of seeds, knowledge and practice amongst farmers and with scientists. It supports agro-ecology and its application in various cultural and ecological contexts, including marginal areas, where there is limited access to external resources.

In Ethiopia, the focus is on farmer access to a diversity of locally adapted seed, working with Ethio-Organic Seed Action (EOSA). The programme promotes local seed exchange networks and includes work on community seed banks, PVS and farmer-scientist collaboration. One result is publicly funded community seed banks in Southern Region, with expansion of activities to other regions in Ethiopia under way. Farmers conserve crucial genetic resources adapted to their locality and develop back-up stores of local seed supplies.

In Burkina Faso, the programme focuses on strengthening local seed supply systems, rehabilitating degraded soils, supporting farmer-to-farmer knowledge exchange and promoting sustainable biodiversity-based agriculture. It includes community seed banks and a seed bank network, on-farm seed conservation, and women's groups. Diversification and adaptation of varieties to dynamic local conditions is identified as an area for more work.

In Mali, the programme aims to strengthen resilience of local farming systems and support community-based seed supply systems, including a seed bank network and one field gene bank. Activities include seed conservation, crop multiplication, PVS, multiplication of improved local varieties, soil and water conservation and agro-forestry. The focus is on production for markets. In the context of high political conflict and violence, farmer networks and seed banks

have enabled farmers to continue planting. Village committees coordinate monitoring and evaluation of activities.

In Asia, work in the programme is being done with women's farmer groups, home and community gardens, and vegetable seed saving (Bangladesh); seed supply and diversity of plant genetic resources, including enhancement (Nepal); and sustainable agriculture and home gardens with biodiversity and seed as integrated components (Timor Leste). The programme works with the NGO, Local Initiatives for Biodiversity, Research, and Development (LI-BIRD), amongst others, in Nepal.

In Latin America, activities include: broad agricultural biodiversity (Bolivia); increasing the availability of indigenous crop varieties and saving and sharing seeds, seed diversity management at municipal level, participatory seed diffusion and plant breeding, on-farm conservation of farmer seed varieties and seed banking, securing seed supply through seed reproduction and diversity, and farmer-scientist collaboration (Cuba); working with Comités de Investigación Agricola Local (CIALs) farmer-researchers in farmer co-operatives on plant breeding/crop improvement and seed banks, and preserving biodiversity of maize and beans (Guatemala); on-farm conservation of farmer seed varieties, PPB, seed reproduction and sale, and seed banks (Honduras); and piloting CIALs working with farmer co-operatives, training in PPB and PVS, and seed banks (Nicaragua). USC Canada works with the Program for Local Agricultural Innovation (PIAL) of the National Institute for Agrarian Science (INCA) in Cuba; and the Foundation for Participatory Research with Honduran Farmers (FIPAH) in Honduras. No detailed reports of activities are readily available.

Oxfam-Novib Sowing Diversity, Harvesting Security (SD=HS)

The aim of the programme is to improve access to and use of crop diversity and to change current unequal and unsustainable food systems through farmer-based seed conservation and maintenance, and creation of new diversity. Activities include farmer field schools (FFS) with farmers, scientists and extension workers on breeding and selection, farmer seed enterprises for production and marketing, community seed banks as a basis of diversity for crop improvement, seed fairs to share materials and knowledge, and policy engagement.

In Zimbabwe, the programme works with Community Technology Development Trust (CTDT), with FFS in eight districts. They have produced a facilitator's field guide for PPB in maize, pearl millet, sorghum and groundnut. Seed and food fairs are linked to access to farmer materials by gene banks. A farmer seed enterprise has been started with the aim of testing laws with regard to sale of farmer seed in local markets. In Peru, the programme works with Asociacion ANDES on repatriation and multiplication of potato varieties with materials from gene banks and FFS. In Vietnam, Lao PDR and Myanmar, the programme works with Southeast Asia Regional Initiatives for Community Empowerment (SEARICE) and farmers, local NGO partners, ARIs, universities, and extension services. Seed clubs are based on past work in FFS and PPB. The focus in Asia is on access to diverse genetic resources, variety selection and enhancement for local adaptation.

Bioversity International Seed for Needs

The programme contributes to the CGIAR Climate Change, Agriculture and Food Security (CCAFS) programme, focusing on improved access to a diversity of adapted crops and varieties. The primary objective is the effective dissemination of diverse materials to farmers to select and adapt to their conditions, and to feed preferences back into priorities for formal breeding programmes. The programme makes use of a citizen's science approach, upon which thousands of farmers can become involved. This is a novel feature, not previously adopted by any PPB programme or project globally. Methods include farmer field schools for variety selection, seed banks and crowdsourcing trials, which involve widespread dissemination to many farmers in diverse contexts, to carry out small trials and feed results back quickly (see Steinke et al., 2016).