Participatory plant breeding in Canada: The political ecology of participatory research networks for organic agriculture

By

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Abstract

Organic farmers face many disadvantaging and marginalizing factors in their agricultural practices. Participatory plant breeding (PPB) is a method of crop breeding that pairs farmers' knowledge with the skills of formal plant breeders to bolster the insights generated by each partner. This study examines the potential of PPB programs to benefit Canadian organic farmers through a case study of the first-ever national PPB program. This study adopts a political ecology approach to analyze how PPB better meets the needs of organic farmers, compared to the dominant industrial seed systems. Farmers identified the networks and collaboration derived from the program to be as important as the actual materials developed. They also expressed the need for consistent institutional funding for PPB and organic agronomy. These findings will allow improvements to be made to the structure and methodologies of existing and new PPB programs to the benefit of all stakeholders.

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Contents

Abbreviations

BFICSS – Bauta Family Initiative in Canadian Seed Security

CSA – Community Supported Agriculture

FIPAH – Fundación para la Investigación Participativa con Agricultores de Honduras

OFRF – Organic Farming Research Foundation

PAR – Participatory Action Research

PPB – Participatory Plant Breeding

1.0 Research summary

This research project assesses participatory plant breeding (PPB) in a Canadian context, including how it better facilitates the work of organic farmers and whether this offers a better system for accessing seeds and genetic resources. Current research concerned with PPB in Canada focuses on agronomic performance of varieties developed from PPB, however, there is interest among participating farmers and non-profit interest groups to understand the many underlying factors a farmer would encounter when taking part in PPB. Considerations include how different methodologies are used in breeding and selection, how different selection methodologies are deployed to favor particular traits and crop performance in organic conditions and regional environments, what differing factors influence farmers' selection preferences across regions, and what social-political implications this participatory model offers for organic agriculture overall. This research addresses these gaps in knowledge to understand how farmers perceive PPB in practice and its function in the broader context of organic agriculture development.

Chapter 1 offers the foundational literature and justification for this research project. Section 1.1 provides an overview of the existing literature on PPB globally, as well as literature that applies to the social, political, and economic implications of participatory research networks. Section 1.2 introduces the project partner, SeedChange, and justifies the research by explaining the structure of the PPB program this organization helps facilitate, along with their guiding motivations to undertake this research. Section 1.3 concludes with an overview of the research aims, hypothesis, and guiding research questions involved in this project.

1.1 Introduction to research context and literature review

The availability of crop varieties that are well-suited to both organic production practices and regional environmental conditions is increasingly recognized as crucial for the continued success of organic agriculture, including the ability of organic farmers to minimize environmental impacts and adapt to changing climatic and economic conditions (Lammerts van Bueren et al., 2011, 2018; Entz et al., 2018). Organic crops face challenges from weeds, pests, and diseases in increasingly complex ways, and they must contend with a biologically-mediated nutrient supply system (as opposed to the synthetic nutrient supply associated with conventional agriculture). The adaptations required for varieties to thrive under these conditions lead to a specific organic ideotype which is distinct from conditions in conventional farming that require regular inputs of chemical fertilizers and pesticides (Lammerts van Bueren et al., 2011).

In Canada, few organic farmers have access to varieties developed for regional organic farming practices. Breeding for organic agriculture can reduce farmers' reliance on both conventional and organic inputs by creating varieties that tolerate more stressful conditions (Murphy et al., 2005). These circumstances make early-generation selection under organic management a useful organic crop breeding approach (Kirk et al., 2012; Wiebe et al., 2017). In a country as vast and regionally diverse as Canada, in terms of both growing environments and market access, breeding approaches also require regionally embedded knowledge to most effectively address the needs of local organic farmers.

Participatory plant breeding (PPB) pairs farmers' knowledge with the skills of formal plant breeders to bolster the insights generated by each partner. Increasingly recognized as an effective approach, PPB develops better varieties for organic farming systems by not only using the environmental conditions of working organic farms as selection environments, but also

incorporating farmers' needs and observations into the selection criteria (Adam, 2005; Murphy et al., 2005; Almekinders, Thiele, & Danial, 2006; Dawson et al., 2011; Shelton & Tracy, 2016). A participatory, collaborative breeding model could also prove better suited to sustain locally adapted varieties through *in situ* agricultural biodiversity conservation, as these *in situ* practices consider the social and cultural dimensions that go into variety development (Graddy, 2013).

PPB is already an established methodology in farming contexts outside of Canada. For example, in Nepal, a group of farmers have collaborated with non-profit organizations leading to the development of regionally-adapted strains of 'Pokhareli Jethobodu' rice. In Honduras, local participatory research collectives (FIPAH) supported farmer-led development of 26 different varieties of beans (Halewood et al., 2007). Other examples can be found in countries with regulatory environments and market dynamics similar to Canada. In the Netherlands, farmers successfully engaged in participatory breeding of potato cultivars in collaboration with researchers and industry partners for many years (Almekinders et al., 2014). In the U.S., participatory research projects such as the Northern Organic Vegetable Improvement Collaborative and the Bread Lab at Washington State University developed high-performing varieties of peppers, cucumbers, tomatoes, sweet corn, and wheat (Brzozowksi, Holdsworth & Mazourek, 2016; Myers, McKenzie & Voorrips, 2012; Shelton & Tracy, 2016; Murphy et al., 2005; Healy & Dawson, 2019).

PPB offers an alternative to the conventional model of crop breeding and helps to overcome the growing hegemony of conventional practices in agriculture that have gradually, over the course of the 20th century, dispossessed farmers of the power to control their enterprises, especially organic farmers (Kloppenburg, 1988). This project explores the role that properly adapted seeds play in the effective management of farming activities and uncovers how the dispossession of the seed through commodification might affect farming practices. Kloppenburg (2008) argues that

industrial mechanisms used to develop seed varieties for conventional agriculture are based unjustly in 'bioprospecting' genetic material and modification of plant varieties that have been fostered and developed freely by famers over centuries into proprietary material for commercial sale. This dispossession of the cultural heritage that seeds hold will also be explored as it proves significant to the narrative many organic farmers use to explain their practice.

A participatory model for crop breeding offers an approach for farmers marginalized by conventional production systems to overcome institutional barriers (Rossi et al., 2019). PPB approaches differ from conventional plant breeding methods which rely on centralized research stations to produce varieties that are only tested in limited growing environments (Dawson et al., 2011; Entz et al., 2015; Shelton & Tracy, 2016). This approach reconfigures several unequal power relations that farmers face, providing them with a more advantageous position in managing their enterprise (Fuchs & Glaab, 2011; Carstensen & Schmidt, 2016). PPB also allows for the local knowledge of farmers to be incorporated in variety development. Local knowledge, and specifically the hands-on knowledge-through-practice developed by these farmers, involves skills "integrating hand, brain, and heart" towards building knowledge (Kloppenburg, 1991). These hands-on knowledge and practices can be likened to forms of embodied knowledge, know as 'heuristics', and can be understood as skills and knowledge adopted more through habitual practice in the workplace than what is derived from strictly economic thinking (Findlater et al., 2019). Providing farmers with a strategy to overcome challenges of farm-enterprise management and giving voice to their embodied knowledge could allow them to implement more sustainable farming methods and business practices, such as low-input systems that lessen environmental impacts, and more strategic marketing to navigate institutional economic barriers.

The literature on PPB as a methodology is diverse: agricultural and technical publications focus on breeding methods, designs, and agronomic results, while social science and conceptual publications focus on values reflected in methodology and the social implications for farming communities (Ceccarelli & Grando, 2019). However, PPB remains under researched in Canada from both a physical and social science perspective, as the methodology is only beginning to be formally implemented and adopted by Canadian farmers, and agricultural practitioners. This study seeks to begin to fill this gap in knowledge around the social, economic, and political consequences of PPB practices in a Canadian context, both for the famers involved in this research model and for their organic farming enterprises.

1.2 Research justification

To investigate the ongoing developments of PPB in Canada, this research explores farmers' experiences with participatory breeding programs, and questions how the declared social implications of PPB might be realized. This research project assesses the participatory breeding program facilitated by the organization SeedChange – the only national-scale participatory breeding program in Canada. Since 2013, through its Canadian field program, the Bauta Family Initiative on Canadian Seed Security, SeedChange has worked with over 75 farmers across Canada to implement a national organic participatory plant breeding program in wheat and oats. Research results have been successful: varieties of wheat developed through this program have shown greater early vigour, better disease resistance, greater concentration of micronutrients, and higher yield than conventional varieties when tested in organic environments (Entz et al., 2018). According to SeedChange representatives, many farmers participating in the program have expressed interest in understanding the diversity of methodologies in plant breeding and selection deployed by other farmers, including how different selection methods have impacted

agronomic performance, and what factors have influenced other farmers' selection preferences. These variables greatly differ across regions and require systematic documentation.

Documentation of this on-farm research would be the first of its kind in Canada. This research has the potential to help PPB participants involved in the program understand and improve their selection methods and provide guidance for organic farmers aspiring to become involved in organic breeding projects. In addition to the improved agricultural performance from the developed traits mentioned above (e.g., early vigour, better disease resistance, higher yield, etc.) this research assesses the basis for context-specific traits that would be useful to organic farmers over their conventional counterparts (such as earlier harvestability or better milling qualities). Furthermore, this information helps to assess the overall structure of Canada's first nationally-coordinated PPB program, its partnerships, and how it ultimately works *for*, and *with*, organic farmers. In so doing, this research evaluates the effectiveness of PPB as a model for collaborative variety development to improve organic agricultural practices in Canada and to better adapt farms to changing economic and environmental conditions. This research was facilitated through a MITACS grant from the Canadian government, along with funding provided by the Organic Farming Research Foundation (OFRF). The National Research Program Director, Dr. Helen Jensen, was the lead project contact through SeedChange and serves on the committee for this thesis. More detail on research funding on the MITACS grant are included in Chapter 3 of this thesis.

1.3 Research questions, aims, and hypothesis

This research project aims to better understand why Canadian farmers seek out and take part in PPB programs and the value they draw from this engagement. It explores the challenges to adaptation that Canadian organic farmers face, through both the biophysical conditions of their farms, as well as the market channels through which they do business. I hypothesize that PPB offers an alternative model of crop variety development that is better suited to addressing the specific challenges faced by organic farmers.

As an alternative, I expect that PPB helps to address the challenges faced by the organic agriculture industry in at least five distinct ways. First, it develops context-specific traits better suited to organic agriculture over their conventional counterparts (Lammerts van Bueren et al., 2011, 2018; Entz et al., 2018; Murphy et al., 2005; Kirk et al., 2012; Wiebe et al., 2017; Shelton & Tracy, 2016; Dawson et al., 2008). Second, it helps farmers overcome marginalizing forces in the agricultural industry (Rossi et al., 2019; Fuchs & Glaab, 2011; Carstensen & Schmidt, 2016). Third, it incorporates the lived experiences and local knowledges of farmers (Kloppenburg, 1991; Findlater et al., 2019). Fourth, it provides in-situ research and development of adapted crop traits (Graddy, 2013). And finally, it respects the heritage of crop breeding work of farmers that has contributed to our modern crop varieties (Kloppenberg, 2008).

The questions used to approach this hypothesis will be: (1) What methods do farmers deploy to select desired crop traits and why are these methods used?; (2) What strengths and limitations do program participants face and how do these relate to either farm-scale systems or industry structure in Canada?; and, (3) How do participating farmers perceive the function of PPB in the broader context of organic agriculture development?

This research seeks to address the following three objectives:

i. (Questions 1) Assess the outcomes of different selection methods that organic farmers use while engaging in PPB for wheat and oats. This objective is pursued with the aim of sharing that information with existing and prospective PPB participants across the country.

ii. (Questions 2 & 3) Evaluate both strengths and limitations of this PPB project and consider the future potential for these program in Canada, drawing from the perspectives of the farmers who have experience with PPB.

iii. (Questions 2 & 3) Contribute to the knowledge and development of exemplary structure of PPB programs for organic agriculture in a Canadian context by analyzing the seed selection methodologies and perspectives of participating farmers.

This thesis begins with a chapter briefly detailing the relevant literatures and theoretical approaches of political ecology used throughout the project. Chapter 3 details the study methods and methodology, including an explanation of research partnerships involved in the project, the participant groups, study area, and research methods grounded in participatory action research. Chapter 4 discusses results of the study with direct quotations from interviews to offer context. Results are categorized by the research questions they directly address. Chapter 5 explores the three guiding questions of this study through a discussion of the results interpretation, followed by suggested implications for the findings. Chapter 6 concludes the project and suggests areas for further research.

2.0 Theoretical framework

This study is informed by theoretical concepts drawn from the field of political ecology. The specific focus is on concepts that engage critically with the ecology of agricultural systems as these systems interact with broader environmental and political systems. Political ecology concepts enable an exploration of the multiple functions that PPB serves for farmers in the context of their position within the political economy of seeds and agriculture, as well as their position within the agro-ecosystems they work in. These concepts help us see that organic agriculture (in Canada) is situated within political economic conditions that effectively marginalize organic farmers and limit their ability to shape the crop genetics they work with. With the practice of PPB functioning at the confluence of the agro-environment and political economy of organic agriculture, it is theorized that PPB offers an approach to addressing some of these marginalizing forces. This chapter proceeds in four parts: Section 2.1 provides an overview of the principles of political ecology most relevant to this study. Section 2.2 then provides a deeper discussion of key political ecology concepts relevant to agriculture and seed production. Section 2.3 looks at how PPB is best understood through the lens of political ecology. Finally, Section 2.4 provides a conclusion that summarizes the chapter and explains how these concepts inform the methodology of this study.

2.1 Definition of political ecology

Political ecology is defined in a variety of ways depending on the research field or specific question pursued. The definition given by Watts (2000) fits best within the context of PPB as political ecology allows an understanding of "the complex relations between nature and society through a careful analysis of what one might call the forms of access and control over resources and their implications for environmental health and sustainable livelihoods" (Watts, 2000). The environmental resources in the context of this study include the genetic resources of seed varieties adapted to organics. Watt's definition, with its focus on access and control over such resources, puts immediate attention on the power relations among people and institutions in society concerned with the breeding of, and access to, seed varieties.

The critical lens of political ecology assumes that interwoven relationships of human-environment interactions exist. From a standpoint of environmental resource utility, this involves political matters of *access to* and *power over* resources, following closely the thesis of environmental conflict and exclusion presented by Paul Robbins (2012). Robbins' thinking highlights the division of labour in resource extraction and use. This division of labour is not only a division in who has control over resources, but also who is expected to do certain *tasks* in the use or mobilization of resources. Regarding political ecologies and seeds, the latter half of the 20th century saw the task of seed breeding and genetic innovation become increasingly concentrated in larger seed companies and formalized institutions (Kloppenberg, 1988; Bonny, 2017). This topic will be explored in greater depth in the next section, where the political ecology of seed breeding is given specific attention.

Global economic and political forces also cause marginalization in agricultural systems, especially through marginalizing market dynamics and the inequitable seed access faced by organic growers. While studying small-scale farming, Watts (1983) found that commodification caused economic marginalization by undermining localized systems and increasing dependence on (often unstable) global and trans-national markets. By seeking more resources from these external markets, the farmers became more vulnerable, having to take on greater financial risks to obtain the means of production. Narratives of degradation of environmental resources have even been used to justify dispossession of resources through commodification (Benjaminsen, 2015). This narrative suggests that unregulated, uncontrolled access to environmental resources would lead to rapid degradation from over-exploitation and mismanagement. Adherence to this narrative by governments has led to increased commodification of natural resources and stricter control over their access. In the context of the genetic resource in seeds, this narrative is framed in terms of the expected degradation of genetic purity and efficacy through poor selection practices by farmers, therefore warranting regulation and the adoption of industrial methods to undertake and oversee seed production and trade. Whether or not this narrative is accurate (and this is a question I revisit in my discussion section), it is one of the forces that has served to marginalize organic farmers by justifying a legal separation between them and the genetic resources they work with.

Markets also have inherent dynamics of exclusion caused by the rules and regulations that determine one's capacity to buy and sell competitively (Amirtham, 2018). Economic marginalization can occur in agricultural policy frameworks when actors (such as farmers) are excluded from equitable access to resources through market dynamics that favor the competitive advantage of other (larger, industrial) actors. So, while organic farmers are forced to operate in

markets alongside conventional farmers (due in large part to limited options for organic seed) the rules and regulations of these markets heavily favour the production systems of the conventional farmers. This marginalizes organic farmers through a competitive disadvantage. Put most simply, the most abundantly available seeds are not necessarily suited to their production systems. In response to this competitive disadvantage, D'Orfeuil (2012) stresses the need for a supportive policy environment for small-scale and marginalized farmers that enter global markets as their production practices often have distinct needs.

In sum, the conceptual framework of political ecology adopted in this study encourages us to consider how the particular environmental and economic aspects of organic agriculture (for wheat and oats) are shaped by legal and economic forms of marginalization. This framework also offers ways to think about whether, and to what extent, organic farmers can address and even overcome these marginalizing forces. Case studies by Armitham (2018) have demonstrated that "farming communities can organize to handle market marginalization in creative ways and to harness the potentials that emerging markets offer them." Their research shows that such action involves harnessing the potential in community knowledge systems, accessing different forms of social capital, developing distinct value-added farming practices, ensuring sustainable use of resources, and handling market marginalization to ensure livelihood security. The political ecology concepts explored herein lead us to ask whether such pathways are also available and being utilized by organic oat and wheat farmers in Canada, in response to the forces which constrain their activities.

The next two sections of this chapter (2.2 and 2.3) focus on the application of this conceptual frame in this study. Section 2.2 discusses the political ecology concepts most relevant to the study of seeds and agriculture. Section 2.3 then presents this study's conceptual framework

in terms of two spheres of analysis suited to unpacking the political ecology of PPB in organic agriculture: the first is termed 'agro-environment'; and the second 'political economy'. The remainder of section 2.3 considers the role that PPB plays at the intersection of these two spheres, showing how the questions asked in this study are informed by this conceptual frame.

2.2 Political ecology of seeds and agriculture

The political ecology of agriculture, and specifically – seeds – in the context of this study, offers a fitting analytical lens when interpreting the stark changes to the practice of farming and agriculture that have taken place over recent decades. The dispossession of resources, division of labour, and increasing proprietary degrees of ownership that came with the commodification of agriculture stem significantly from the relationships between the environmental characteristics of crops and the political and economic systems of humans. The work of Robbins (2012) on political ecology demonstrates the interwoven relationship of human-environment interactions that apply to politicized processes of environmental resource extraction and use. The theses developed by Robbins can be applied to agricultural production in a number of ways.

Robbins' definition of political ecology can be applied to topics of seeds, genetics, and agriculture through the division of labour and dispossession of resources. The division of labour and dispossession of resources has played out through the history of the seed industry (and its associated politics in the 20th century). Foundational to Robbins (2012) is the seminal work of Kloppenberg (1988) on the political ecology of seeds. In his book – *First, The Seed* – Kloppenberg explains the formative basis of the global seed industry in the beginning of the 20th century, detailing how capital and resources for seed procurement became concentrated in increasingly fewer corporate entities. The capitalisation of agriculture worked to produce a

system that removes farmer control over the means of production. The outset for this process of capitalisation itself came with the development of inbreeding/hybridization in maize, which separated the farmer from the effective reproduction of planting material as a means of production and created the opening needed for private capital to profit from the seed sector (Kloppenburg, 1988).

Once seeds had been commodified and, hence, made into property under the structure of a capitalist agriculture, seed varieties came to be controlled by increasingly fewer entities. So where is the connection between seed production and Robbins' thesis on environmental conflict and resource access? Seeds begin to take an exploitative nature that allows them to be owned and controlled as these technologies of breeding and hybridization are coupled with legal structures that allow for proprietary ownership, demonstrating Robbins' thesis of access and power over their use. Plant genetics, or *germplasm*, can be understood as environmental resources subject to the same issues surrounding access, use, and equitable distribution. Increased understanding of genetic sequencing in modern times, and more specifically the application of genetic science to agriculture, has resulted in the purposeful accumulation of germplasm. The concept of "bioprospecting" or "genetic harvesting" can be used to further exemplify the accumulation of germplasm as characteristic of an environmental resource subject to exploitation (Nambisan, 2017).

Along with the scientific developments of hybridization that capitalize agriculture are the political developments in intellectual property rights (IPR) for the varieties or specific genes developed in the breeding process (Kloppenburg, 1988; Kloppenburg, 2010). These IPR lie at the heart of marginalization through environmental conflict and exclusion by allowing exclusive ownership and access to germplasm. This can also be understood as articulating processes of

accumulation by dispossession (Harvey, 2003), whereby processes and policies work to separate those who produce goods from the means of production. Processes of accumulation by dispossession can take many forms in social and economic systems (Harvey, 2003; de Angelis, 2004; Kloppenburg, 2010), though generally involve the conceptual control of enclosures around a given resource. 'Enclosures' refers to "the transformation of common resources into exclusively owned spaces, and the embedded loss of longstanding common rights to natural resources" (Hansen et al, 2015). These enclosures define the conceptual geographies of landscapes, mindscapes, and, in this circumstance, genescapes. Kloppenburg (2010) argues that "IPRs are actually a means of circumventing and obscuring the reality of social production and subsuming the products of social production under private ownership for the purposes of excluding others from use." This argument calls into question whether a system like this could be anything but antagonistic – excluding co-operative, collective forms of knowledge production.

It follows that through the dispossession of resources, division of labour, and IPR, organic farming is pitted into a marginalizing space of practice for agricultural production. This study is informed by the framework of political ecology as it considers the ways in which PPB can be used to circumvent these marginalizing processes and create a more equitable, counter-hegemonic environment for organic grain farmers in Canada. Within the context of this study, the dynamic between hegemonic and counter-hegemonic actors is theorized as a "war of position", that involves a struggle between actors to capture ground within state institutions, the economy, and the cultural sphere. This on-going struggle will strive, for each position, to try and build or maintain coalitions in support of their class interest (Adkin, 2022). Those positions deemed 'hegemonic' are ones that hold a more dominant, overbearing, and overall directing agency in society and culture.

To offer a definition that specifies organic agriculture, this explanation can take many iterations depending on who is putting forward that definition. The Food and Agriculture Organization of the United Nations (FAO) defines organic as "a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. These systems strive to optimize the productivity and fitness of diverse communities within the agro-ecosystem, including soil organisms, plants, livestock, and people. The principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment (Martin, 2009). Whereas other industry definitions align with simply choosing not to use pesticides, fertilizers, genetically modified organisms, antibiotics, and growth hormones (Government of Canada, 2021). Although practices of organic and conventional agriculture are often delineated as dichotomous, both modes of production share much in common. At a larger scale of production, organic farming adheres to almost as much an industrial model of production than do conventional farmers. The environmental and human health considerations of organic production are mainly realized through the lack of chemical inputs. The next section of this chapter explores some of the specific facets of PPB that can circumvent marginalization for organic grain farmers that is found through the "war of positions" between hegemonic and counter-hegemonic actors.

2.3 PPB and political ecology

Blaikie and Brookfield (1987), in their foundational work for the emerging field, state that "'political ecology' combines the concerns of ecology and a broadly defined political economy". What is understood by both these aspects of 'ecology' and 'political economy' is important to how this study conceives of PPB within the broader field of political ecology. Building on this foundational work, this study is based on the premise that interpreting the benefits and challenges of PPB is best undertaken through a mode of theorizing that places these practices at the intersection of two types of farmer interaction with the world around them. As illustrated in Figure 1, these interactions are organized in terms of farmer engagement with their "agro-environment" and with the broader "political economy".

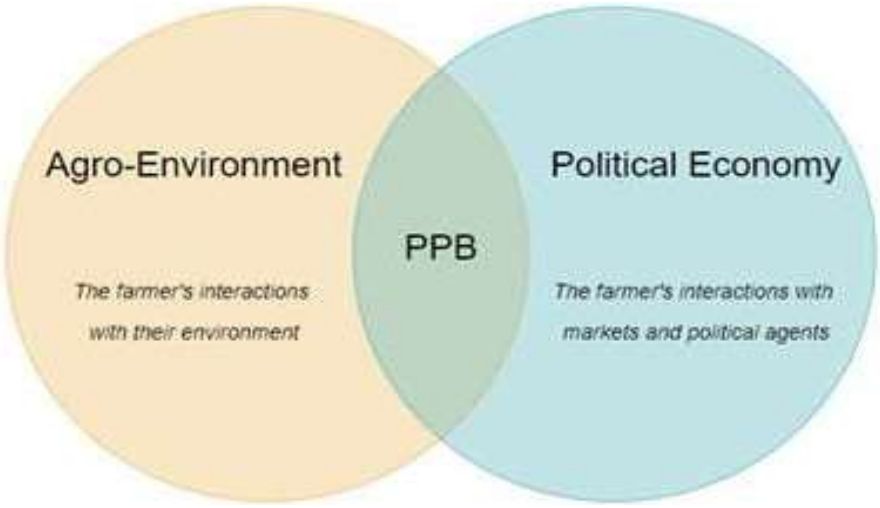

Figure 1: A Conceptual Framework for Studying PPB. Participatory plant breeding (PPB) fits at the intersection of a farmer's agri-environmental and political economic interactions.

What is meant by political economy within this context and what does that definition entail? As Paulson et al. (2003) explains, "By highlighting political economic relations and systems, political ecology brings social relations into analysis that are not necessarily proximal to the ecological symptoms of land degradation." This puts the focus on global political and economic factors, rather than on conventions of human and cultural ecology that situate causes of, and solutions to, environmental crises in locally based problems such as poor land management, inappropriate technology, or overpopulation (Paulson et al., 2003). The definition of political economy used in this study follow this supposition that power relations involving economic actions are equally affected by national and global political and economic dynamics as much as they are through locally embedded ones. This is articulated well by the example of IPR

(embedded in both national regulations and international norms) and the effect this has on the power relations between organic farms and seed companies. Because of global and national seed policies, farmers are limited in the decisions they can make with regards to their farming practices.

This study understands the agro-environment as the biotic and abiotic environmental conditions on the farm. This includes not only climatic conditions, soil type, daylight hours, temperatures, and weather patterns, but also the agronomic factors that influence soil health, nutrient cycling, weed competition, as well as other biological trade-offs that occur through organic agricultural management.

Organic agriculture is unique in that the adaptations required to thrive under these environmental conditions lead to a specific organic ideotype which is distinct from conventional farming that rely on homogenized conditions resulting from the use of agrochemicals and synthetic fertilizers (Lammerts van Bueren et al., 2011; Entz et al., 2015; Murphy et al., 2005; Shelton & Tracy, 2016; Dawson et al., 2008). Organic farms may have increased SOM, crops must adapt to slower released and soil bound nutrient sources, farmers may have to pay more attention to weed competition, and therefore require crop phenotypes that better suit organic production conditions (taller stem length for weed competition/snow capture, greater leaf area for weed competition, larger root network for nutrient capture, etc). The unique agri-environmental conditions of organic agriculture are therefore an important factor influencing the function of PPB. Further, these agro-environmental interactions necessarily intersect with the farmer's political economic interactions, whether at the level of seed germplasm (what can be planted?) or markets (what can the farmer sell?).

Placing PPB at the intersection of agro-environments and political economy in the conceptual framework (Figure 1) focuses on the complex function of PPB within organic agriculture. It illustrates the fact that these two sets of interactions always exist in relation to one another – they are mutually constitutive. This position also allows us to explore the possibility that a farmer's agro-environmental practices, in the form of PPB, could serve as to counter the hegemonic (political-economy) forces they are otherwise subject to.

There are several ways that PPB seeks to address challenges faced by farmers in the organic agriculture industry. The remainder of this section demonstrates how a framework grounded in political ecology allows analytical perspective on the wider set of ecological, social, and economic relations within which PPB takes place. It also interprets how, and to what extent, PPB represents a mechanism for circumventing the marginalizing forces in organic seed systems.

2.3.1 Developing crop traits specific to environmental and economic contexts

PPB acts as a form of resistance to the hegemonic order of commodified seed production. It seeks to develop traits suitable to both organic agriculture and the specific farms where these crops are used. Through the provision of an alternative order of seed production available to farmers, PPB generates crop varieties developed with context-specific traits better suited to the farmers involved. This process addresses the specific marginalizing factors over the conventional systems for several reasons.

Organic agricultural systems differ exceptionally in both the environmental conditions that the crops require for growth, as well the economic conditions that organic goods face in the market. Many studies have shown that the specific environmental contexts of organic crops

warrant crop breeding strategies specific to the environmental conditions organic crops contend with (as listed above); namely through breeding strategies of PPB (Lammerts van Bueren et al., 2011; Entz et al., 2015; Murphy et al., 2005; Shelton & Tracy, 2016; Dawson et al., 2008). The economic contexts that organic farmers work within may also require distinct cultivars. For example, organic goods may need to respond to unique consumer demands, such as preferred culinary quality, sensory preferences (taste, smell, aesthetic), cultivation techniques (i.e. "naturalness"), and nutritional content (Asioli et al., 2014; Sidali et al. 2016). Framing an analysis for these contexts within political ecology allows us to see the wider set of ecological, social, and economic relations within which the breeding goals of participating farmers are situated, and to interpret the politicized response to the relationship that these farmers have with their economic and environmental contexts.

2.3.2 Helping create alternative systems for seed procurement counter to a hegemonic, commodified seed industry.

Organic producers encounter marginalizing forces both on and off the farm in the form of inequitable economic competition through production and sale of goods, compared to their conventional counterparts. These forces can be pressing enough that they become barriers to enter the industry or motivators for farmers to leave organic farming altogether (Kaltoft & Risgaard, 2006). Forces can include issues of marketing and obtaining the required premium to overcome increased costs of production. Organics require a system unto its own that allows for a more liberal exchange of seeds and genetics, one that reflects the diversity in growing conditions found on organic farms and offers a flexible means to produce seed in this manner. As well as a system that would develop seeds to best address the aforementioned agronomic needs specific to

organic production systems. Although the concerns around agronomic specificities and market access are issues that most farmers have top-of-mind, some marginalizing forces are at broader ecological scales and may present themselves less tangibly.

Within the political economic sphere, ideological inequalities hinder organic farmers from operating competitively relative to their conventional counterparts. As certain hegemonic ideas become normalized, the dominant meta narratives become taken for granted, while other alternative counter-narratives (like PPB) become dismissed and/or silenced. The governance of agri-food systems can be conceptualized as a field of power struggles between global and local actors characterized through material flows (financial and technological) and ideational sources of power (such as influence and cultural embeddedness) (Fuchs & Glaab, 2011). Ideational power inequalities can effectively depoliticize ideas and customs until they recede into the background of what is considered valid practice, which then structures people's thoughts about the economy, polity, and society (Carstensen & Schmidt, 2016). Depoliticization happens through practices such as standardized production using the agri-chemical regimes, the acceptance of IPRs as a normal way of doing business, and the aesthetic quality of food grown under conventional practices. These practices are examples that place organic production on an "unequal footing", where production practices and marketing are at an inherent disadvantage. Organic agriculture is then considered a "niche" market and not given full, due consideration by policy and market institutions.

In response to these hegemonic ideational structures, the validation of alternative breeding and knowledge networks, as exemplified by PPB, can be seen as counter-narrative that claim ideational power. Although ideational inequalities exist and pose challenges to the

equitable access of agri-food systems' governance, the growth and normalization of PPB suggests that actors at all levels may still have the means to activate and shape ideational power in the form of knowledge and cultural legitimacy in pursuit of their interests and farming practices (Fuchs & Glaab, 2011). I will return to this idea in the discussion of research results below.

As one step toward building resilient and diverse seed systems, PPB also has the potential to create a more democratic approach to the perception (or ideation) of information and technology networks. Rossi et al. (2019) suggest the need to consider genetic resource management as a matter which goes beyond the pure conservation perspective and includes a direct, active engagement of the key actors involved in the process – starting with farmers. This approach aims to create more varied and localized pathways of social mobilization and to increase democratisation of decision-making around food issues. Robbins' thesis of environmental conflict and exclusion also details thinking around who is granted the power of *decision making* in the process of resource management. Escobar (2006) highlights the need to consider diverse ecologies, economies, and cultures in understanding access to environmental resources. Escobar's position grapples with how to allow differences in a system of resource use/extraction while also maintaining equality in natural resource access. This position is relevant when considering the counter-hegemonic role that PPB supports to establish alternative models of seed production and genetic resource adaptation. Within the thesis of environmental conflict and exclusion, the PPB serves a counter-hegemonic role by redistributing power regarding who makes decisions about genetic resource innovation and management. Farmers' direct experience in their production practices inform such input through close observation of their farms (e.g., noting changing weather phenomena, soil degradations, and shifting market

trends, among other variables). Given the power struggles surrounding access, use, and decision making in agricultural resources, the co-operative and democratic nature of PPB asserts renewed agency over the means of production for farmers by allowing them to meaningfully contribute to the development of the seeds they use.

2.3.3 In-situ research to access lived experiences, values, and local knowledge of farmers

PPB involves an expression of both natural and political knowledges from its practitioners. Political ecologists have long upheld the importance of localized and 'situated' knowledge to overcome hegemonic biases in environmental management issues (Haraway, 1988). Incorporating the direct, active engagement of farmers and key actors in the process of seed breeding creates value that manifests at many levels, from democratization and farmer empowerment to greater efficiency in production models (Kloppenburg, 1991; Findlater et al., 2019). Involving the lived realities of farmers provides an in-situ approach to research that has been found to provide context-adapted crop traits in overlooked, underserved contexts (Graddy, 2013). The value of an in-situ approach to crop breeding also involves ideational power relations through respect for the heritage of crop breeding work that has developed our modern crop varieties (Kloppenberg, 2008). Continued development of agronomically useful and novel plant varieties must be predicated on access by breeders to the enormous pool of biodiversity and knowledge that has been maintained through history by farmers, localized institutions, and Indigenous peoples (Kloppenburg, 2010). PPB allows for an amalgamation of this process between both scientific and political knowledges, in which natural knowledge and political order are co-produced "through a common social project that shores up the legitimacy of each"

(Jasanoff & Wynne, 1998). This helps illuminate the process of knowledge creation in agriculture as political: various sites of knowledge making emerge from dominant institutions of political-economy and governance, whereas hegemonic political order often relies on depoliticizing and de-legitimizing the production of knowledge that occur through "alternative", counter-hegemonic forms of practice.

2.4 Conclusion

Political ecology – a diverse and interdisciplinary mode of theorizing – provides conceptual tools suited to the analysis of PPB. Watts' (2000) definition of political ecology, and Robbins (2012) insights into environmental exclusion and access to resources, can be readily applied to cases involving agriculture, seeds, and marginalized farmers. Kloppenberg (1988, 2008, 2010), Escobar (2006), and Amirtham (2018) each demonstrate the direct applicability of a political ecology lens to fields of agriculture and seeds. This research focuses on counter-hegemonic processes that can be taken to better understand and overcome restrictive regulatory and ideological constraints. By allowing a better understanding of how concepts like the dispossession of resources, division of labour, and IPR act as direct challenges to the full potential of organic farmers, the theoretical framework of political ecology allows for a more all-encompassing look at the challenges to seed access faced by organic farmers. Considering these challenges, PPB is positioned as an ideal platform to address issues surrounding marginalization in organic grain farming and seed procurement.

Deploying the theoretical framework of political ecology helps inform this research and approach the three main research questions of this study by offering a lens to interpret the

benefits and challenges of PPB. The research study adopts this theoretical framework to analyze both the biophysical challenges of the organic agro-environment (Question 1) as well as the socio-economic challenges of the political economy and cultural contexts of organic farming (Questions 2 & 3). Chapter 3 details the methodology used to explore concepts of political ecology in practice through interviews with farmers participating in the BFICSS national program of PPB in Canada.

3.0 Methodology

Chapter 3 delineates the methodology of this study, as well as the research design and partnerships. First, it elaborates on the nature of the research relationships between the University of Manitoba, the community partners of SeedChange and BFICSS, and me as the principal investigator. Second, it presents a review of participatory action research (PAR) as a research methodology, lending specific insight into the dynamics of doing PAR with NGO community partners. And finally, it explains the research methods and ethical considerations involved in this study.

3.1 Research Partnerships between the University of Manitoba, BFICSS, and SeedChange

Since 2010, the University of Manitoba-based PPB project has worked with farmers in the Canadian prairie provinces to implement a collaborative breeding strategy for grain crops of wheat and oats. The University of Manitoba's PPB program aimed to develop cultivars relevant to farmers' needs by selecting seed in the farm environments—under conditions in which they will be grown. The PPB program also sought to give farmers more control over seed resources

by helping them develop and maintain their own varieties (University of Manitoba, 2016). The project operates through the Natural Systems Agriculture Lab of Dr. Martin Entz. Within the context of this program, this applied component of this study operates as an evaluative process to determine the perspectives of the farmers who take part in the program. Established as a MITACS Accelerate Internship, I engage with the University of Manitoba's PPB program and SeedChange to conduct applied research for both these organizations. My main contact at SeedChange is Dr. Helen Jensen, National Research Program Director, and a member of my thesis committee.

This program has received assistance both in terms of funding and in-kind support with farmer communication and networking from the Bauta Family Initiative on Canadian Seed Security (BFICSS) and the Growing Forward 2 program of Agriculture and Agri-Food Canada, via the Organic Science Cluster 2 and Organic Science Cluster 3 grants. The support of additional funding and partners helps build capacity and increase national reach of the PPB program—enriching the skills and knowledge of farmers, researchers, and other participants involved in the program (University of Manitoba, 2016). The directing principles of the program have been for farmers to guide the breeding objectives and provide farmers the opportunity to have more control over their seeds. The BFICSS has staff members located in 5 Canadian regions. It is this presence that allows the program to achieve national reach beyond the Prairie province.

BFICSS is a national program with the mandate "to support Canadian seed systems that promote food security and are resilient in the face of climate change" (BFICSS, 2019). As the Canadian field program of SeedChange, program proponents of BFICSS work with the University of Manitoba to implement a national organic PPB program in wheat, oats, and

potatoes. The program has grown to a stage where farmer selections of wheat and oats are now being evaluated at regional field sites across the country. Data collected from these field sites provide farmers with agronomic data on how selections perform regionally across the country.

SeedChange, formerly known as USC Canada, acts as the main funding and administrative organization for BFICSS and the PPB program. SeedChange obtained a grant from the Organic Farming Research Foundation to support this work and also acted as the partnering organization for the MITACS Accelerate Internship associated with this research project. This internship involved regular liaison with SeedChange staff and the Natural Agriculture Systems Lab at the University of Manitoba to chart direction and best practice for interactions with program participants during the interview process. Research funding was also provided by Food: Locally Embedded, Globally Engaged (FLEdGE) through involvement with their SSHRC-funded Partnership Grant.

3.2. Positionality

It is important to situate myself in relation to the PPB program and research participant networks of SeedChange. Positionality is normally identified by locating the researcher within three areas: (1) the subject under investigation, (2) the research participants, and (3) the research context and process (Howard, 2020). Regarding this study, my positionality as a graduate student researching organic agriculture and participatory research networks stems from my many years working in agricultural research and development. These years involved roles as diverse as field plot research, to technical agronomic support, and supply chain analysis for sales support.

In relation to the research participants, I identify as a researcher in environmental and agricultural sciences who comes from a non-agricultural background. My experience in these

domains involves both conventional and organic agricultural practices. Though heavily involved in agricultural industry, development, and working alongside agrarian lifestyles, my worldview is removed from the realities faced by those who engage in farming as both a livelihood and lifestyle. The level of detail observed, as well my embeddedness in the social and economic systems involved in organic agriculture, is not as adept as someone who comes from that kind of organic farming background. In relation the research partner SeedChange, I have a casual working history with them that has involved taking on short internships, attending field days, and participating in preliminary program support roles to help introduce me to the program structure before beginning my graduate research.

In terms of my positionality within the research context and process, this research took place remotely from my home in urban Ottawa, Ontario. This was due to restrictions of the COVID-19 pandemic. This barrier to visiting the farmers' farms personally greatly influence my ability to situate myself in the context of the research participant. The research process also involved a practice of reflexivity to check my assumptions and relationship to the research processes. A reflexive approach is a prerequisite and an ongoing process for the researcher to be able to identify, construct, critique, and articulate their positionality (Howard, 2020). I took a reflexive approach to my research interviews to try and notice which conversation topics the research participant seemed most interested in discussing and digging deeper into. This reflexive process was adopted with hopes of responding directly to the values expressed by the research participants.

3.3 Participatory Action Research

This project uses participatory action research (PAR) as a guiding methodology for the research partnership with SeedChange. Scholars describe PAR as a more collaborative, democratic approach to research and learning built on communication, negotiation, observation, reflection and analysis between scientists and non-scientist stakeholders *sharing* local knowledge and expertise (Ballard and Belsky, 2010, emphasis added). According to Baum, MacDougall, & Smith (2006), the process of PAR should empower local communities and lead these communities to have increased control over their lives.

As a methodology, PAR differs from conventional research in several ways: 1) by actively and iteratively reflecting on the information gained, which in turn achieves action upon that reflection; 2) by democratically involving those being researched in the process; and 3) by paying attention to power relationships between the researcher and researched (Baum, MacDougall, & Smith, 2006). Through these characteristics, PAR as a research methodology enables both the process of research and the results found to have a direct impact on social and ecological issues in the communities in which it is used. Though historically it has been dominantly applied to human health and sociological research (Ozanne & Saatcioglu, 2008; Kidd & Kral, 2005; Minkler & Wallerstein, 2003), growing bodies of literature have applied the methodology to environmental and agricultural contexts (Mendez et al., 2017; Eelderink, Vervoort, & van Laerhoven, 2020; Milich et al. 2020). PAR can be used in agricultural research to collaborate with local agriculture and farming communities directly in the research process. The management of complex social and ecological systems can be improved through incorporating both scientific and traditional (or local) ecological knowledge. This can help address the underlying political context in which knowledge is generated and used (Berkes,

Colding, & Folke, 2003). By incorporating scientific and traditional knowledges, PAR enables greater autonomy and self-management for agricultural producers, as well more thorough insights for researchers through active learning and reflection in the process. Highlighted here is the iterative process of PAR that crucially incorporates reflective cycles and active learning throughout (Fahy, 2015; Guzman et al. 2012; Baum, MacDougall, & Smith, 2006). These reflective processes themselves are meant to be directly linked to action, "influenced by understanding of history, culture, and local context and embedded in social relationships" (Baum, MacDougall, & Smith, 2006).

The second key aspect of PAR, allowing the active democratic involvement of those researched, underscores its multi-lateral nature by incorporating the voices and perspectives of those researched in the results and implications of the study. However, the use of this approach has not always resulted in ideal, equitable, and democratic outcomes, with inconsistencies arising in how participation and action are incorporated through the process (Benjamin-Thomas et al., 2018). Studies such as the principal investigation of this paper are still needed to apply PAR frameworks to diverse fields to assess different power relations present in the research process and to help achieve more equitable research contexts.

Lastly, PAR draws attention to leveling relationships of power between researcher and researched, achieved through building strong working and personal relationships of trust with the communities and participants of study (Barbera, 2008). My personal relationship with the research partners of SeedChange and BFICSS extends back several years before this study, involving initial internships that introduced me to the organizations and their mandates. While preparing to conduct graduate studies and planning a master's thesis project, I reconnected with both the BFICSS's National Director and Research Manager to establish a research project most

relevant to these organizations. SeedChange, BFICSS, and the University of Manitoba have long held relationships with the farmers involved in the PPB program, as well as various farmer representation organizations. These relationships allowed my research study to be introduced in a well-regarded manner and an understood context applied to the organizations with whom I was collaborating. Through the partner organizations and their existing relationships with the program participants, I was able to engage with participants at an equal and more personable level given that relationships had already been established over years. My research process was originally intended to involve time spent on the study participants' farms ahead of the interviews to develop my own relationships with them and their farming practices. This was meant, as Barbera (2008) explains, to build trust and comfort by working closely with another person, which benefits PAR through a shared reconstruction of the situation being discussed. Due to research constraints posed by the COVID-19 pandemic, however, visits to participants' farmers were prohibited by Carleton's Research Ethics Board, and this element of PAR methodology was not able to come to full fruition.

3.3.1 PAR and NGO Collaboration

This research project involved several aspects which made it somewhat distinct from the idealized approach to PAR discussed above. Most importantly, this research project involved engagement with the study community mediated through a community partner, in this case SeedChange. It is important to consider how PAR processes are modified when working with or alongside NGO community partner organizations, rather than directly with the research population itself (i.e., the farmers participating in the PPB program).

Strand et al. (2003) describe community-based research that is mediated through a community partner as "doing research *in the middle*". There are some obvious advantages to this type of approach to PAR. For instance, NGO partners are organized groups with staff and leadership who are easy to identify and contact when developing a research study. There are disadvantages as well. For example, working through community partners may put distance between the academic researchers and the community members being studied and, hence, fall short of the ideal degree of community collaboration. In the context of this study specifically, the distance between myself as researcher and the group of participants involved in this study played a particular disadvantage considering the limitations on engagement due to the COVID-19 pandemic. Because I had not previously established contact with the research participants, let alone a working relationship, the COVID-19 pandemic prevented meeting in person with participants and in many ways increased the distance between researcher and research participant even further. Another disadvantage of doing PAR research "*in the middle*" is that some social service and other helping organizations may in fact pacify or disempower the community (Strand et al., 2003). This latter disadvantage is not considered an issue in the context of this study, however.

The relationship dynamic taking place between academic and NGO during collaborative studies can take several different forms. Aniekwe et al. (2012) explain five different types of academic-NGO collaboration. Two of these types of collaboration seem relevant to the nature of this study and the research relationship with SeedChange. One type is the "joint-learning model", in which partners are co-conspirators and co-producers of knowledge, identifying and originating the research process focused on long-term interest and sustainability of research goals. This model was reflected in the way that the research design, interviewing process, and interpretation

of results were co-produced between SeedChange, the study participants, and myself. The other type of collaboration relevant to this study is the "best practice" model. This is a form of collaboration in which an academic researcher identifies and documents best practices that could be shared and replicated by other similar organizations or NGOs. This is achieved through this study's aim to provide a review of PPB practices in Canada, identifying ways to expand their use and best practice.

When considering the co-production and complementary nature of knowledge formation found in PAR practices (Berkes, Colding, & Folke, 2003; Ballard and Belsky, 2010), the dichotomy between scientific and local knowledge is not necessarily simply delineated in the context of this study. As explained in earlier sections of this chapter, many PAR studies working with local communities and partners divide knowledge according to this dichotomy, whereas the reality is quite different regarding the dynamic between SeedChange and the local communities of organic farmers. Many of the farmers have advanced training in agronomy, engineering, business, and other technical fields already, in addition to their experiential and local knowledge. Similarly, many of the staff at SeedChange are trained in science and research in addition to their roles in project management. Carolan (2006) demonstrates that academic knowledge is often generalized, and abstract compared to the scientific knowledge of the farmers which are place-based in their experiences with their farms and agri-environmental conditions. Both types are scientific knowledge but differ in the language and practice of how they are communicated to one another. Carolan (2006) also details how farmers will even employ their own scientific knowledges and methodologies to set up experimental trials on their farms to test new production methods.

Furthermore, in academic writing the active democratic involvement of local communities does not often extend to including these communities in the process of writing up study results. This could perhaps stem from the dichotomy in assigned knowledge types and debates over the objectivity of local knowledge used for academic work (Ludwig, 2017). This leads to publications that are not the best they could be, and also restricts many people from contributing to the recognized body of knowledge that is peer-reviewed literature. FIPAH, in Honduras, is example of PPB that includes farmers, researchers, and community partners in the authorship of their publications (FIPAH, 2012).

In sum, the process of doing participatory research "in the middle" allows for researchers to easily access populations for study through pre-existing working relationships. By partnering with SeedChange in this research, along with their field branch of BFICSS, I was able to establish quick contact and communication with research participants I would otherwise have not had the chance to work with, and who will help to disseminate the findings of this study directly. In this way, PAR helps shape this study and facilitates knowledge production and dissemination through direct working relationships with study participants. To properly carry out a PAR methodology with both SeedChange and their program participants an ethics review was of course necessary. The considerations taken in this ethics approval process was then reflected through the specific research methods taken. Both ethics considerations and methods will be discussed in Section 3.3 of this chapter.

3.4 Ethics

I obtained ethics approval from the Carleton University Research Ethics Board in May 2020. The purpose of ethics review is to ensure the respect and safety of those who are taking part in human-based research. The aspects of this review most relevant to this project were the storage and confidentiality of information discussed in the interviews, access to information by those involved in the study, and the consented dissemination of information and findings after study completion. These issues were mediated by informing participants of confidentiality measures through informed consent forms distributed before scheduled interviews. The storage and access to data were mediated by data files being stored in just the computer of the PI and data spreadsheets having access by only those involved in the core study research team.

Working with regional program coordinators of BFICSS, participants were selected through an open invitation (to all participants in the BFICSS program) inviting them to take part in the study. To obtain informed consent from interested individuals, I distributed plain language recruitment letters and a copy of the interview guide (see Appendix A) to possible participants—written in both English and French. Study participants were also given a two-week period following their interview to retract the information they provided from the study if they wished to do so. Finally, the participants provided verbal consent to proceed with the interview and acknowledged they could withdraw consent to participate at any time or strike individual comments from the record. Throughout the course of this project, all information was kept confidential, and participants were given coded aliases to maintain anonymity.

3.5 Methods

The data collection process of this research lasted from July 2020 - December 2020. The BFICSS breeding program works with over 75 farmers across the country to implement a national PPB program on wheat, oats, and potatoes. Of this group of participants, 47 were considered eligible for this study (i.e., they work in wheat and oats, still farming, completed >1 year of the program). From this total, 19 farmers participated in the study across 7 provinces (see Appendix B). Given the number of eligible candidates for this study, this sample size is deemed representative considering the diversity in regions represented through the study participants, as well the mix of farming scales and backgrounds. The relative heterogeneity of composition among the farms is also noteworthy and validates the sample group as being well-representative of total program composition. These farms consisted of a variety of acreages, crops, geographies, and integrated livestock (see Appendix B).

Data collection was undertaken through semi-structured interviews, using a list of eleven questions as a guiding research instrument (see Appendix C). Interview questions were developed in collaboration with BFICSS regional coordinators to best capture relevant information most useful to the research partner, SeedChange, and to present the questions in a way that would be understood by the study participants. Interview questions were designed to be very broad to generate a dialogue. Although these questions were prepared in a way to address certain topics of interest for the study and to maintain consistency between interviews, questions were flexible in that they did not necessarily follow a prescribed order (depending on the flow of conversation) and questions were sometimes supplemented with follow-up inquiry to prompt more discussion into a particular area. Supplemental inquiry and prompts were not determined ahead of time and were not fixed. The list of guiding questions was provided for participants ahead of their scheduled interview so that they could prepare in advance if they wished. As

mentioned in section 3.3, interviews were held over the telephone with no visual component of observation/data collection. While interview dialogues were recorded, I kept a research journal to track my thoughts and make note of topics to investigate further following the interview. Farmers were offered an honorarium of $200 for the time given to participate in the study.

The interview questions and the resulting coding approach were designed in such a way to emphasize the ecological dimensions of farmers' PPB selection practices and to explore the political economic dimensions of their farming practices to emphasize the focus of the conceptual framework grounded in the political ecology literature discussed in Chapter 2.

3.6 Coding and Data Analysis

Interviews were recorded using Tape-A-Call recording software and then later transcribed. The qualitative data generated from interviews was imported into Nvivo—qualitative data software that facilitates coding and analysis. A combination of both *a priori* and *a posteriori approaches* were used to determine analytical codes (and how these codes would be grouped in further analysis). Documents from previous PPB studies that were carried out by BFICSS were reviewed ahead of interviews to determine coding themes that would be relevant to this study (USC Canada, 2013). For a posteriori approaches, prevailing themes discussed across interviews were pulled out during the transcription process for analysis and use in the coding process. Qualitative data groups included areas such as political, social, economic, operational, biological, all of which were later organized into the underlying analytical themes of this study.

Quantitative data were also compiled, including the selection methods and selection timing deployed by farmers. Selection methods are based on either positive selection, negative selection, blended methods, or "autonomous" selection. Positive selection involves targeting the

desired individuals within a population for harvest and retaining them for downstream analysis and further stages in the breeding program. Negative selection involves removing several undesirable individuals within a population, leaving those of interest untouched for cumulative harvest at the end of the season. Blended selection methods involve adopting a combination of both positive and negative selection used during the same selection season. The use of blended selections would depend on the desired trait(s) of interest in the trial, as well the specific timing that the selections are made. "Autonomous selection" is used in this study to describe a type of selection where growers leave their entire trial population in the field until harvest and depend on natural weather and environmental processes to eliminate or cull the weaker plants within the population. The perceived aim of this natural selection method is to select for genetic traits that are most well adapted to the environmental conditions within which they are grown, with the least human intervention possible. Timing of assessment/selection was the time frame or schedule that the farmer followed to make their selections. Timing categories were determined a posteriori from interview feedback. The seasonal time frames used for selections were found to be heading, post-heading, at harvest, regular weekly visits, following storm events, or whenever the farmer had time available to visit the plots.

3.7 Methodology Constraints

Unfortunately, due to the COVID-19 pandemic, data collection and data analysis for this project was not as participatory or community engaged as originally planned (as mentioned in Section 3.3). When I formalized a plan for my thesis project in winter 2020, I hoped to supplement my interviews with farm stays at participants' farms and help in farm activities for 1-2 days before the interviews. However, since I was unable to travel interprovincially or visit farms for the

summer of 2020, due to travel and research restrictions during this time, this was no longer possible. Furthermore, the change to remote research interviews added additional challenges through the difficulty in reaching farmers to coordinate schedules. This was particularly difficult for those farmers who had irregular internet access. Additionally, there were some language constraints for the interviews in Quebec, given that French is a second language of mine and self-taught. For one of the Quebec interviews, there was interpretive assistance from the Quebec Regional Coordinator of BFICSS.

3.8 Conclusion

This section provided details of the underlying research methodology, theoretical basis for that methodology, research methods used, considerations for ethics, and discussion of constraints. The research methodology of PAR was explained in detail. Focus on how community collaboration through PAR differs in the context of doing research through the medium of an NGO community partner. The next section will present the results from the study. Results are presented in accordance with the PAR methodology, including both qualitative and quantitative data to explore the perspectives that farmers have towards their PPB practices.

4.0 Results

The information presented in this chapter details the responses provided by 9 wheat farmers, 7 wheat and oat farmers, and 3 oat farmers from across the country during the interview process. More details about the specific regions, farm structure, and production practices of each farmer are included in Appendix B. The coding process used to determine dominant themes in farmers'

responses to interview questions was based in the analytical concepts of political ecology provided in Chapter 2.

To understand what participatory seed breeding means to the organic farmers in this study, imposing key ideas or themes onto the data from the onset using deductive coding alone would have limited the scope of this chapter's analysis. Instead, I wanted to allow for most of the data found in the dialogue to speak for itself, so that insights on possible perceived benefits, challenges, and deeper layers of meaning could emerge from the participants' own words. Inductive codes used in this study included topics such as collaboration, knowledge integration, time constraints, land races and heritage seeds, additional infrastructure need in the program, the current condition of public research, and the effects of the COVID 19 pandemic. I did, however, apply more detailed questions to help guide this process and to ensure the key areas of interest to the political ecology framework were addressed. This was accomplished through deductive coding to address key areas such as variety registration and pedigree certifications, breeding goals, motivations for participation, work systems and operational efficiencies, risk tolerance, and power dynamics of the seed industry. These key areas were also identified in collaboration with the directors and regional coordinators at SeedChange. As a result, this chapter presents an analysis of the perceived benefits, challenges, and deeper layers of significance that emerged from these more general inquiries.

As discussed in the previous chapter, my own positionality affected, to a degree, how these themes are analyzed, and thereafter discussed. The effects of positionality were managed through the application of *a posteriori* observation and identification of major themes that arose across conversations with farmers. This approach introduced themes into the data analysis that I had not

considered beforehand from my position as researcher but which I realized were important only through my conversations with farmers.

This chapter is organized in three parts, each focusing on data related to one of the three research questions guiding this study. First, what methods do farms deploy to select desired crop traits and why are these methods used? Second, what strengths and limitations do program participants face and how do these relate to either farm-scale systems or institutional structures in Canada? And finally, how do participating farmers perceive the function of PPB in the broader context of organic agriculture development?

4.1 Methods used to select desired crop traits: PPB in practice

Study participants were explicitly asked which crop traits they were selecting in their trials, the methods they used to select for desired traits, and how they chose the right time to make selections in the growing season. Results found are summarized in Tables 4a and 4b, with appendices included.

Results indicate that most farmers in this study use positive selection methods and make these selections at harvest time. The second most popular selection window was at post-heading (after the flowering head of the grain has emerged), which also coincided with those who made negative selections in their trials. Note that interviews from one Ontario farmer and one Quebec farmer did not address the specific question of selection methods used and this is expressed as a gap in the data of Table 4b Although only one farmer indicated selecting timings after rain events, this was worth noting because Regional Coordinators of BFICCS were specifically interested in this relationship of selection practices and weather phenomena. Tables 4a and b

provide a specific breakdown of selection practices by desired traits selected, including methods used, and timing.

The most common traits sought after in selection were height (straw length), straw strength, and grain size; followed by yield, disease resistance, and weed competition as traits of secondary importance. Crop height (longer straw length) was mainly selected through positive selection at harvest time once the crop had fully grown and set its grain. Straw strength involved a mix of positive and negative selection. This trait was mostly assessed through lodging in the crop, where positive selection was made by assessing lodging at harvest and negative selection by removing fallen plants as lodging occurred during the season. Grain size was selected mostly at or close to harvest, though two farmers used negative selection for this trait around heading. Yield was mostly assessed at harvest, though one farmer made visual assessments of potential yield pre-harvest using positive selection. Disease resistance showed the highest prevalence of negative selections, usually coinciding with crop development stages such as tillering, heading, or grain filling. These selections involved removing infected individuals from the trial when signs of disease occurred. Other farmers used a positive selection approach by noting signs of disease at harvest. One farmer marked healthy individuals at heading and post-heading stages for positive selection later during harvest. Weed competition was noted by a few farmers as a desired selection trait and was assessed at or close to harvest as it is influenced by straw height and total leaf area. The trait of processing quality (threshing) is noteworthy as it applied specifically to oats where the metric for determining good threshing quality was the absence of hulls on the oats.

Selection methods and timings

	Height, Vigor			Straw Strength			Grain Size			Yield		
Farmer ID	Selection	Method	Timing	Selection	Method	Timing	Selection	Method	Timing	Selection	Method	Timing
BCFarmer_A	yes	pos	hdg	-	-	-	yes	pos	harv	-	-	-
BCFarmer_B	-	-	-	yes	neg	pre-harv	yes	pos, neg	threshing	-	-	-
PRFarmer_A	yes	pos	harv	yes	pos	harv	yes	pos	harv	yes	pos	harv
PRFarmer_B	yes	pos	harv	yes	pos	harv	-	-	-	-	-	-
PRFarmer_C	yes	pos	harv	-	-	-	-	-	-	-	-	-
PRFarmer_D	yes	pos	-	-	-	-	-	-	-	-	-	-
PRFarmer_E	yes	pos	pre-harv	-	-	-	yes	pos	pre-harv	yes	pos	harv
PRFarmer_F	yes	pos	harv	-	-	-	yes	pos	harv	-	-	-
PRFarmer_G	-	-	-	-	-	-	yes	-	-	-	-	-
ONFarmer_A	yes	neg, pos	pst-hdg, harv	yes	neg, nat*	cont.	yes	neg, pos	pst-hdg, harv	-	-	-
ONFarmer_B	-	-	-	yes	pos	harv	-	-	-	yes	pos	harv
ONFarmer_C	x	x	x	x	x	x	x	x	x	x	x	x
ONFarmer_D	yes	pos	-	yes	pos	stm evt	-	-	-	-	-	-
ONFarmer_E	yes	pos	-	-	-	-	-	-	-	-	-	-
QCFarmer_A	yes	pos	-	-	-	-	yes	pos	pst-hdg, harv	-	-	-
QCFarmer_B	x	x	x	x	x	x	x	x	x	x	x	x
QCFarmer_C	-	-	-	yes	neg	hdg	yes	neg, pos	hdg, harv	yes	pos	harv
QCFarmer_D	-	-	-	-	-	-	-	-	-	yes	neg	-
MTFarmer_A	yes	pos	pre-harv	yes	pos	pre-harv	-	-	-	yes	pos	pre-harv

	Disease Resistance			Weed Competition			Early Establishment			Maturity			Processing (threshing)		
Farmer ID	Selection	Method	Timing	Selection	Method	Timing	Selection	Method	Timing	Selection	Method	Timing	Selection	Method	Timing
BCFarmer_A	yes	-	hdg	-	-	-	-	-	-	-	-	-	-	-	-
BCFarmer_B	-	-	-	yes	-	-	-	-	-	yes	-	-	-	-	-
PRFarmer_A	yes	pos	harv	yes	pos	harv	-	-	-	-	-	-	-	-	-
PRFarmer_B	yes	pos	harv	yes	pos	harv	-	-	-	-	-	-	-	-	-
PRFarmer_C	-	-	-	yes	-	-	yes	-	-	-	-	-	-	-	-
PRFarmer_D	yes	neg	hdg	-	-	-	-	-	-	-	-	-	-	-	-
PRFarmer_E	-	-	-	yes	pos	pre-harv	-	-	-	-	-	-	-	-	-
PRFarmer_F	yes	pos	harv	-	-	-	-	-	-	yes*	-	-	-	-	-
PRFarmer_G	yes	neg	-	yes	-	-	-	-	-	-	-	-	-	-	-
ONFarmer_A	-	-	-	-	-	-	-	-	-	yes	nat*	harv	-	-	-
ONFarmer_B	-	-	-	-	-	-	-	-	-	-	-	-	yes	pos	harv
ONFarmer_C	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ONFarmer_D	yes	pos	stm evt	-	-	-	-	-	-	yes*	pos	-	-	-	-
ONFarmer_E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
QCFarmer_A	yes	pos	pst-hdg	-	-	-	-	-	-	-	-	-	-	-	-
QCFarmer_B	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
QCFarmer_C	yes	neg	harv	-	-	-	-	-	-	-	-	-	-	-	-
QCFarmer_D	yes	neg	-	yes	neg	-	-	-	-	-	-	-	-	-	-
MTFarmer_A	yes	pos	hdg, pst-hdg	-	-	-	-	-	-	-	-	-	-	-	-

Tables 4a and b: Specific breakdown of selection practices and timing by participants by region. pos = positive selection, neg = negative selection, nat = "natural selection", harv = harvest time, pre-harv = pre-harvest, hdg = heading, pre-hdg = pre-heading, pst-hdg = post-heading, stm evt = after storm event, cont. = continuous assessment throughout season

This data leads me to suggest the following observations about the selection practices and preferences of organic farmers taking part in PPB. First, it is evident from the list of traits being selected by these farmers that there are various biological trade-offs and specific trait adaptations required for productive organic grain farming. These include trade-offs that allow crops in organic systems to better adapt to a more variable agro-environment and biologically mediated nutrient sources (e.g., weed competition, plant height, root networks for better nutrient uptake). These trade-offs through adaptation to organic agro-environments are critical for productivity given the omission of synthetic pesticides and fertilizers from the production system. Second, there are several critical times in the growth cycle of crops that selections are made from both an agronomic perspective and from a perspective of timing in the operation of the farm as a whole. Farmers working in PPB coordinate their selection practices with specific stages in the growth cycle of their crop critical to assessing productivity and agronomic performance. Third, and related to the second aspect, it can be difficult for farmers to find the time to complete proper, thorough selections in addition to the regular work that needs to be done on the farm. Time is particularly scarce when selection for specific traits must be made during rather narrow time windows in the growing cycle. All these aspects and more will be discussed in the following sections when presenting and analyzing the motivations of, and perspectives on, PPB held by organic farmers.

4.2 PPB strengths and limitations: From farm-scale systems to institutional structures in Canada

The analysis of results that deal with program strengths and limitations is organized by coded themes, with supporting quotes from study participants to help illustrate the themes from the data. Themes are further organized into categories of scale based on the scale of analysis most appropriate to understand the relevant political, economic, and environmental ecologies that the PPB program encounters.

4.2.1 Program strengths

During the interview process, study participants were asked several questions to address their perceptions of the strengths and benefits that coincide with PPB program participation. Strengths here are defined as a situation, occurrence, or state of being that provides benefit or incentive for the farmer to remain in the program. Categories for these perceived benefits were organized into scales of: Farm-level, Program-level, Industry-level. The categorization according to scale was done to better facilitate analysis of results in relation to political ecology considerations identified in Chapter Two. Categorization of scale helps to facilitate analysis by producing boundaries around the various dimensions of political and economic processes used in analysis, allowing delineation between different agents and stakeholders at each scale. The political and economic processes under analysis in this study will provide a unique lens to examine how the concepts of political ecology play out in PPB. These are summarized in Table 4c.

Further detail and insight into each category are provided below with interview quotations as examples:

Scale	Strengths	Limitations
Farm level	● Genetic Innovation and Seed System Resilience ● Stories and Branding for Seeds	● Scheduling Plot Assessments and Time Constraints ● Limited Utility of PPB Varieties Across Regions
Program level	● Collaboration Among Farmers, Networking and Knowledge Sharing ● Collaboration With Universities, Providing Technical Research Capacities	● Lack of Capacity for Lab-based Assessments ● Multiple, Changing Points of Contact ● Limited Access to Appropriate Machinery
Industry level	● Public Research for Public Benefit ● Farmer Empowerment to Make Decisions in Research	● Limitations to Growth Without PPB Varieties Registration ● Lack of Proper Governmental Support and Funding

Table 4c: BFICSS PPB program strengths and limitations according to scale.

Farm-level strengths

Genetic innovation and seed system resilience

The value of genetic improvement and how this contributes to resilient seed varieties is a common theme across interviews. Some farmers see this simply as creating genetically improved varieties for organic systems, while others see an additional benefit of supporting genetic heritage for varieties that have fallen out of favour in conventional seed systems. The notion of genetic heritage is mentioned most in Ontario, with a few mentions as well coming from the Prairies. The following quotes are illustrative of the 9 farmers that mentioned this theme:

> One thing that happened is a lot of organic farmers went back and started trying to grow really old varieties, heritage varieties that are no longer registered, and they're successfully marketing those.
>
> Having varieties that we developed ourselves that work really well on our land, that we can save from year to year, and improve from year to year as well would be a huge part of our resilience in the whole system.
>
> Why the hell are we breeding for specialization again when there's so much genetic material in the existing 5,000 named wheat varieties? Maybe we should be reintroducing those, restoring them, and bringing back that broad genetic resilience rather than specializing?

Clearly, these farmers recognize the strengths found through increasing the genetic resources available for organic adaptation. Concepts mentioned include “systems resilience”, “heritage preservation”, and “broad genetic adaptations and generalization”. These concepts were framed as running counter to the conventional agriculture system’s tendency to focus varietal development on continuously new and novel genetics that take a “specialized” genetic approach to overcoming agronomic challenges on the farm.

Stories and branding for seeds

Only a few participants mention the value of the 'story' created through a PPB developed variety. These 'seed stories' can be characterized as the "non-reductionist epistemology and deontology" of seeds, in other words, the socio-cultural understanding and values held about seeds that go beyond viewing them simply as packages of genes (Carolan, 2007). What is passed down to future generations through seed breeding and conservation is more than just the traits and genetics, it is also the history of the people who grew them, and the cultures nourished by the food that is grown from those crops. Seed stories relate to increased marketability for the grain in certain contexts, such as CSA baskets. This concept of building a story was applied more broadly to the participants' farms than to just the grain variety itself. Of the 2 farmers that mentioned this theme, the following quote was the most illustrative:

> And also at the same time, have that story attached to it, that connection with the land and with the people and with the broader community is really important to all of our customers, bar none... In terms of having this farm be part of that broader community, it's entirely feasible. And in fact, it's now part of what we consider our farm.

This farmer mentions seed stories to connect both with "the land" and "the broader community". This farmer even considers connection with the community to be an integral part of farm identity. This way, seed varieties developed on-farm create a three-way link between land, farm, and broader community.

Program-level strengths

Collaboration among farmers, networking, and knowledge sharing

Inclusion in a collaborative network of other farmers alongside researchers proved the most recurring theme of opportunity and benefit mentioned by participants. This network of mutual connection and communication facilitates knowledge sharing, as well as access to information

resources, sharing equipment, and seed stock. Often, organic farmers can feel isolated in their individual practices and lack information and resources to approach issues found on farm. Farmer isolation, and how the PPB program works to overcome this barrier, was discussed by most of the interviewees in the study. Of the 13 farmers that mentioned this theme, the following quotes proved the most illustrative.

> And then now, with this club that's been started up and we can all communicate on the webinar, and chat, and learn from each other. So, I think that's another positive outcome of the whole program, is the network that's building between us producers.
>
> It's what happens when you get a group of farmers together, and researchers...It's a great opportunity to share ideas and to share our experiences and, ultimately, we're sharing those selections with each other.
>
> When you're out in the field by yourself, it's kind of a daunting task just to be there and kind of start to question, if all this work is really worth it? [Farm Clubs and webinars] validated the work that you're putting into it, to see how much it did affect other people.

The farmers mentioning this theme of collaboration in conversation did so with gusto and enthusiasm, expressing noticeable potential for the outcomes of knowledge sharing and, ultimately, variety sharing and collaboration among the other farmers.

The program also facilitates a cooperative model for research that helps distribute the costs and lower the risks taken on by the farmers through the research process. Cooperation can add value to the varieties developed through the program from a marketing perspective (i.e., developed in direct collaboration with Canadian grain farmers). The following quotes help to illustrate the economic/financial incentive of collaboration. They also touch on how value added through collaboration transfers to potential marketability of the PPB materials.

> It holds out to me the hope of a greater appreciation for farming done differently, for organic farming, for cooperative farming, for cooperative marketing, for cooperative branding, in a way that we haven't seen for probably upwards of a generation now.

> Not only are we grateful for the research being done there, but also being able to phone somebody and say, 'We have a really bad weed problem,' which we do, 'what are the various options?' It's been a bit of an extension service.

> It's a huge hole. I've been so frustrated about this for years …[There] has to be somebody, a person, not a website, that you can phone up and has fingers in all kinds of different pies and knowledge about other people who have knowledge who you can phone up... how do you control [pests] organically, whether it's particular weeds in grain crops, where can I get seed, and all those sorts of things.

Farmers find the most benefit from the program comes from this farmer-to-farmer collaboration. PPB clearly helps facilitate a need for a readily accessible network for sharing information and resources, including both knowledge-based and physical resources.

<u>Collaboration with universities, providing technical research capacities</u>

The access to university facilities, researchers, and technical capabilities offered through the program allows farmers to try new approaches to farming and scale up the varieties of seed they are interested in growing or have crossed. Of the 11 farmers that mentioned this theme, the following quotes were the most illustrative:

> That's very important, we can't do that on our own. It's very difficult to do, most farmers don't have the ability to do it, or the time. And then to actually increase the multiplication of any particular variety that we think is our preferred…That's a really big advantage.

> [There was] no other point where I have had access to plant breeders who were willing to do [the] crosses that we wanted. So, just that potential was amazing.

Clearly, these farmers valued the expertise and capacity they could access through the program.

Related closely to university collaboration is access to leading edge agronomic advice that comes with close contact to university researchers. The advice and support received is not always limited to seeds or breeding, but also includes insights into organic agricultural practices in general. Many interviewees compare the program to an agricultural extension service – much

needed in Canada. Below, they attest to this access to university researchers and their knowledge at a broader level regarding organic agricultural science.

> ...anything, any opportunity to pose a problem to a researcher of any sort who has even half an hour to just scroll through some studies and see if there's something relevant is amazing.
>
> I think there's a real demand just for extension agronomy on organic farms, period. And then there's the whole demand for better genetics, and genetics that are selected and adapted for organic farms. So, I think having agronomist to understand that and are supportive of that is very, very important. And certainly, that's the kind of support that we get from the University of Manitoba and Martin Entz's program and his students and researchers who were working with him. So, it's the foundation of really improvement of what we do here.
>
> I felt that they had a wealth of information that we were missing here. Most of our agronomists and our extension workers here, are either employed by chemical companies or fertilizer companies, that are giving advice on a different production model.

These farmers remark about how the information gaps they have as individuals are filled by the knowledge of university researchers. This information is also tailored to the specific production models that these farmers are using and to their organic production practices.

Industry-level strengths

<u>Public research for public benefit</u>

The PPB program compensates, to a certain degree, for the gap in public research on Canadian grain. Participants appreciate the transparency of the process and information found through their contribution. Of the 7 farmers that mentioned this theme, the following quotes were the most illustrative:

> What I liked about the public funding for plant breeding was that there wasn't necessarily a plant breeders rate premium that had to get paid, because the collective... all of the society of Canada paid for that whole process, for the betterment of the overall good of Canada.

> This is another reason why I feel honored to be included. Because no information gets out of the Ottawa Experimental Farm. I could go there with a question, and they couldn't care less about my question. It's all for research for a few big companies. It's got nothing to do with helping farmers.

Participants feel that the research process of PPB addressed many more of their concerns as organic farmers than what would typically be addressed by research programs facilitated by government or industry. The other research led by government and industry are believed to prioritize seed company profits over the direct agronomic needs of organic farmers. The following quotes illustrate these farmers' frustration with the conventional system for research and extension that they believe does more to facilitate corporate and "Big Ag" interests over those of organic farmers, including their needs to better their business and production practices. These quotes not only touch upon how the PPB program fills gaps left by government or industry research, but also claim that this program could act as an example proving that farmers have the power to take part in, and conduct, research that meets their needs directly.

> Que je souhaite obtenir de ce programme là c'est de prouver à l'industrie et prouver aux gens, aux décideurs, qu'on est capables, en tant que producteurs, de faire de la sélection et de produire nos propres semences sans avoir à être dépendants de l'industrie.

> So much of it has been corporatized and just become more for corporate profit interest rather than the public interest.

These farmers have expressed a need for more publicly supported research that furthers the public interest. Some see PPB as a way of "proving to the industry…that farmers are capable of facilitating this research themselves".

<u>Farmer empowerment to make decisions in research</u>

The PPB program democratizes the scientific process in agriculture. Participants believe that including farmers directly in agricultural research of any kind is of crucial importance and,

through this process, feel empowered to bring forward their opinions and decisions in research. The following quotes illustrate the views of the 2 farmers that mentioned this theme.

> I think it's really important to include farmers in any kind of research, because the work that's done on an experimental farm, or of a university owned little plot, that's all wonderful, but things look different when you're out in a great big field using big machinery.
>
> Maybe the public plant breeders weren't making the same choices that farmers would, so I like this process of getting the farmers involved and we might get different results because of it.
>
> It wasn't like, 'Oh, I'm a plant breeder. And you guys are just farmers.' [Martin Entz] really genuinely believes and encourages farmers' participation because he believes that they have the most valuable input.

Farmers work in a separate context from the research plots, fields, and laboratories of larger-scale, privatized research programs. By opening the research process, and including the opinions and insights of farmers, their lived realities are brought into the context of the research.

4.2.2 Program limitations

Study participants were asked several questions in the interview process regarding their perspectives on challenges and barriers faced by the PPB program and how these might hinder growth and wider adoption of the program. Limitations here are defined as a situation, occurrence, or state of being that limits the potential of participants to fully achieve their program goals. Results were again organized by scale from farm-level, to program-level, to industry-level limitations:

Farm-level limitations

Scheduling plot assessments and time constraints

Time constraints and trade-off with other farm duties make it difficult or impossible for participants to make assessments at specific critical stages during the season. Time constraints are mentioned regarding assessing disease, maturity, and early emergence. These are typically traits that require negative selection. The additional time commitment on top of farm duties was also believed to be responsible for lower participation rates among farmers. Of the 5 farmers that mentioned this theme, the following quotes were illustrative:

> … our farm was fairly large... We'd find that we kind of neglected paying a whole lot of attention to the plots and focused more of both of our attention to harvesting and the positive selection process rather than the negative selection process.
>
> And so, it didn't necessarily get seeded at the exact right time, it didn't always necessarily get harvested at the exact right time.

Not only were negative selections of the PPB plots missed throughout the season but seeding time and harvest times were also carried out at neither the intended nor ideal time in the growing season. This ultimately impacts the desired outcomes from the program because the farmer would not be selecting the PPB variety under the exact conditions that the rest of their crop was grown. The focus of their work, understandably, is their main crop.

Limited utility of PPB varieties across regions

There is some concern that PPB varieties will be too genetically restricted to their region(s) of development. Varietal restrictions refer to both restricted agronomic performance as well as a restricted marketability of these varieties in the regions they perform best. This limitation is only mentioned in the Prairies and BC. Of the 3 farmers that mentioned this theme, the following quotes were analyzed between the respective regions of BC and the Prairies.

For the farmers in BC discussing this concern, there is an understanding that their growing conditions were much different from conditions in the Prairies where these variety lines originated. Furthermore, the relative insignificance of grain production and local markets in southern BC would focus program directives away from this growing region.

> The notion of trying to insert some of these selections and put a lot of time and effort into making them registered varieties on the prairies might make some sense, but is of no great interest to me on the west coast outside the main grain area.

Meanwhile, farmers in the Prairie regions appear more concerned with scaling up the model to suit export markets, as follows.

> I know there needs to be alternative systems where the control of seed is more democratic, but I still kind of think there needs to be a better way towards an industrial scale approach to cereal seed... I'm just still not sure if that individual farm approach makes sense on the push for cereals.

Additionally, within the region of Quebec, the varieties used in the PPB trials are found to underperform when compared to the typical varieties these farmers use in their production. Of the 2 farmers that mentioned this theme, the following quotes were the most illustrative:

> Ça n'a pas sorti côté rendement comme j'espérais...Je ne sais pas; c'était de la semence qui venait pas mal de l'ouest canadien, je pense. Peut-être que c'est moins bien adapté pour le climat que l'on a ici.

> Le rendement, par contre, est un peu faible par rapport à la variété que j'utilise actuellement sur ma ferme, donc il y a encore des améliorations à faire au niveau du rendement, du yield, qui est inférieur à ce que je peux trouver avec le Walton.

The concerns over regional limitations expressed by these farmers are based in both economic and environmental considerations. Restructuring the composition of this PPB program could be a strategy to addressing these concerns – to be discussed in Chapter 5.

Program-level limitations

Lack of capacity for lab-based assessments

At this stage in the program, there are limitations to assessing flavour and consumption qualities to help drive demand. This limitation is due to both a lack of technical resources available to the farmers for making assessments, and due to limitations on the amount of grain they can grow of one variety (i.e., not enough seed can be grown out to facilitate a proper tasting trial). Of the 4 farmers that mentioned this theme, the following quotes were the most illustrative:

> The quality aspect of it isn't something that I've looked into at this point. I don't even know exactly what that work would be to do.

> I did three or four years of selections. And during that selection process, we were looking for characteristics that were more agronomic, and now we got to look at the quality characteristics and to see whether it's suitable for the marketplace.

These quotes reveal that farmers view the program as successful at developing agronomically preferred varieties. However, farmers also identify additional steps to deliver a superior (or preferred) product to the customer. Capacities will need to expand to properly develop grains suitable for direct-to-consumer markets preferred by organic grain consumers.

> I had no way of really distinguishing the sweetness, so I didn't bother selecting for that. But that would've been good to know.

Participants are also limited to taking only visual assessments of their plants. Many wish to gain a better understanding of qualities like nutrient uptake and grain protein content in their selections.

> And then towards harvest, you get a better sort of understanding of which ones just look better visually. But that doesn't always tell though, it's really hard to see much differences. You can't really feel real difference very effectively, just looking at it, you have to measure it. So that's a little hard to do without following good science.

Farmers express concerns over the limited attention to consumer preference in the seed selection practices. As the program grows in scale and output, consumer preference and culinary quality will be critical traits to consider for PPB varieties to effectively enter the market. At present, there are many capacities in the breeding program that the farmer cannot facilitate regarding consumer preference without appropriate analytical equipment. To fill this gap in program capacities, access to lab-based analysis and/or appropriate analytical equipment will be necessary.

Multiple, changing points of contact

Though it was understood that roles often shift in programs such as this, several participants found it difficult from a communications and research continuity perspective that the program has seen many changing points of contact over the years. Of the 3 farmers that mentioned this theme, the following quote proved the most illustrative:

> … but just doing work with farmers, and knowing how important consistent relationships are – that I could see being a bit of a challenge. I'm thinking back to all of the different main points of contacts that I've had on the PPB over the six or seven years.

Clearly, farmers would prefer greater stability in key support staff and program liaisons.

Limited access to appropriate machinery

Participants identify a need for mid-sized, research appropriate seeding and combining equipment to scale up on-farm research capabilities. Farmers express concern about the size of their regular equipment and the risk of genetic contamination from their regular production. Of the 2 farmers that mentioned this theme, the following quotes proved the most illustrative:

> We were fortunate enough to find a small plot combine, and that's one of the reasons our trial work has gone through the roof. We actually grew more wheat last year than they have in the last 10 years put together. Five minutes on the plot combine is almost 14 hours of manual hand harvesting and threshing.
>
> When you need to multiply there is a problem of scale. Because the farmer usually has large equipment and in research centers, they have small equipment for smaller plots. And when you need to increase your variety... it is very difficult for the farmer to use his own equipment because it is way too big to be able to keep the purity of the variety. With a conventional combine you cannot clean that combine enough to make sure you have the purity for such a small quantity.

Clearly, access to scale-appropriate machinery capable of maintaining genetic integrity is important to these farmers. There are desires among many farmers to increase their on-farm research capacities, and access to the appropriate machine is vital to that process.

Industry-level limitations

<u>Limitations to growth without PPB varieties registration</u>

Without any kind of variety registration, the market price of PPB varieties may not justify the additional work needed for their ongoing development. Limitations are created by the regulatory structure, including the costs associated with variety registration. Farmers believe that some, if not most, of these costs will fall on them in either real financial costs or opportunity costs through the registration process. Barriers presented in the costs of varietal registrations for PPB varieties will need to be considered thoroughly by farmers and organizations that take part in this program. Of the 5 farmers that mentioned this theme, the following quotes proved the most illustrative:

> I would like to see that Canada recognizes participatory plant breeding as a viable and important agronomic solution for environmental change. But it's not even on the radar of most people ... We need to engage our farmers in participating in this. But we're not going to see that as long as there's so much control on seed stock.

> That doesn't really seem like that benefits the farmer in the end with the hoops to jump through and the cost in the end.

Clearly, in spite of the costs incurred and hoops to jump through, at least this one participant viewed PPB as an important adaptive strategy to climate change.

Lack of proper governmental support and funding

The noticeable lack of funding needed to properly scale up the program relates to how PPB can facilitate public research. For programs such as this to provide the proper degree of support for farmers, the scale of operation should match as closely as possible to comparable government or other publicly funded programs. Some participants identify the program's relatively small budget as a major limitation, resulting in lack of equipment, resource constraints, and staffing limitations. The lack of support from larger governmental and institutional structures was pointed out as a barrier to the program achieving greater outcomes for those participating. Of the 2 farmers that mentioned this theme, the following quotes proved the most illustrative:

> I'm a bit frustrated that the program has to exist, and that it does exist as a separate entity. Because it's no substitute for an adequate replacement for public research in my view. And I'm very frustrated at that. And I think they do an amazing job given that the funding that they do have that is provided. But it really should be a government-funded program. And that should be a part of the broad public interest research function that is in agriculture research.

> It needs to be valued as a national enterprise, and it needs to feed into that broader public policy research...the same could be said for wheat breeding generally. So much of it has been corporatized and just become more for corporate profit interest rather than the public interest.

Building off many of the earlier limitations discussed in this section, these farmers feel the lack of proper funding is directly linked to limited resources and scalability of the program. These farmers appear to think that there should be a greater buy-in and support by government

administrations, either through staffing or through adequate funding, which would help realize the full potential of this program.

4.3 PPB in the broader context of organic agriculture development

The third research question, concerned with the perception that farmers have towards PPB in the broader context of organic agriculture, was developed to explore the broader personal and socially embedded relationships that farmers have with PPB in practice.

4.3.1 Perceived values and meaning: Why do farmers engage in PPB?

Study participants express a wide range of initial motivations for taking part in the PPB program. Motivations here are defined as incentives to participate in the program – recognized ahead of having taken part in the actual program. Usually, farmers became motivated to participate in the program after learning about its objectives and structure. I developed research questions to explore this sub-topic in collaboration with BFICSS regional coordinators.

<u>Develop tools for organic farmers</u>

Organic farmers view the PPB program as a chance to develop new 'tools' to improve production capabilities, either at the individual farm scale or across the industry nationally. In fact, farmers use the expression "tools" to broadly denote the different strategies and on-farm resources available to improve their production practices. In the case of this study, the tools mentioned referred mostly to available seed varieties, environment-adapted crop traits, and crops

traits tailored to the specific production practices of organic farming. The following quotes are a few of the sentiments that participating farmers had for developing these new variety lines:

> I'd love for the program to progress where we're getting lines available commercially for organic growers.
>
> This program was breeding crops in the conditions that they're going to be grown at, so they would have a more representative yield, and disease [resistance], and potential all around. So, I felt that it was going to be better for the farmer, rather than for a report.

These farmers see direct utility in variety lines that are developed within the context they will be grown. This was a clear motivation right from the outset of their involvement in the program.

Create movement towards greater seed sovereignty

Participants view the PPB program as a decided movement away from sole reliance on larger companies to provide seed for grain farmers. By embracing PPB, farmers gained more control over distribution, use, and pricing of these seeds. This motivating theme often evokes a political tone. As these three participants noted:

> I think one of the most important things for farmers is genetics. So, variety development is very, very important for successful farmers of all types. So being able to be involved in that is significant.
>
> Les retombées que je souhaite obtenir de ce programme là c'est de prouver à l'industrie et prouver aux gens, aux décideurs, qu'on est capables, en tant que producteurs, de faire de la sélection et de produire nos propres semences sans avoir à être dépendants de l'industrie.
>
> There's a philosophical thing too in having control over our own seed, and the drive towards more and more proprietary ... plant breeders' rights is not something I've ever felt comfortable with, and [I] continue to have concerns about where the control of seed is going in Canada.

By participating in this program, these farmers hope to set a precedent that shows farmers don't need to rely solely on the major seed industry to supply their means of production. The farmers

are expressing their discontent with a seed system that places too much power and proprietary control over seeds with conventional seed companies and conventional plant breeders. In their view, this propriety control over seed comes at the expense of basic operating rights of organic farmers.

Empower farmers and create engagement in the R&D process

Through taking part in the program, participants feel respected – that program proponents value their opinions as farmers. These participants recognize the inherent empowerment and agency to guide their own farming practices by contributing to seed variety research and development. The farmers taking part in this study often have specific needs they are trying to satisfy for their customers, given that they produce on a relatively small scale, and strive to produce more specialized grain for organic, consumer-ready markets. These participants noted that:

> Because I deal with the consumer, something like taste is a factor. Whereas taste isn't even on the radar of a normal crop breeder.
>
> Part of the rationale behind the program is so that farmers have that economy and freedom and power, like empowering farmers, to take charge of that breeding process a little bit and do some of that work and see some of the benefits.
>
> I believe that the program is something that's valuable, including farmers in the research portion of breeding and also encouraging farmers and pushing them towards that work.

These farmers make heard their close connection to the consumers and markets that they are dealing with, and that their views and input is invaluable to the research process.

Support innovation needed in Canada

The PPB program offers innovation for organic farmers in Canada, an area of focus that has fallen out of favour in public research in recent decades. To many, the very act of contributing to a unique and innovative research program like this provides incentive to participate, regardless of individual gain through outcomes. This motivating theme often coincides with a general curiosity for the research process, or interest in scientific innovation in general. Farmers expressed some of this gratitude and scientific curiosity in the following quotes:

> I found it is quite an absolute honor to be included in the whole information and breeding process. I thought that was quite neat. Way beyond what the direct gain is.
>
> I'd say that initially one of our primary interests was to be supportive of the program, not so much what we could get out of it, but rather see if we could be a participant in a scheme that sounded pretty innovative and much needed in Canada. So, it really started out trying to be supportive.

These quotes highlight the notion of community and collective outcomes found through participatory research. Even if the participation of these farmers doesn't generate individual gains for them, they feel still that their contributions to growing this program are reward enough.

Foster collaboration and cooperation between farmers and researchers

Building on these sentiments of collective outcomes, farmers note the collaboration fostered between farmers and researchers across the country. The PPB program offers a collaborative network that spans nationally and regionally. The program allows farmers from across the country to connect and share knowledge on their farming practices and breeding strategies. Collaboration is sought by farmers to share genetics resources between farms and universities. Many participants are inclined to operating a farm business through collaboration and saw potential therein by taking part in the program. To this end, two participants explained:

> [The PPB program involves] the whole cooperative community of like-minded organic farmers across the country helping to build that I think is a real outcome. And it's one that's important to our farm. And just being part of that cooperative venture.
>
> [When] the collaborative program came along… I was kind of just looking for something that would be better suited for our farm.

These farmers express how the cooperative nature of this program represents a basic tenet of their approach to farming. The nature of organic farming and organic agricultural knowledge lends itself to a cooperative model.

4.3.2 Significance of PPB

In the last question of the interview process, farmers were asked, rather straightforwardly: "What does PPB mean to you, and what does it mean to you in terms of organic agriculture as a whole?" (see Appendix C). By posing this question, I sought to gain understanding around how farmers perceived their role in the PPB program, and the broader role played by the PPB program in organic agricultural development in Canada. In responding to this question, many farmers discuss the personal values and meaning they ascribe to the process of PPB in general (apart from the BFICSS program specifically). Participants provide a wide range of feedback. The topic of PPB outside of just the BFICSS program is discussed to gain a broader perspective on how the BFICSS program might differentiate from other PPB programs found globally, and where there could be areas of improvement. Responses to the question of meaning are grouped into several categories listed below with examples.

PPB reinforces a sense of empowerment and autonomy

A political notion of empowerment is noted across most responses to the question of meaning pertaining to PPB. The concept and practice of PPB evoked a sense of resistance to the hegemony of conventional agricultural practices, demonstrating to some the power farmers hold to create alternative systems

> ... the community aspect of PPB. One of my favorite things that I love about this program is that it's empowering farmers to do things to help themselves. We're being encouraged to select for lines that work in our region, we're being encouraged to participate in such an important aspect. Seed is so important and being able to participate in a program that allows us to strengthen the seed supply in organic agriculture is pretty special. That's a big part of what is motivating me to be a part of the program in the first place, is that whole aspect of empowering organic farmers to be able to make their own choices and make their own seed is really important.
>
> Fundamentally to me, I see it as a resistance. It's giving power back to the seed growers and the seed users, as opposed predominantly the patent owners.
>
> I think one of the things that this program is doing is reminding farmers that we do have a certain amount of power and that this work of saving seed and being aware of just some basics of plant breeding and making selections, that can empower farmers to do more of that and to be more independent.
>
> Pour ce qui est des pratiques modernes, ça prend de la dimension des développements durables. Puis pour la développer, ça rejoint l'autonomie de l'agriculteur versus l'industrie des semences. Puis ça aussi, ça conduit à l'autonomie financière de l'exploitation agricole.
>
> C'est une très belle évolution, qui j'espère va prendre de l'ampleur, qui va grandir, car c'est une alternative au modèle qui a été développé dans les dernières années, qui a fait que les agriculteurs ont perdu leur autonomie sur les semences.
>
> It means that the farmers can still have a major role in developing new varieties... companies are leading farmers to believe that it's a really complex thing, breeding seed, and that the farmers shouldn't really be involved, so participatory breeding has flipped that around...it's important [for farmers] to be involved… millions of dollars research budgets aren't necessarily getting any further ahead than what we could do as part of the program as well.

Strong, political sentiments are presented here, involving “resistance”, “autonomy”, and how the program is “reminding the farm that they have the power” to make the changes they wish to see in their seed systems. These farmers remark that this program is a reminder that developing seed varieties doesn’t need to be viewing a such a complex process that it should only be under the control of large companies.

PPB supports farmers’ role in food sovereignty

Some participants focus on the role of the farmer in greater social and community-based food systems when discussing the meaning of PPB. This went beyond just the process of PPB and its outcomes. The dialogue positions the process of PPB as a tool to help the farmer facilitate greater roles for society in food production and public health. A part of this role is described as the ability of farmers to retain and improve their own seed for the purposes they say are crucial for their communities and society. Farmers had this to say regarding these larger roles in food sovereignty:

> The PPB, to me, is literally empowering the farmer back to the land steward, to the environmental steward, the biodiversity steward. The old farmer...pre green revolution ... they did all those roles and had a vast amount of knowledge. I think now, there's a real displaced authority…
>
> PPB to me would be summed up in food sovereignty and food security...Food sovereignty and food security mean farmers' rights, which has always been and should always be, and it's part of the reason why I stepped into this, is when we take the right of the farmer to keep back his seed, we have given up the right and we have given up the ability of the farmer to produce food for their own nation.

These quotes highlight farmers as ambassadors for food security and thus their role in maintaining our food systems. Where, at the heart of the food system, lies the seed.

PPB offers democratic model of research

PPB is described as creating a more democratic and egalitarian process of crop development. Democratic and egalitarian aspects are identified in the cooperation central to the research process, the allowance of farmers' input, and the overall transparency of the information created through the research. Transparency in this program is articulated as access to the results of the research findings at every stage of the program. The value in participation was linked to respect for farmers' opinions, having those opinions heard, and having access to the information they need to improve their production. Of the farmers who defined PPB as research democracy, the following quotes best illustrated this:

> I think the perception in agriculture often is so that research goals, objectives aren't coming from the ground up, they're coming from other places and other motivations.
>
> [On the conventional approaches of government-led research…] No information gets out of the Ottawa Experimental Farm. I could go there with a question, and they couldn't care less about my question. It's all for research for a few big companies. It's got nothing to do with helping farmers.
>
> I think PPB means respect for the farmer… the idea of farmers working together with researchers and respecting both the researcher and the farmer. You're coming at it from different angles, as opposed to that conventional thing where you have this big company developing a seed, and then imposing it on the farmer, and it may or may not be appropriate.
>
> To me, PPB means opening up the breeding and the plant varieties system to a more democratic process, less controlled by a very small number of companies who own seeds, ... I really do think it's a lot of potential for opening that area of science up to a wider body of people, and then finding the people who have the passion for it...not just something that's locked away to a select few highly trained individuals.
>
> It's like citizen science.

It is clear from these quotations that these farmers feel their needs and interests are left out of conventional agricultural research. They conceive of PPB as offering a new "respect" for the voice and opinion of (organic) farmers. PPB adopts a bottom-up approach to research that

considers the knowledge of "citizens", not just the lab coat science of major agro-chemical companies.

PPB builds genetic resources and offers agronomic tools

Participants see PPB as a practical means to develop better crop genetics with specific adaptations to organic systems. From this perspective, PPB means a more effective method for crop variety development that better answers the needs of organic farmers. The participatory model allows for farmers to have assistance in the more technical "grunt work" of evaluating and growing larger quantities of experimental seed. There is also potential seen in evaluating PPB varieties across multiple sites, so that these varieties can have a greater utility for farmers across the country. The farmers who mentioned this as a pillar of PPB had this to say:

> The value of genetics on farms and plant breeding, how fundamental it is to its success. To be involved in that, to actually be part of that process and to do selections on our own farm that are going to potentially lead to varieties that are better or more adapted to our organic farm, that's a great opportunity. And to have the participatory breeding program means that we don't have to do the grunt work...evaluating them in different sites and collecting data, and evaluating them for us relative to our weather. That's very important, we can't do that on our own.
>
> We need to be able to produce grain crops with lower inputs, but higher yields. And breeding crops that would respond to those situations, in those climates regionally, I think are paramount to get a diversity of seed, rather than this current system of coming into a handful of less diverse varieties of seed that could be wiped out with one disease… Diversity is key, and I felt that that's what this program was allowing people to have their input, and have the diversity of how they wanted the crops to be grown out on their farms.

These farmers recognize the potential of this program to build the capacity for the work of developing novel genetic resources suited for organic agriculture.

4.5 Conclusion

This chapter presents the data attained through semi-structured interviews with the 19 farmers who took part in this study. I coded and grouped this data into themes that explore the methods these farmers use in their PPB selection, including both the strengths and limitations experienced in this PPB program, as well as further insights into future potential and values inherent to PPB in practice.

Chapter 5 discusses these results in the context of the existing research and literature of PPB. Specifically, the theoretical framework established in Chapter 2, along with the associated literature, will be used to analyze the findings of this study and the implications this holds for future developments of PPB in a Canadian context.

5.0 Discussion

This study aims to better understand why Canadian farmers choose to take part in PPB programs and the value they draw from participation. This is accomplished by exploring the context specific challenges and marginalizing forces that Canadian organic farmers face, considering both the biophysical conditions of their farms, as well as the market channels through which they do business. Additionally, it seeks to evaluate the methodology and perspectives of participants in the PPB program managed at the University of Manitoba and facilitated through the Bauta Family Initiative on Canadian Seed Security (BFICSS). This study asks whether PPB offers an alternative model of crop variety development that is better suited to addressing the specific challenges faced by organic farmers. It poses three research questions: (1) What methods do farmers deploy to select desired crop traits and why are these methods used?; (2) What strengths

and limitations do program participants face and how do these relate to either farm-scale systems or industry structures in Canada?; and, (3) How do participating farmers perceive the function of PPB in the broader context of organic agriculture development? A theoretical framework based in the political ecology of agriculture and seeds allows me to explore and present responses to these questions using participant's own words and reflections of the context of PPB in Canada.

Understood through a political ecology lens, the feedback provided by farmers suggests that the dominant agri-food system dispossesses them of resources, namely their meaningful involvement in seed systems, affecting many aspects of their organic farming practices. Dispossession creates inabilities to respond to the unique needs of their organic farming practices, as well as adapting appropriately to changing environmental and economic conditions. Ideas held by farmers about this dispossession of seed resources are expressed for the most part through their concerns with overly centralized control of seed development by large, industrially oriented companies.

Chapter 5 discusses the implications this study within the existing literation on PPB and political ecology. Section 5.1 interprets the methods farmers used to interpret crop traits, including motivators and constraints, as well as strengths and limitations of the BFICSS program. Section 5.2 outlines the implications the study results hold for PPB in a Canadian context. Specifically, this involves the adaptations to economic and environmental conditions that PPB crop varieties offer. Also included in section 5.2 is a discussion of how the process of PPB offers an alternative seed system for organic farmers and how this helps counter-act hegemonic industrial seed production. Section 5.3 outlines the limitations to this study and how this compromised the scope of results that could be gathered, before a conclusion to the Chapter is presented in section 5.4.

5.1 Interpretations

Methods of selection

The first research question of this study is concerned with what methods farmers deploy to select desired crop traits and why these methods are used. Investigating this research question is an important first step involved in exploring the values, perspectives, and priorities of the farmers practicing PPB. Asking this question sheds light on the lived realities of farmers and their engagement with political ecology at the agro-environment level of their farms.

Farmers have the knowledge of and desire to select traits they need to improve production, but not always the time to make these selections in the growing season. Trade-offs between PPB work and prioritized farm work create conflict for the farmers and prevent the full potential of this program from being realized. Though not necessarily part of this study, the agronomic performance for PPB materials could greatly be enhanced if the issue of time allocation for selections could be solved (i.e., by allowing better selection for disease resistance and early crop establishment).

Weather phenomena (namely excessive rainfall) were not a commonly mentioned factor influencing selection timing. However, that weather phenomena were not said to influence selection doesn't necessarily indicate that weather was not an important consideration for the farmers interviewed. When asked about whether selections were made regarding weather phenomena, many farmers indicated they simply could not make the time to get into the field when such phenomena occurred. However, straw strength was indicated as one of the most common crop traits selected, which would imply that most farmers value straw strength to resist lodging ("blow down") during weather events with strong winds.

Crop traits that would normally detract from productivity (such as crop height and straw strength) in a conventional agricultural system, are desired by farmers in the PPB trials to better adapt to the unique agro-environments of organic production. Adaptative traits are selected by farmers because of the understanding that these are better suited to organic systems. These traits include adaptations for a biologically mediated nutrient supply, cultivation techniques, and pest/disease pressures that would be dealt with through chemical pesticides in a conventional system. These adaptative traits would, in fact, increase productivity for organic systems despite the physiological trade-offs that are made at the biological level of the plant. PPB becomes an appropriate and context specific method to optimize productivity for organic agriculture given the benefits that come with localized adaptation.

Context specific traits and adaptations for the crop varieties produced through PPB are the cornerstone of most PPB programs, however, there are many more potential benefits that can be realized through these programs. This study uncovered how auxiliary benefits provided through program structure help to support organic farmers across Canada. The next section of this chapter discusses the diverse strengths and limitations of the BFICSS program and how these can be interpreted to better design the program to support the auxiliary benefits achieved through PPB.

Most of these findings are supported by the literature as being commonly desired trait adaptations for wheat and oats through PPB practices (Dawson et al., 2011; Entz et al., 2015). The findings indicate, however, that trait adaptations for disease resistance could be better supported through program restructuring to facilitate easier selections at specific timings. To expand on this, the literature on PPB mentions how these selections better adapt disease resistance for crop varieties (Colley et al. 2021), however, the findings of my study demonstrate

that these adaptations are not necessarily realized by Canadian farmers (because farmers cannot make the appropriate selections for disease at the correct timings). Though not necessarily an unexpected result in this study, the available literature does not accurately address the lived experience of farmers and how this influences their ability to make optimal selections. Optimal selections would better position PPB material as a preferable crop variety for organic systems, especially if disease adaptations can be optimized in systems that do not use chemical fungicides.

Strengths and limitations

The discussion regarding program strengths and limitations addresses directly the second guiding research question of this study. A closer analysis of strengths and limitations provides not only feedback on how the BFICSS program can operate most effectively, but also further insight, informed by political ecology theory, on how PPB addresses the marginalization of organic production practices.

Strengths

The merits of the BFICSS program stem mostly from the network of research and collaboration formed through participation. The networks of collaboration built through participation in the program contribute to an important resource in agricultural systems often overlooked: social capital. The notion of social capital in the literature comes from the study of how communities and social groups achieve greater outcomes through rich inter-personal relationships that exist through these groups, over what the achievements would be an individual effort (Rivera et al., 2019). Social capital in agriculture and rural development can be expressed in many forms, involving examples in the literature such as cross-sectoral management, co-operative enterprises, and collaborative strategies that can better provide services for rural landscapes (Rivera et al.,

2019). Through these examples, social capital can be used as an important analytical tool for local policy developments (Midgley, 2013). The concepts of social capital are not explicitly discussed in the literature dealing with PPB directly, however, as PPB programs interact with networks of rural development and public policy, social capital can be used as an appropriate analytical tool to discuss the social benefits associated with these participatory research networks.

These research networks also include resources beyond the social capital of farmer-to-farmer collaboration. By involving university researchers, and the associated research capacities of the universities themselves, the efforts of farmers participating in PPB are greatly increased. These efforts are characterized by increasing the capacity for farmers to explore new possibilities and approaches to their organic farming. Famers expressed this as having increased access to agronomic knowledge and support specific to organic practices, as well as the technical capacities to scale up the number of seeds they can plant and harvest each year.

Results imply that most participating farmers prioritize the need to better facilitate public research for public benefit. The dearth of public agricultural research in Canada, especially for organic crops such as grains, was often mentioned as a barrier for the growth of organic agriculture in Canada. The barrier of limited public research also led to the belief that this PPB program could fill many of the gaps this barrier creates. Concerning topics of organic seed system resilience and genetic innovation, every study participant mentioned this program benefit to some extent. The PPB program fosters genetic innovation specific to the needs of the farmers involved. This innovation helps build seed system resilience through the localized knowledge. Localized knowledge that is applied through input from the farmers helps keep seed innovation solutions most relevant to the context within which they are applied.

Limitations

Many study participants found the BFICSS program to be spread thinly across the entire country. The staffing and program resources were not able to entirely meet the needs of participating farmers. The lack of in-person, regular engagement with program facilitators might have hindered many participant outcomes, especially given overarching farm duties that are prioritized before trial selections. There is interest in having regional hubs for PPB and similar research across the country that could better facilitate geographically specific needs. Increasing localization of food systems has been shown to better integrate diversity and differences across regions (Hinrichs, 2003). Diversity in this context allows for a more enriching environment of agricultural practice that counteracts many hegemonic processes of the industrialized agricultural industry. A similar model that increases localization for participatory research programs could likewise better accommodate the regional differences for farmers and growing regions across Canada.

Farmers are limited in the amount of time they can commit to making selections in the growing season, given that their regular farming practices must take priority. Time constraints hinder the full potential of crop selections that are made in the program. Participating farmers called for more involvement of program staff whenever possible, without compromising too much the influence that the participants have over the final outcomes of their selections. This consideration for time constraints of the farmer and a greater need for support in making selections could be connected directly to recommendations for more regionally based program networks, to help facilitate access to staff and resources at closer proximity for farmers across the country.

The need for increased access to resources (examples: machinery, seed stock, testing necessary for consumption quality) is also limiting to program development. Having access to more of these technical resources will allow the program to scale up selections of PPB material at a field-scale level. A greater amount of material produced through PPB trials would allow selection testing for flavour and consumption quality, as well as providing a marketable amount of PPB grain.

In addition to the barriers presented by limited technical resources, the incentive to scale up selections to a larger, field-scale acreage is hindered further by a restrictive regulatory environment. The restrictive regulatory environment for PPB material creates a major barrier for the potential expansion of this program to accessing larger-scale supply chains, supply chains that could help better sustain program participation and enable fuller realization of the benefits that PPB brings to novel organic crop varieties. Without certifications and registrations for PPB varieties that allow for wider distribution, and at a fair price, the economic incentive to mass produce these materials is not there. The greatest potential benefit for these crop varieties would best be realized through a larger base of consumption in larger supply chains. This could help bring to light the economic and environmental benefits for farmers who wish to grow the PPB varieties at much greater acreages. As well this could demonstrate the benefits to the consumer through a preferred product. Without reform to seed policy this is unlikely to be realized because the current restrictive regulatory environment works to perpetuate the use of varieties that fit better in the production practice for conventional agriculture.

The existing literature mainly highlights how PPB generates better adapted (Dawson et al., 2011; Entz et al., 2015; Entz et al., 2018) and more favourable (perceived through consumer preference and agronomic quality) crop varieties. This research expands on the literature by

generating insight into how networks of knowledge exchange and research-farmer interactions found in this PPB program can create auxiliary benefits to participatory research networks beyond just the materials generated from the program activities. Limitations are also highlighted in the constraints that farmers face in both time commitments to PPB selections and through plot specific machinery. Existing literature often presents PPB within smaller, more isolated programs, where program management can be overseen more precisely. PPB in a Canadian context will need to adapt to the larger geographic area over which to distribute resources, as well as staffing limitations across such an area.

Organic farmers (and their marginalization) within the larger agricultural and seed systems

The third research question of this study asks farmers their perception of PPB and how this perception shapes the role this research has in organic agriculture. This question presents an opportunity to engage in a discussion on how organic farmers, their farms, and their farming practices can be understood within the larger agriculture industry and seed system. The findings in this study reinforce the position that organic agriculture faces a degree of marginalization in agricultural markets when pitted against conventional agriculture (Halberg et al., 2006).

Organic farmers facilitate a market need to supply an organic product to the consumer. Some organic farmers in this study saw themselves as bringing quality, healthy food to their customers. These farmers see themselves, in many ways, as being stewards of the land, and of our food systems. Organic farmers are also expected to comply to specific production rules, which in the case of Canadian organic production, must be done with fewer available resources: such as readily available seed varieties, regionally specific research, and extension agronomists. In this context, PPB acts as a method of resistance that bolsters the power and autonomy of these

farmers. Organic farmers also work within relatively isolated networks of practice. This is especially true for organic grain farmers who lie outside the more dominant grain producing Prairie regions.

Through a participatory research model, the place of organic farmers is extended to being directly involved in the research process. Following from the thesis of environmental conflict and exclusion put forward by Robbins (2012), the process of PPB re-established the *access to* and *power over* genetic innovation for seeds. In this program, farmers have direct involvement in research that governs the nature and direction of the seed selection, as well as sovereignty through liberal access to and use of the varieties bred through the participatory process. Considering the developments in IPR and corporate ownership over seeds that have taken place in the 20th century, PPB helps re-instate seeds as a common resource. This politicizing process re-embeds a farmer's right to seeds as a natural resource and a means of production. Marginalization still exists, however, given the limitations for PPB varieties presented by the lack of registrations and certifications these varieties can obtain. This will limit the sovereignty and embeddedness of farmers' rights in the current regulatory context.

The results of this study met certain expectations, though several findings provided new insights for participatory agricultural research that did not prove prevalent in the literature. Findings that focused on the function that the PPB program provides as a collaborative network and agronomic support system offer unique insights. These novel findings present new opportunities to investigate alternative program structures that could further support organic farmers. In the next section of this chapter, several implications for these findings will be discussed and recommendations made for how PPB program could be re-structured in Canada.

5.2 Implications for PPB programs in Canada

The findings in this study allow for improvement to the structure and methodologies of existing and new PPB programs and ultimately the benefit of all stakeholders involved. This has great potential leading to increased adoption of PPB by a broader range of organic farmers, particularly in Canada. Findings also identify several clearly articulated needs identified by Canadian organic farmers that can be advocated for at the policy and institutional level. Through investigating measures that can meet these needs, the capacities for PPB in Canada could open up and expand operations. Expansion would offer potential for increased adoption by a broader range of organic farmers. Examples of potential measures are discussed below.

5.2.1 Adaptation to environmental and economic conditions

The leading measure that PPB helps facilitate for organic farmers is the adaptation of crop varieties to local environmental (weather, soil type, weed pressure, insects, disease) and economic (supply chains, market access) conditions. This measure not only encompasses the initial directives of most PPB programs (as well as this study), but also encompasses the most tangible benefit from PPB programs. The adaptation of crop varieties to the local environmental and economic context of these farmers can facilitate a more democratic model of organic production for several reasons.

PPB helps to reverse the process of depoliticization discussed in Chapter 2 (see Carstensen & Schmidt, 2016), that occurs through hegemonic industrialized agricultural practices. There's opportunity as well for the BFICSS program to involve consumers and market stakeholders to contribute input on what varieties might work best at the consumer level, either

through flavour, marketability, or what market channel would be most effective. There are examples of PPB programs globally that have included consumers in the research design and selections for varieties that resulted in great success for the materials produced (Casals et al., 2019). Involvement of consumers and additional stakeholders could present the opportunity for auxiliary funding and even greater leverage for the PPB material by networking them into different market channels.

The findings in this study present opportunities to overcome the limited program capacities discussed in the previous section of this chapter. Issues of limited program capacity affect the abilities of this program to meet farmers' needs across the entire expanse of the country. Furthermore, there are agronomic limitations to the PPB varieties in certain regions in Canada, namely in Quebec and BC. There seems be isolated issues of regionality and genetic adaptation of the PPB varieties. The concerns of regional limitations expressed by these farmers are based in both economic foundations (as with BC through relatively small market access and limited supply chains) and environmental ones (as with Quebec through the poorer agronomic performance and adaptations for PPB varieties locally). Both these limitations might be addressed by restructuring the composition of this PPB program to offer committed regional research hubs.

It is important to keep in mind that PPB as a research model globally has dominantly taken place within smaller regions, just as the examples shown in countries like Honduras (FIPAH, 2012), Nepal (Gyawali et al., 2010), and the Netherlands (Almekinders et al., 2014). Examples of PPB programs that have operated across larger geographic areas, such as the USA, have been structured through the support of land grant universities that offer more full-time extension agents (Dawson et al., 2011; Brzozowksi, Holdsworth & Mazourek, 2016; Sheldon &

Tracy, 2016) Canada may not have the funding yet to accommodate the kind of support seen in the USA, but there still exists the potential for collaboration with a greater number of universities across the country. More dispersed university collaboration across the country could allow for more in-person collaborations between farmers and researchers.

A potential measure to address the economic regionality across Canada was offered in one of the interviews for this study. This participant suggested a cross-regional, co-operative model that involves selections in less intensive grain cultivation regions (e.g. Ontario, BC, Maritimes), followed by growing out much larger quantities of these selections in more grain-intensive Prairie regions, then marketing the grain back to regions where the initial selections were made (reference interview ONFarmer_A). A cross-regional, co-operative model to grow and sell grain might allow for greater amounts of grain to be grown in higher producing, expansive acreages, and then be sold to larger consumer bases closer to participating farmers, all while maintaining the degree of localization that distinguishes PPB. This model would of course need to consider regional adaptations for the PPB crops to ensure optimal yields between regions.

5.2.2 Creating alternative systems of seed production: A counter-hegemonic approach

The feedback provided by farmers provides implications for the study's foundations in political ecology. Feedback suggests that the dispossession of resources from these farmers, namely democratic involvement in seed systems, affects many aspects of their organic farming practices.

Organic producers encounter marginalizing forces both on and off the farm. Organic

production requires a system unto its own that allows for a more liberal exchange of seeds and genetics, one that reflects the diversity in growing conditions found on organic farms and offers a flexible means to produce seed varieties to this end. The dominant, hegemonic narrative that rationalizes regulation and control over agricultural (seed) resources serves the interest of those who benefit directly from commodification. Those who benefit most from commodification are the seed companies, distributors, and agro-chemical companies that establish patents for seed genetics.

The assumptions of these companies concerning degradation of genetic resources can be interpreted as inaccurate, where they believe their work is continually improving seed stocks and resilience of germplasm globally. In reality, the so-called improvements these companies create serve only a portion of the agricultural world: that portion which subscribes fully to a conventional production system – operating farms at very large acreages, and trading on global commodity markets. Furthermore, both global and national seed regulations perpetuate these commodified seed systems by standardizing their agricultural trade around these types of seeds. The combination of hegemonic order to seed production and strict regulations around seed use and procurement inherently gatekeeps what production methods benefit most from the seeds this dominant system produces. This creates a system that dispossesses many farmers from appropriate genetic resources and calls for an alternative system that appeals to the production practices of a broader group of farmers. The dispossession of genetic resources through seeds is manifest at various levels of the seed system. Using scale as a lens to organize the narrative for this discussion, results extend what the literature already puts forward regarding PPB and seed sovereignty (Kloppenburg, 1991; Kloppenberg, 2008; Fuchs & Glaab, 2011; Rossi et al., 2019). PPB presents the opportunity to counter-act some of these marginalizing forces that dispossess the farmer of their seed sovereignty.

Farm level

Local adaptations of the organic crop varieties that come out of the PPB program contribute towards organic systems resilience. Heuristics of organic farmers manifest in the social embeddedness of their knowledge and understanding of how organic agriculture functions in both their local and regional communities (Findlater et al., 2019). The social-embeddedness of political ecological systems is important when considered from the perspective of social-ecological systems. Specifically, it is important to consider how social-embeddedness facilitates system resilience and sustainability by facilitating cooperation and understanding at a local level. Sustainability in resource management is achieved mainly because those involved in collective, localized systems of knowledge and practice are less likely to engage in unfettered private actions that result in negative impacts, such as resource degradation (Pretty, 2003; Saint Ville et al., 2016).

Contemporary developments in seed sovereignty increasingly involve paradigm shifts regarding the struggle over seeds. These paradigm shifts from simple farm-based seed saving towards changes needed in farming practices (Peschard& Randeria, 2020). PPB is in a good position to function as one of these radical changes that needs to be adopted into more common practice to allow later stages of seed sovereignty to be realized. Some of the most beneficial changes for participating farmers involved in the BFICSS program were seen through the access to agronomic knowledge and support. In addition to the realities in seed sovereignty gained through seed saving and sovereign genetic innovation, participatory research networks such as the BFICSS can create collaborative networks that foster knowledge sharing and collaboration at the farm-level. The effective dissemination of such knowledge is key to ensuring continued

innovation in farming practices, especially for smallholders and marginalized farmers (Saint Ville et al., 2016).

Industry level

In-situ research practices, such as participatory research models, generate access to experience, values, and localized knowledge normally unavailable, or unapparent, to the researchers. Political ecologists have long upheld the importance of localized and 'situated' knowledge to overcome hegemonic biases in environmental management issues. The ideational power relations inherent in the crop breeding work of practices like PPB act as counter hegemonic strategies to conventional seed development. This paradigm shift is what Kloppenberg (2008) meant when stating that participatory breeding supports a diversity of thought and practice that respects the heritage of crop breeding work that has developed our modern crop varieties.

How situated knowledges helps overcome hegemonic biases illuminates the process of knowledge creation in agriculture as political. Various sites of knowledge making emerge from dominant institutions of political economy and governance, whereas hegemonic political order often relies on depoliticizing and de-legitimizing the production of knowledge that occur through "alternative", counter-hegemonic forms of practice. Although ideational inequalities exist and pose challenges to the equitable access of agri-food systems' governance, the growth and normalization of PPB suggests that actors at all levels may still have the means to activate and shape ideational power in the form of knowledge and cultural legitimacy in pursuit of their interests and farming practices (Fuchs & Glaab, 2011). Activating ideational power creates a democratic process for knowledge generation that legitimizes those farmers who have been marginalized by larger, hegemonic institutions.

Given the current variety registration system and plant breeding acts in Canada, there are major limitations to how far PPB varieties can currently be used. The discussion of variety registration system and seed regulatory systems itself is more complex than what can fit within the scope of this study. The limitations to PPB material presented by restrictive seed registration systems need mentioning, however, as the processes of social and economic re-structuring that start with PPB will be key to establishing greater seed sovereignty for organic farmers. Seed sovereignty will likely be realized through reform to seed system regulations. Continuing the questions and perspectives surrounding issues of dispossession present opportunity for PPB to re-envision and re-structure organic agriculture by growing support for ground-up management strategies in social and economic systems.

5.3 Limitations of the study

The generalizability of these results is limited by a relatively small, and in many ways restricted, sample size of participants. Those involved in this research had to be involved in the BFICSS program for wheat and oats and be involved for at least 3 years. Participant involvement could have been previously undertaken at the time of this study and did not need to be currently ongoing. This sample size, however limited in a general sense, was agreed upon by research partners at BFICSS and Carleton University as being fully representative of the group eligible for this study. The limited group of crops under investigation in this study represents another limiting factor to the generalizability of these findings. Although research methodologies of PPB are rather similar between different crops, the dynamics of seed systems between crops, especially between horticultural and field crops (such as the grain crops focused on in this study),

can create dynamics between farmers/seed producers and other industry actors. Differences between different PPB programs could also play a role in how transferable these findings will be to other programs and regions, apart from those involved in the BFICCS program specifically.

Methodological choices were constrained dominantly by mandates and restrictions imposed by the COVID-19 pandemic that was ongoing during the research phase of this study. These restrictions were imposed at the federal, provincial, and institutional levels. Foremost was the inability to consider farm stays as part of the research methodology. These farm stays were meant to help situate the researcher in the context of the research subject (both farm and farmer) to better represent the lived realities that the associated PPB work was undertaken. This aspect of the research methodology, though originally planned in early iterations of the research proposal, had to the forgone. Accordingly, research interviews had to be conducted over the phone (instead of in-person) and therefore lacked a visual and contextual observational element. Degrees of separation between the research subjects and the researcher also limited the researcher's ability to establish research relationships with study participants. These "degrees of separation" allude to the fact that initial contact between researcher and research participant was mediated by the BFICSS Regional Coordinators, as the coordinators had already established relationships and communication with these farmers. These constraints to the researcher-participant relationship are also discussed as being part of the specific form of PAR used in this study, detailed in Chapter 3. The desire to create deeper working relationships with study participants, either through work-stays or engaging conversations, was meant to create a degree of situatedness for myself, the researcher, in cultural, historical, and geographically lived experiences of the participants themselves (Overend, 2022).

It is beyond the scope of this research to further explore, and prescribe emendation to, the marginalizing forces that limit organic grain farmers from employing greater seed sovereignty, or to explore possible inroads to equitable seed breeding and registration policies. It is also beyond the scope of this research to altogether prescribe methods to restructure seed markets in ways that would better allow PPB varieties to enter Canadian markets, though insights might certainly be inferred.

5.4 Conclusion

These findings from this study are shown to present some new perspectives in the future developments for PPB in Canada. Many results proved in line with the hypothesis that PPB offers a novel approach for seed system management better suited to organic agriculture than the conventional system(s) currently in place. What is most unexpected from this study is how it is not so much the genetic innovation of the PPB materials themselves that offer the most potential for improving organic farming practices, but rather the collaborative networks that help disseminate agronomic knowledge and additional resource that support organic practices. It is these networks that help support organic farming practices that generate the greatest seed sovereignty for participating farmers. Chapter 6 summarizes and concludes this thesis, suggesting future directions for research that can follow and build on these results.

6.0 Conclusion and suggestions for future research

This project analyzed the ways in which PPB offers an alternative system for organic farmers to develop adapted seeds suited for their production practices through a research framework based in the political ecology of seeds and agriculture. It aimed to investigate the potential for PPB to offer seed system alternatives for organic agriculture, and to present an in-depth participatory work that explored and noted these practices, ideas, and narratives using BFICSS program participants. Additionally, it integrated concepts from political ecology and methodologies of participatory action research.

Most farmers participating in this project implicitly mentioned benefits from PPB – notably enhanced agronomic performance, engagement in collaborative research networks, and feelings of empowerment that came from involvement in a more democratic system for seed development. Participants also noted program limitations, including limited time availability to make the best selections for disease resistance and emergence, the lack of available equipment to make lab-based assessments (including consumption quality), and the lack of appropriate regulatory frameworks to permit the equitable distribution of PPB material. With respect to organic agriculture and the notion of seed system sovereignty, the dominant patterns expressed by participants in this study were empowerment, autonomy, collaboration, and democratic engagement in seed development.

<u>Future research</u>

It stands that further research could be made into policy reforms that would allow participatory plan breeders better access to large domestic and international markets. Access could be coupled with seed registration or classification systems that would bring PPB seed closer in price to

certified or pedigree seeds so that farmers would not have to make such a large financial trade-off to grow PPB varieties. I had initially hoped to investigate this area more thoroughly, however, as the research began it became clear that this topic comprised a whole research question unto itself. What market channels and potential supply chains could best distribute the PPB material is another important area of research to expand developments of the BFICSS. This work is already underway by researchers at the University of Manitoba and will no doubt bring forward findings that are complementary to this study.

It would be interesting to juxtapose this study with the other crop breeding programs that BFICSS facilitates for PPB in Canada, namely potatoes, carrots, and bell peppers. The latter two vegetable crops would be particularly interesting to explore to determine if any differences exist in farmers' perceptions of PPB between field crops and horticultural crops. Additionally, the notion of social capital and how organic farmers weigh its importance in building seed system sovereignty could be explored in greater depth with more questions articulated directly from the available literature.

Clearly, this research (and a growing body of literature) uncovers the dissatisfaction felt by organic farmers in Canada with the state of public research. There is a stark call for government to either re-instate public research programs or make the necessary reforms that allow alternative systems, such as participatory research networks, to exist for research and agricultural development. Such reforms to seed laws would be necessary steps to help fill this gap and provide research that is truly for the public good. Most importantly though, this research was intended as a starting point for future research that discusses how Canadian organic farmers approach the practice of PPB and how perceptions of seed sovereignty manifest within these practices. This theme was overwhelmingly present in what I heard from the farmers in this study

as well: reconciling political marginalization, climate change, and market access. The study and practice of PPB in Canada will continue to develop as all these factors will inevitably continue to change in the coming decades.

Appendix A. – Recruitment Letter

Greetings from SeedChange and the Bauta Initiative. Hoping things are going well for you!

Iain Storosko, a graduate student at Carleton University is conducting a review of our participatory breeding program to assess the methods you are using in your breeding practices, the outcomes from the program, and the value of this type of program in a Canadian context.

As there remains a need for farmers to participate and provide an account of their experience, we are hoping that you can offer some of your time to help us improve upon the program for others.

We will be conducting interviews with the program participants.

The student would get a hold of you directly, but we wanted to give you a heads up that they will be emailing to connect and wanted to know what phone numbers/emails would work best for you.

Please note that the student researcher has signed formal Confidentiality Agreements, so that beyond the student, the specific things you say and/or write will be shared only with Helen Jensen and Aabir Dey at SeedChange, Patricia Ballamingie and Peter Andrée at Carleton University, and no one else.

As you may know, there is growing interest internationally in participatory models for developing adapted crop varieties specific to the needs of farmers. We are hoping to share lessons learned from this evaluation to help build this breeding model across Canada and in the international context as well, in addition to improving support to the farmers who take part in this program in Canada currently. If we write up anything beyond the context of this internal

program review, we will aggregate and anonymize your replies, and take out specific identifying details. If we were ever to publish in a way that could potentially identify you, even indirectly, we would solicit consent at that time.

The student is aiming to do interviews in July. The student has also offered to work with you on the farm for 1 or 2 days to give back for your time and build context around the interview process. He has worked for many years on and around farms in a research context and has extensive farm safety training.

We strongly encourage you to give some of your time to share your experience, reflections, and suggestions. Please let me know what emails or phone numbers they can contact you at. If I don't hear from you, they will use the ones we currently have on file.

Thank you,

PS. If you have any questions, or wish to talk to me directly about something, please email me and we can set a time

Appendix B. – Study participants

Farmer ID	Region - Province	Crops (in Study)	Crops (additional)	Acreage
BCFarmer_A	BC	Wheat	various fresh vegetables, potatoes	4
BCFarmer_B	BC	Wheat	cattle, hens, forage/silage, hay, share cropping,	20 grain (94 total)
PRFarmer_A	PR	Wheat, Oat	lentils, flax, cattle	4500
PRFarmer_B	PR	Wheat	flax, hemp, alfalfa seed, peas, mustard	4500
PRFarmer_C	PR	Wheat	cattle, alfalfa, flax, rye	800 grain (2000 total)
PRFarmer_D	PR	Wheat	rye, oats, peas, flax, canola, soybeans, corn, sunflower	2400
PRFarmer_E	PR	Oat	wheat, cattle	130 grain (480 total)
PRFarmer_F	PR	Oat	hay, sunflower	145
PRFarmer_G	PR	Wheat	custom grazing, grain, oilseed, pulses	800
ONFarmer_A	ON	Wheat, Oat	potato, soybean, dry beans, chickens	90
ONFarmer_B	ON	Oats	wheat, barley, buckwheat, triticale, soft wheat, spelt	60
ONFarmer_C	ON	Wheat	NA	
ONFarmer_D	ON	Wheat, Oat	barley, white corn, red corn, dry beans	250
ONFarmer_E	ON	Oat	garlic	34
QCFarmer_A	QC	Wheat	maize, soybean, buckwheat, rye	
QCFarmer_B	QC	Wheat. Oat	NA	na
QCFarmer_C	QC	Wheat	sunflower, soybean	1500
QCFarmer_D	QC	Oat	wheat, maize, soy	240
MTFarmer_A	MT	Wheat, Oat	clover, soybeans, barley, field peas	500

Appendix C. – Research Instrument: Semi-Structured Interview Guide

Project Title: Evaluating Participatory Plant Breeding in a Canadian Context: Bringing Better Grains to Canadian Farmers (Project #112812)

Research question: How do participatory breeding programs benefit farmers in Canada through improved farming practices and/or farm business management?

Research Sub-questions:

- What methods are being used by farmers to select for desired crop traits and why?
- What selection methods prove the most effective and under what conditions?
- How the development of these crop traits contributes towards more beneficial land-use practices and management on organic farms?
- How farmers perceive the function of PPB in the broader context of organic agriculture development?
- How can PPB act as an adaptive strategy against harmful impacts posed by changing economic and environmental conditions in agricultural systems?

Interview Questions:

1) Can you describe the story of your farm, your principal crops and crop rotations? What other crops or farm products do you work with?
2) Can you tell me the history of your involvement with the U of Manitoba program? How did you first become aware of it?

3) How would you characterize the nature of your involvement? What motivated you to become involved?
4) What outcomes are you most interested in getting from the program? Why?
5) What were your thoughts about the collaboration with U of Manitoba and the program outcomes in the end? Did you get the outcome(s) you were looking for? What changes would you suggest that might have improved your outcomes?
6) What informs your decisions for the traits you are selecting? What methods are you using to select for these traits?
7) How do you make the decision on the right time to visit your plot and make your selections? (i.e. What informs your choice in the timing(s) to make selections?)
8) How have weather conditions over the last three years affected your selections? How might you associate this, if at all, with concepts of climate change?
9) How do you find the relationship you have with the breeders/researchers? How might you like to see this change?
10) How do the PPB resources you have been provided (i.e. online training, calls, visits by Martin Entz, news bulletins) contribute to best operating this program on your farm?
11) What does PPB mean to you? What does it mean to you in terms of agricultural practice today?

Version française

1) Pouvez-vous me décrire l'histoire de la ferme, vos cultures principales et votre système de rotations? Quels sont les autres produits agricoles que vous produisez?
2) Pouvez-vous me décrire l'histoire de votre implication dans le programme Bauta? Comment est-il venu à votre attention?
3) Comment dériveriez-vous ou comment qualifieriez-vous la nature de votre implication au sein de programme Bauta? Quelle était votre motivation pour vous impliquer?
4) Quelles sont les retombées que vous souhaites le plus obtenir du programme? Pourquoi?
5) Que pensez-vous du partenariat avec l'Initiatif Bauta et des retombées finales du projet? Avez-vous atteint les résultats vous vous étiez donné? Est-ce que vous avez des propositions qui permettraient d'améliorer les retombées du programme?
6) Qu'est-ce qui informe/influence vos choix des traits que vous sélectez? Quelles méthodes utilisez-vous lorsque vous faites vos sélections?
7) Qu'est-ce qui influence votre choix en ce qui concerne le moment de la saison ou le timing lorsque vous faites votre sélection?
8) Comment est-ce que la météo au cours des trois dernières années ont influencé vos sélections? Est-ce que vous associez, du moins en partie, avec la notion des changements climatiques?
9) Comment avez-vous trouvé l'aspect logistique et opérationnel du programme et les rapports vous tenez avec les chercheurs? Comment pensez-vous que ces composantes du projet pourraient être améliorées?

10) Qu’est-ce que la Sélection Végétale Participative signifie pour vous? Selon vous, que signifie la SVP en ce qui concerne les pratiques agricoles modernes?

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