THE BAUTA FAMILY INITIATIVE ON CANADIAN SEED SECURITY

**"Today's agriculture is like a huge inverted pyramid…
it rests on a precariously narrow base."[1]**

Agricultural biodiversity and organic farming have been demonstrated to provide increased resilience to extreme weather events linked to climate change.[2] In addition to crop diversity, genetic diversity of varieties *within* an individual crop species enables that crop to adapt to conditions such as emerging diseases and a changing environment.[3] It is thus alarming that, of the 2500 plant species domesticated by humans, we rely on only about 100 species to meet over 90% of the world's food needs[4] and the past 100 years has seen a loss of up to 75% of the genetic diversity of food crops.[5] While locally adapted varieties are still maintained on small farms throughout the developing world[6], in industrialized regions like Europe and North America, the majority of the varieties developed and cultivated by farmers have disappeared in the past century.[7] This shift is a result of the introduction of modern cultivars and the move towards larger, more homogeneous and mechanized farm systems.

The modern cultivars that Canadian agriculture depends upon are high-yielding but also high-maintenance, genetically uniform and dependent upon agrochemical inputs. This leaves Canadian farmers, and our food supply, vulnerable to changing environmental conditions and with few viable alternative choices. Compounding this problem is an overwhelmingly top-down agricultural research system. Farmers are too often considered recipients of research rather than critical participants. There is a need to examine the plant genetic materials and production systems of Canadian growers, in particular as they relate to the novel challenges of climate change. Farmers need to influence, and when possible, direct this research.

Canadian consumers are demanding nutritious food, produced sustainably, as close to home as possible. Producers who want to provide these options find it extremely difficult to source high quality organic, Canadian seed. In fact, 95% of the crop varieties available to our organic farmers were developed for conventional systems with routine use of synthetic fertilizers and pesticides. The applied research program of *The Bauta Family Initiative on Canadian Seed Security* will respond to this challenge. Across the country, producers will work with scientists on farm landscapes to develop, test and collect data on grown-in-Canada seed varieties. Farmers will, in short, be key partners in research that is dynamic and mutually beneficial.

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1 R. Venooy 2003 *Seeds that give: PARTICIPATORY PLANT BREEDING* Ottawa: International Development Research Centre.
2 Letter DW, Seidel R, Liebhardt W. 2003. The performance of organic and conventional cropping systems in an extreme climate year. *American Journal of Alternative Agriculture* 18, 146–154.
3 Frankel H. 1974. Genetic conservation: our evolutionary responsibility. *Genetics* 78: 53–65.
4 Meyer RS, Duval AE, Jensen HR. 2012. Patterns and processes in crop domestication: an historical review and quantitative analysis of 203 global food crops. *New Phytologist* 196: 29–48.
5 FAO, 2004. What is Agrobiodiversity? From the manual, "Building on Gender, Agrobiodiversity and Local Knowledge".
6 Jarvis DI, Brown AHD, Cuong PH, Collado-Panduro L, Latournerie-Moreno L, Gyawali S, Tanto T, Sawadogo M, Mar I et al. 2008. A global perspective of the richness and evenness of traditional crop-variety diversity maintained by farming communities. *Proceedings of the National Academy of Sciences* 105: 5326–5331.
7 Zeven AC. 1996. Results of activities to maintain landraces and other material in some European countries *in Situ* before 1945 and what we may learn from them. *Genetic Resources and Crop Evolution* 43: 337–341.

Objectives of the Applied Research Program

- Build a Canadian seed supply base for staple crops
- Improve nutrition and flavour in target crops
- Advance knowledge on organic seed production, and improve the quality of ecological seed produced in Canada
- Develop and promote breeding methods that integrate farmer selection into Canada's agricultural system and regulatory framework
- Provide breeding programs specifically tailored for organic production
- Develop varieties that produce high quality seed without synthetic chemicals
- Develop commercially viable varieties that contain the genetic diversity needed for climate resilience

Participatory Plant Breeding

Participatory plant breeding (PPB) is an established methodology pioneered in developing countries, to help meet the needs of farmers cultivating land that differed significantly from the "ideal" conditions found on research stations where many varieties are developed. PPB differs from conventional breeding in that the entire process is built around dialogue and collaboration between farmers and breeders. Farmers help establish the goals of the program, and determine the plant material they will work with. Selection is then conducted on farms, by farmers, rather than at research stations. Research is showing that this process yields varieties with better performance than those resulting from conventional breeding, particularly under organic, heterogeneous, or high stress conditions.[8] In developing a national organic PPB program, we are helping to develop a new model of plant breeding for Canada.

One recent success with this approach is the work of USC Canada's Honduran partners, FIPAH. With selection criteria determined by farmer-researcher teams, this group has developed new varieties of maize able to withstand weather events in one of the most disaster-prone regions in the world. Their work has also contributed to a drop in the number of days per year people experience hunger in the communities where the program is active.[9]

Research Plan

The BFICSS is partnering pioneering researchers and farmers in a 4-year national PPB program. The University of Manitoba and USC Canada will lead the program, ensuring the work is grounded in a solid scientific framework, values the knowledge and needs of farmers, and is linked to the other facets of *the BFICSS*. The current year, 2013, marks the first growing season for the research program. This year, while farmers conduct trials of plant materials currently available, a consultation with growers, industry, and researchers is underway to determine needs for new materials to be developed and supplied to growers for the 2014 season.

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8 Ceccarelli S, Grando S, Bailey E, Amri A, El-Felah M, Nassif F, Rezgui S, Yahyaoui A. 2001. Farmer participation in barley breeding in Syria, Morocco and Tunisia. Euphytica 122: 521–536.

9 Classen L, Humphries S, Fitzsimons, J, Kaaria, S. 2008. Opening participatory spaces for the most marginal: learning from collective action in the Honduran hillsides. World Development 36(11): 2402-2420.

The selection criteria outlined below were determined by researchers with some additions from consultation with farmers, such as the emphasis on vigorous and competitive hulless oat varieties. Upon conclusion of the consultation process, the selection criteria will be expanded and refined on a regional basis. Researchers will then plan new crosses of plant materials, and farmers will select within these populations for performance in their local environment. In subsequent seasons, selection will continue, eventually resulting in new varieties. Over time, it may be possible to broaden the number of crops or varieties included in the program.

Target Crops

Crop	Challenges	Selection Criteria and Research Objectives
Potato	Lack of nutrition and flavour in modern varieties, vulnerability to fungal diseases, in particular in organic production	Late blight resistance, quality, taste, nutrient use efficiency, disease resistance, storability, drought stress
Maize	Input-intensive production requires large quantities of synthetic fertilizer and pesticides which have deleterious impacts on the ecosystem (including human health)	Open-pollinated varieties for human food adapted to an organic production systems Hybrid varieties (GMO free) adapted to organic production systems, free of GMO contamination, and with good performance in short growing seasons
Wheat	Decreased biodiversity, and increasing reports of allergic responses to the forms of the gluten protein commonly found in modern varieties	Good yield, seed protein, milling and baking qualities and disease resistance under organic conditions
Oats	Fungal diseases such as rust and poor competition against weeds (particularly in hulless varieties)	Disease resistance, end-use quality traits, competitive and disease-resistant hulless varieties
Carrots	Pollination by co-occurring populations of Queen Anne's Lace (a wild relative of carrot) results in sterile seeds.	Develop methods to produce carrot seed in high tunnels to reduce pollen contamination, optimize pollinator introduction and determine the optimal conditions for seed production in tunnels

Farm Partners, Industry Partners, Regions and Number of Farms

	Maize	Wheat	Oat	Potato	Carrot seed
Farm/industry partner	Coop. AgroBio du Québec member farms	U. of Manitoba Organic farm	U. of Manitoba Organic farm	Test farms- Fredericton, NB, Winkler, MB	BC seeds, Stellar Seeds, West Coast Seeds
Research partner	Dr. Lana Reid	Drs. Martin Entz, Stephen Fox	Dr. Jennifer Mitchell Fetch	Dr. Benoit Bizimungu	Drs. Rob Currie and Martin Entz
Regions	QC	AB, SK, MB[1]	AB, SK, MB[1]	NB, MB, QC, ON, BC	BC
# farms	TBD	12	12	5-7	4

[1] Regions will be expanded to Eastern Canada in 2014.

Anticipated Outcomes: 4-Year Program Term

- Increased skill and knowledge of farmer and researcher participants
- Improved cohesion between producer priorities and breeding program objectives
- Improved access to research results among producers (program participants and broader networks), facilitated by Regional Program Coordinators
- Research methods and results disseminated to the broader research community via peer-reviewed publications, technical manuals, and conference participation
- Funds secured to continue the work

Anticipated Outcomes: Long-Term

- Establishment of an organic participatory breeding program at a Canadian agricultural institution
- Release and widespread distribution of new varieties of high quality, biodiverse crop varieties adapted to Canadian growing conditions

Collaborations and Fundraising

In Quebec, our research collaborator (La Coopérative AgroBio du Québec) has leveraged support from our program to obtain matching funds from the provincial government for the corn work. Farm Folk City Folk, our regional host organization in British Columbia, has also leveraged our funding to obtain support from the Organic Sector Development Program. This indicates an openness of agricultural institutions to this innovative research, and an awareness of the need to breed for regional conditions. Our partnerships with Plant Gene Resources of Canada (the national gene bank), Organic Agriculture Centre of Canada, Canadian Organic Trade Association, and regional and national producers associations will ensure this work is sustained, and linked to broader movements for ecological agriculture in Canada.