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Resilient Trees: The Role of Genetic Diversity for Adapting Landscapes to Climate Change

A Long History of Tree Breeding and Evaluation

The Prairie Shelterbelt Program started in 1901. Since then, significant advances have been made in the selection and improvement of genetically superior tree and shrub species for planting on agricultural land in Western Canada. Over this time, tree improvement efforts have been led by Angus McKay (1888-1903), Norman Ross (1904-1941), John Walker (1942-1946), Bill Cram (1947-1974), Gordon Howe (1975-1980), William Schroeder (1981-2010) and Raju Soolanayakanahally (2011-present). It is the longest running tree research program targeting the Canadian Prairies.

The goal is to develop diverse genetic materials that are adaptable to current and future environmental and biological stresses to ensure long-term viability and function of agroforestry systems in a changing climate. Improvement strategies concentrate on developing genetically diverse seed strains that are well adapted to local ecosystems. Key traits identified for improvement include cold hardiness, drought tolerance and nutrient uptake efficiency.

Improvement efforts have included many woody species but focused primarily on the following tree (T) and shrub (S) genera: *Caragana* (S), *Fraxinus* (T), *Hippophae* (S), *Larix* (T), *Picea* (T), *Pinus* (T), *Populus* (T), *Prunus* (S), *Quercus* (T), *Salix* (T) and *Shepherdia* (S).

For over 100 years, the program has encompassed species introductions and testing; plant exploration; classical breeding and selection; *ex situ* conservation and genomics (Figure 1). The breeding efforts have changed the landscape and quality of life for thousands of prairie residents by protecting approximately 50,000 farmyards and one million hectares of farmland through the distribution of > 700 million trees and shrubs. That is enough seedlings to sequester over 218 mega tonnes of CO_2.

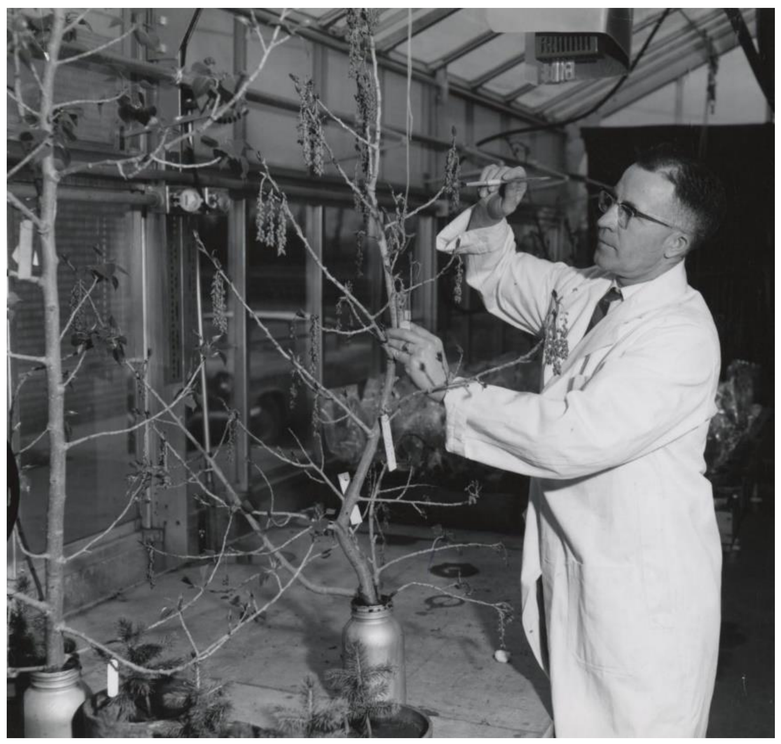

Figure 1. Tree breeding research has been conducted for over 100 years at Indian Head, Saskatchewan, Canada and has resulted in genetically superior trees and shrubs.

Figure 2. Tree and shrubs species currently planted in agroforestry systems are vulnerable to erratic and extreme weather events as well as to fluctuations in insect and disease pressure. Genetic diversity will be important for adapting agricultural landscapes to climate change.

Adaptability of Species Used in Agroforestry

Having woody plant material that is adapted to the future climate conditions of Canada will be critical to the success of agroforestry as a climate change tool. Tree species currently used and potentially available for use in Canada are vulnerable to erratic and extreme weather events and also to climate-induced fluctuations in insect and disease pressure (Figure 2). It is essential to understand the vulnerability of tree species under predicted climate change to determine reasonable options for adaptation of agroforestry plant materials.

Agriculture and Agri-Food Canada's Balsam Poplar (AgCanBaP) program is focussed on developing adaptable native balsam poplar (*Populus balsamifera* L.) for use in agroforestry plantings. Occurring across a wide range of North America, balsam poplar is both highly variable and capable of a broad range of adaptive physiological responses to a changing climate. With its natural range in Canada extending from coast to coast, balsam poplar is one of the most widely distributed poplar species in Canada. The AgCanBaP collection consists of material from throughout North America that provides germplasm for future climate change, breeding and genomic studies. This collection is being screened to identify fast-growing selections that have high carbon sequestration potential and biomass yields.

Contact information

Dr. Raju Soolanayakanahally and Tricia Ward
raju.soolanayakanahally@canada.ca tricia.ward@canada.ca

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