

The Canadian beekeeping industry has faced major challenges, with an average colony loss of 26% since 2007, reaching a peak of 46% in 2022. This has led to increased reliance on imported honeybees and queens, which pose risks such as the introduction of new diseases, treatment-resistant pathogens, and negative impact on queen reproductive quality. Additionally, imported honeybees, which are less adapted to Canada's cold climate, have lower winter survival rates, whereas locally bred honeybees, better suited to Canadian conditions, show higher survival rates. In response to these challenges, the CRSAD/UL honeybee genetic selection program has made significant progress over the past fifteen years in improving crucial traits such as hygienic behavior (+0.30% per year), honey production (+0.63kg per year), and spring development (+164 brood cells per year). Using the BLUP-animal methodology, breeding values for all colonies were estimated and selected for reproduction, leading to notable genetic improvements. The current goal of the program is to develop a methodology that makes these improved genetics available to the entire Canadian beekeeping industry. A pyramidal selection strategy was implemented at the Deschambault Animal Sciences Research Center, where pure lines are maintained in a selection core. From this core, 180 genetically improved queens are distributed to six participating breeders for multiplication. These breeders collect as much phenotypic data on honey production as the research center, using the colonies from the selection program that form the selection core. All this data is then used to estimate the reproductive values of the distributed queens, facilitating the selection of future breeding colonies. Our results have shown significant genetic potential in several queens entrusted to breeders. These queens with superior genetics will be disseminated to beekeepers across Canada through their multiplication by the breeders, who collectively produce 28,000 queens annually. The pyramidal selection strategy aims to enhance the sustainability and self-sufficiency of the Canadian beekeeping industry. This project also seeks to evaluate the effectiveness of this strategy, particularly in honey production, to support the industry's transition to greater autonomy.

Integrated Breeding Strategy for *Apis mellifera*: Towards Sustainable Beekeeping

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Apimondia 2025

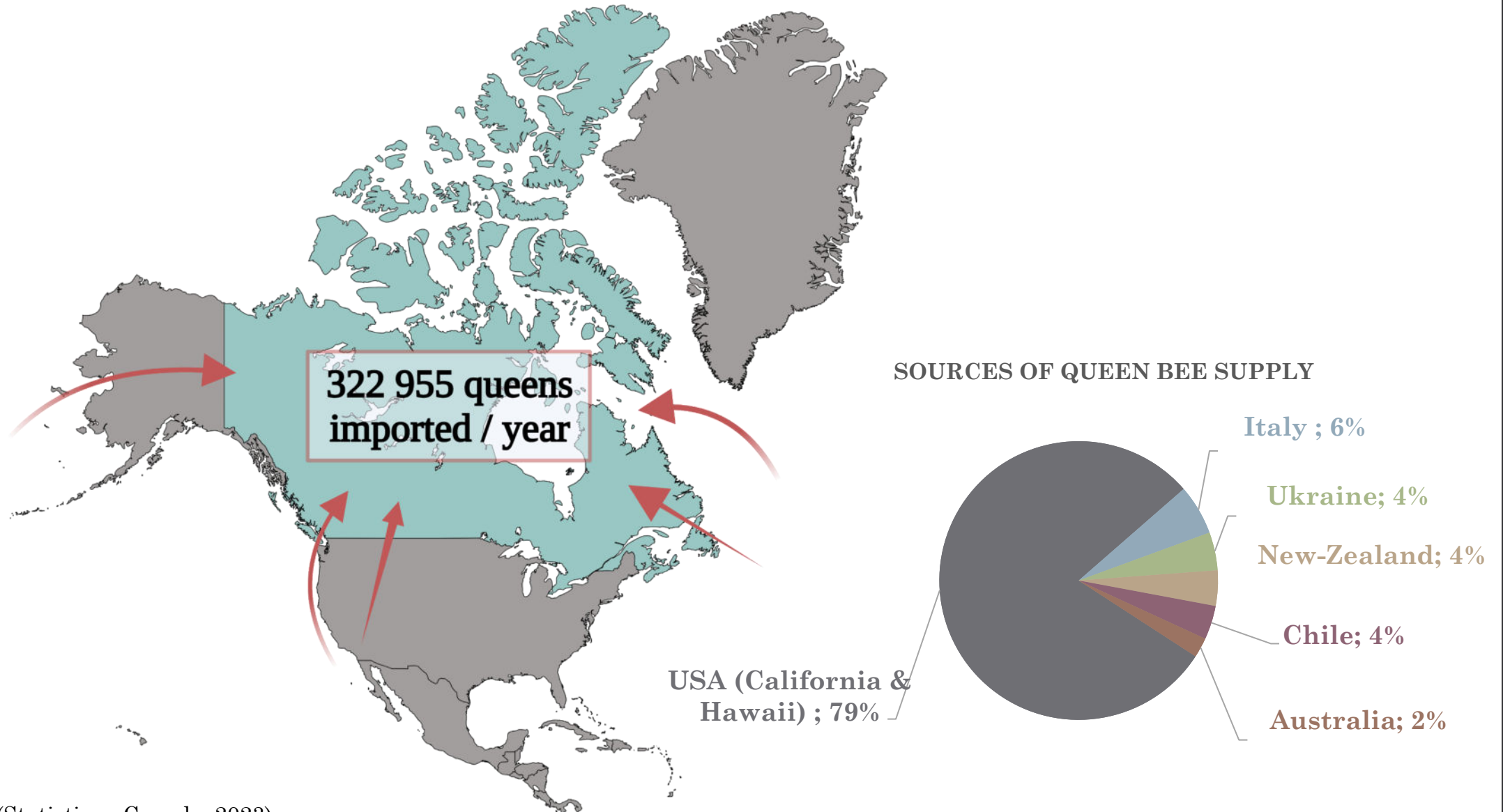
September 27th, 2025



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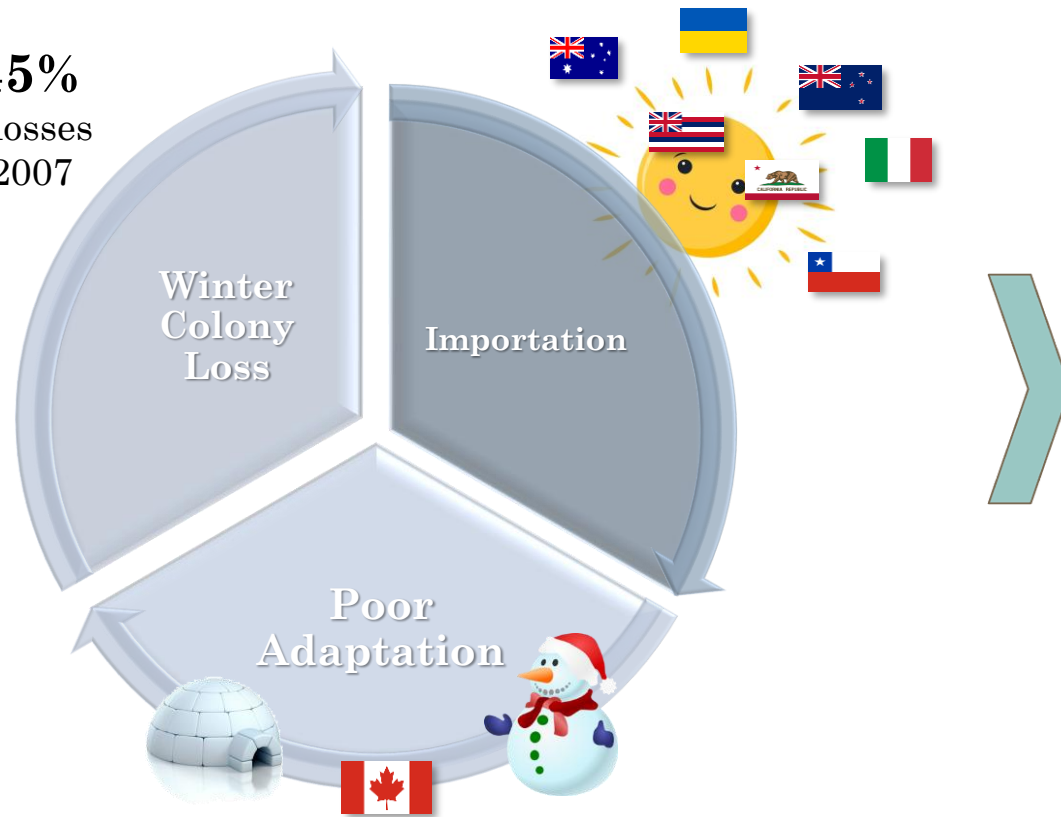
Importation of queen bees into Canada



(Statistique Canada, 2023)

Dependence on honey bee importation: a major issue

15–45%
colony losses
since 2007



Short-term solution

- **Health risks** (Tropilaelaps, *Aethina tumida*, viruses, ...)
- **Undesired genetics** (Africanized bees, non-adapted bees)
- **Queen fertility issues** (due to transport)
- **Risk of supply chain disruptions** (e.g., COVID-19 pandemic)

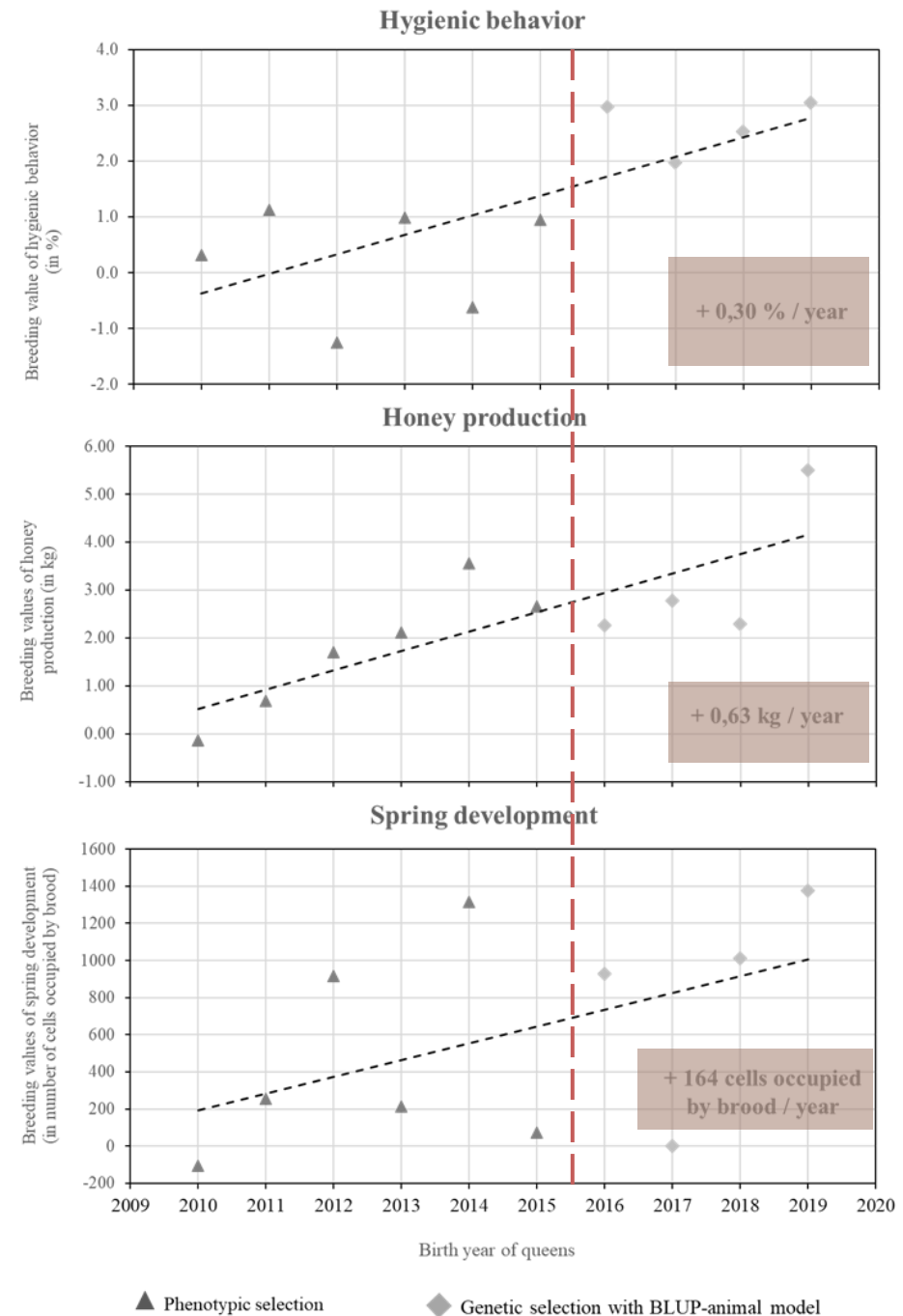
UL-CRSAD's Breeding Program: Resilient, Locally Adapted, and Productive Bees



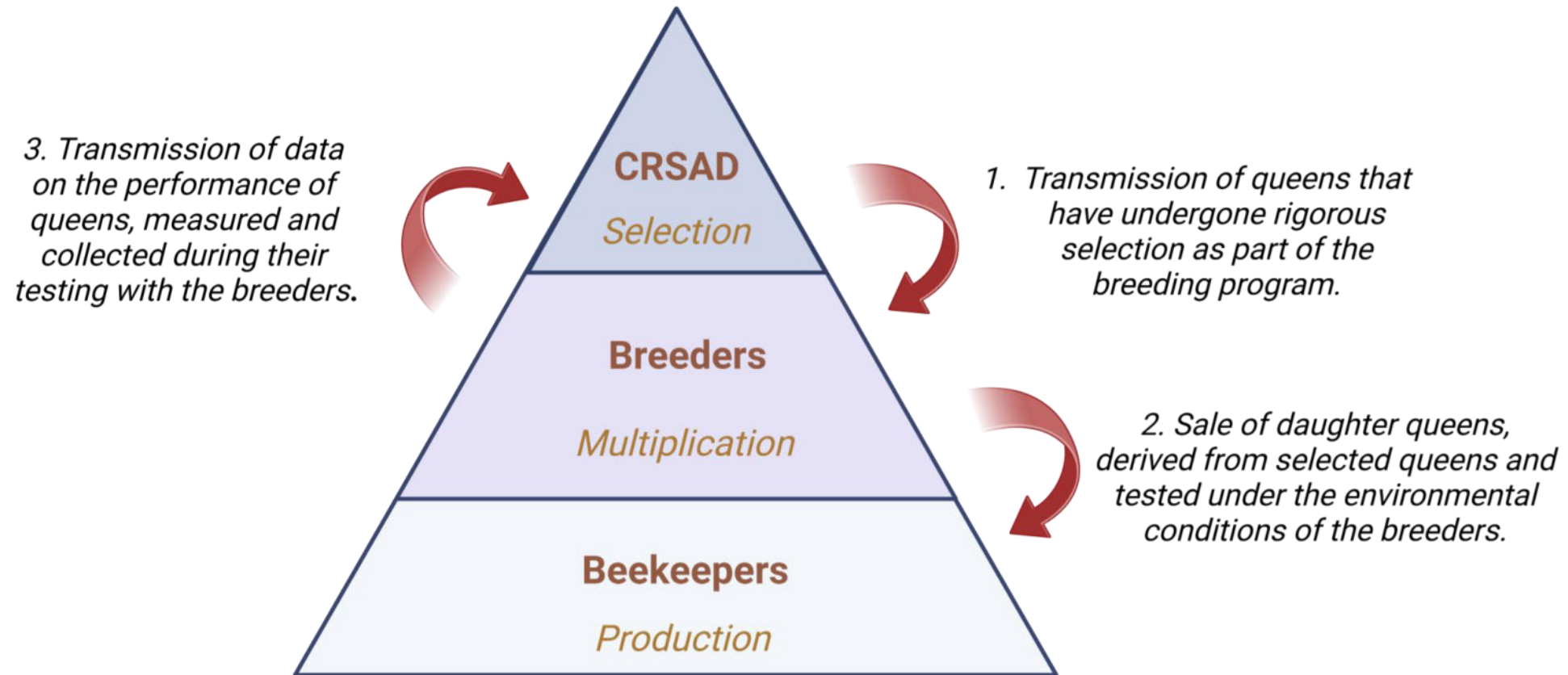
- Created in **2010**
- Includes between **150** and **180 colonies** under performance evaluation each year
- With 8 to 12 groups of sister queens
- Colonies are evaluated on about 10 different performance traits, including: **honey production, hygienic behavior & spring development**

Genetic gains achieved through the UL-CRSAD's breeding program

- **2010-2015:** Phenotype-Only Selection
- **2016-today:** Genetic Selection with BLUP-animal model
- **Selection Index weighted on 3 traits:**
 - 50% Hygienic Behavior
 - 30% Spring Development
 - 20% Honey Production

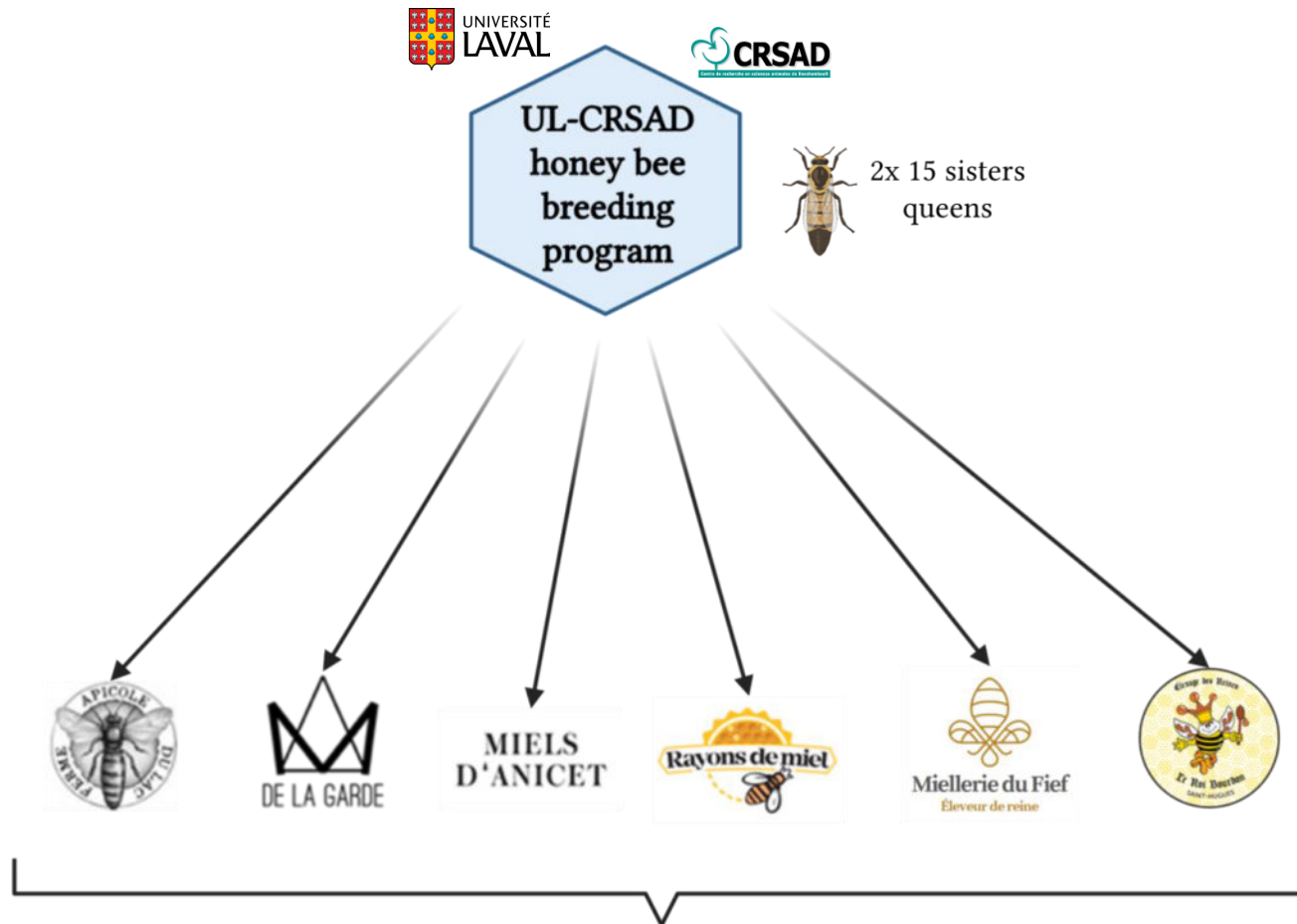


Strategy for disseminating improved genetics



A win-win-win system!!!

Organization around the queen breeders



Year n

Reception and Introduction of Queens
from the Breeding Program

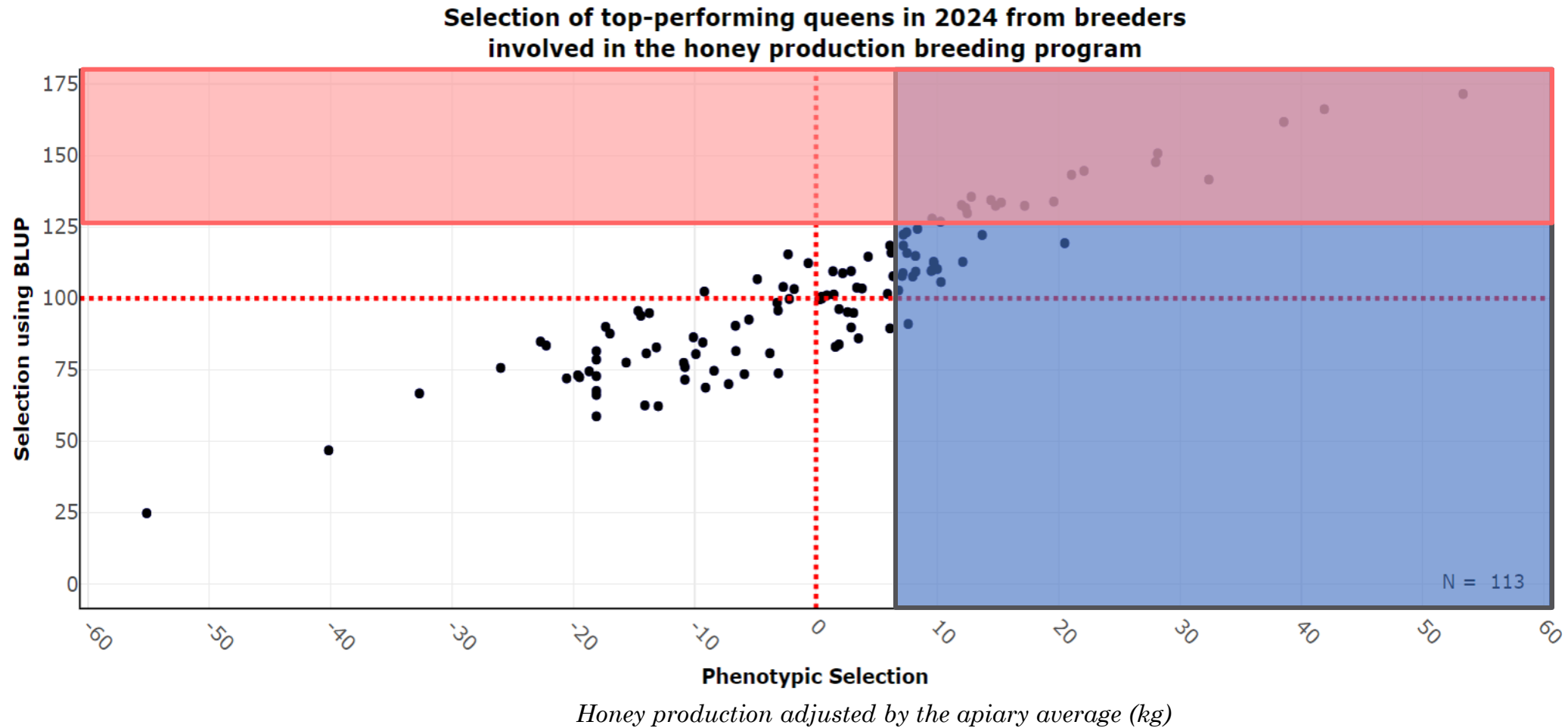
Year n + 1

Evaluation of honey production during a
beekeeping season

Year n + 2

Selection of breeders based on their
genetic value estimated

Breeding program results from UL-CRSAD and partner breeders



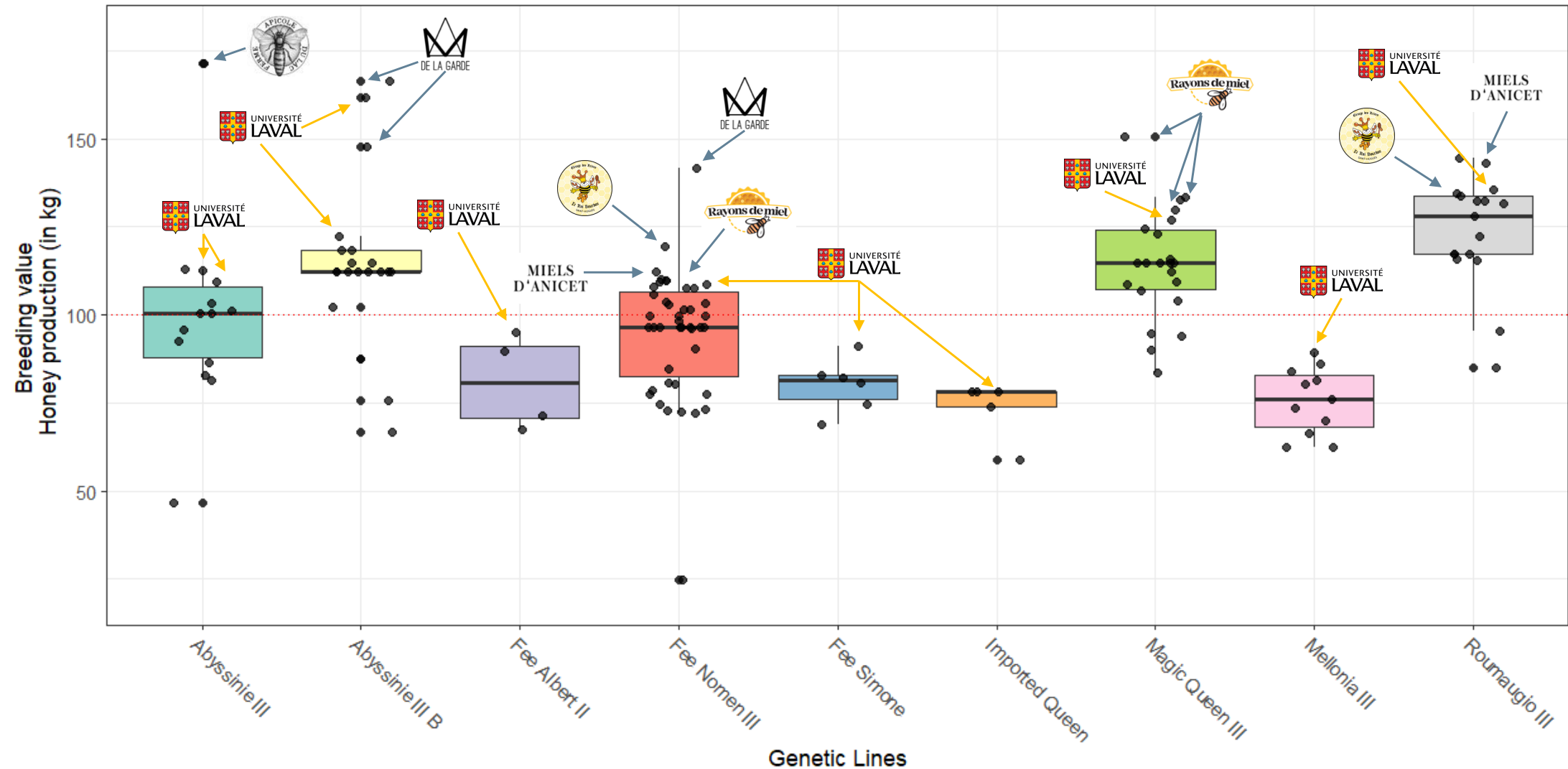
Phenotypic selection of queens



Selection of queens based on breeding value estimation using BLUP

Estimated Breeding Values for Honey Production – UL-CRSAD & partner breeders

– 2024 beekeeping season –



Conclusion



MIELS
D'ANICET



- In 2025, six queen breeders **distributed genetically improved queens** from the UL-CRSAD selection program, making them available to beekeepers across Canada.
- A total of **28,000 queens** were produced during the season.
- The selection program is ongoing, with the progressive integration of **genomic tools** aimed at improving selection efficiency.



For more information on the project:



ApiOmic
Breeding honey bees using genomics



<https://www.giovenazzolab.com/>



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Aknowledgements

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Thanks!