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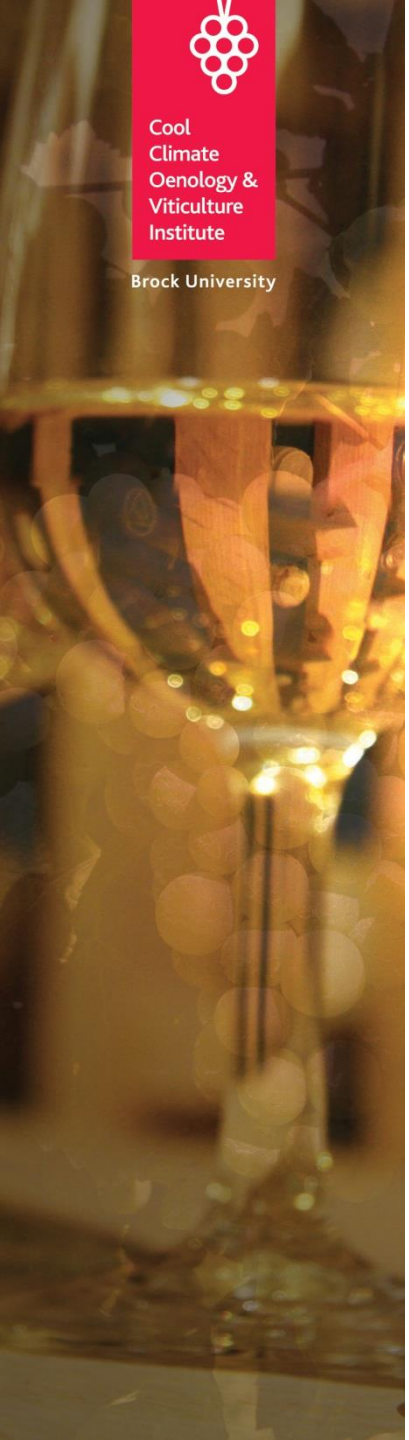

Climate Change Adaptation Requires Integrated, Transdisciplinary Research Across the Value Chain:

a Case Study of the Ontario Grapevine and Wine Research Network

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Scientific Director, Ontario Grapevine & Wine Research Network

Co-authors: Debbie Inglis, Annette Nassuth, Andy Reynolds, Tony Shaw, George van der Merwe

Background

- **The evidence for anthropogenic climate change extremely compelling**
  - ➢ reaches a level of scientific consensus that is almost unprecedented (IPCC,2014).

- Canada's mitigation record extraordinary ….

  E.g. 2014 CC Performance Index:

  - Bottom of G8 countries
  - 30th/30 OECD member countries
  - *" ….. Canada still shows no intention of moving forward with climate policy and therefore remains the worst performer of all industrialised countries"* (Burck et al., 2014)

Background

- The evidence for anthropogenic climate change extremely compelling
  - reaches a level of scientific consensus that is almost unprecedented (IPCC,2014).
- Socio-ecological impacts varied
  - Severity and frequency of extreme weather events likely biggest challenge for agriculture
- Agricultural industry in Canada extremely late to the party re: adaptation planning

Q1 What will CC mean for the Ontario grape and wine industries ?

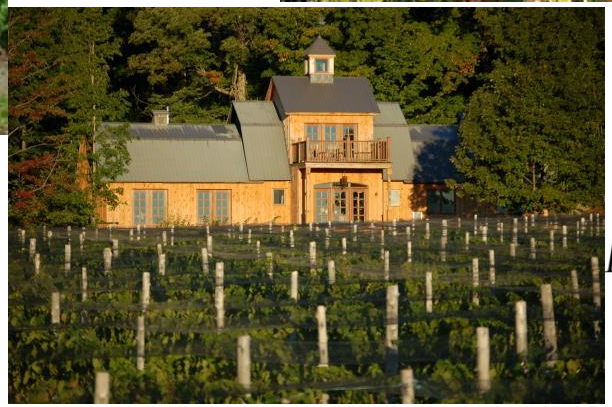
Q2 How best to adapt?

Wine in Canada

- Wine has been produced in Canada for over 200 years, current economic impact CAD $6.8 billion
- Supports 31,000 jobs in agriculture, manufacturing, tourism, transportation, research, restaurants, retail

Ontario

British Columbia



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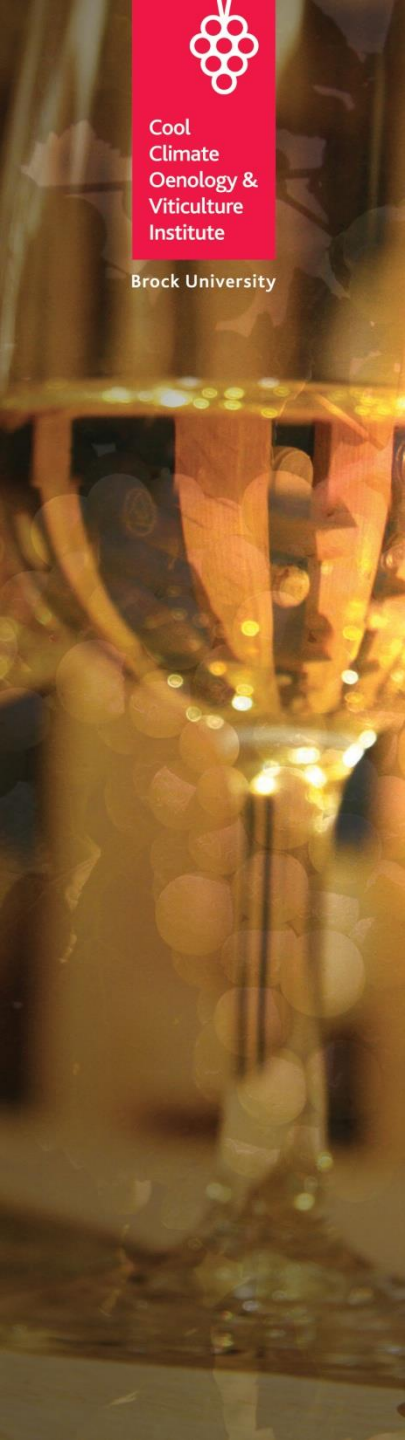
Quebec



Wine in Ontario

- Largest % of Canada's home-grown wine
- Vineyard acreage: Approximately 16,000 acres of wine grape vineyards
  - Another 4000+ acres grapes for juice
  - 3 major appellations; 10 sub-appellations (VQA-O)
- Key wines:

– Whites: Riesling, Chardonnay, Gewurztraminer, Sauvignon Blanc

– Reds: Cabernet Franc, Pinot Noir, Gamay Noir, Cabernet Sauvignon

– Icewine (1000 000L)

– 3 French hybrids, Baco Noir, Maréchal Foch and Vidal have also demonstrated versatility and appeal

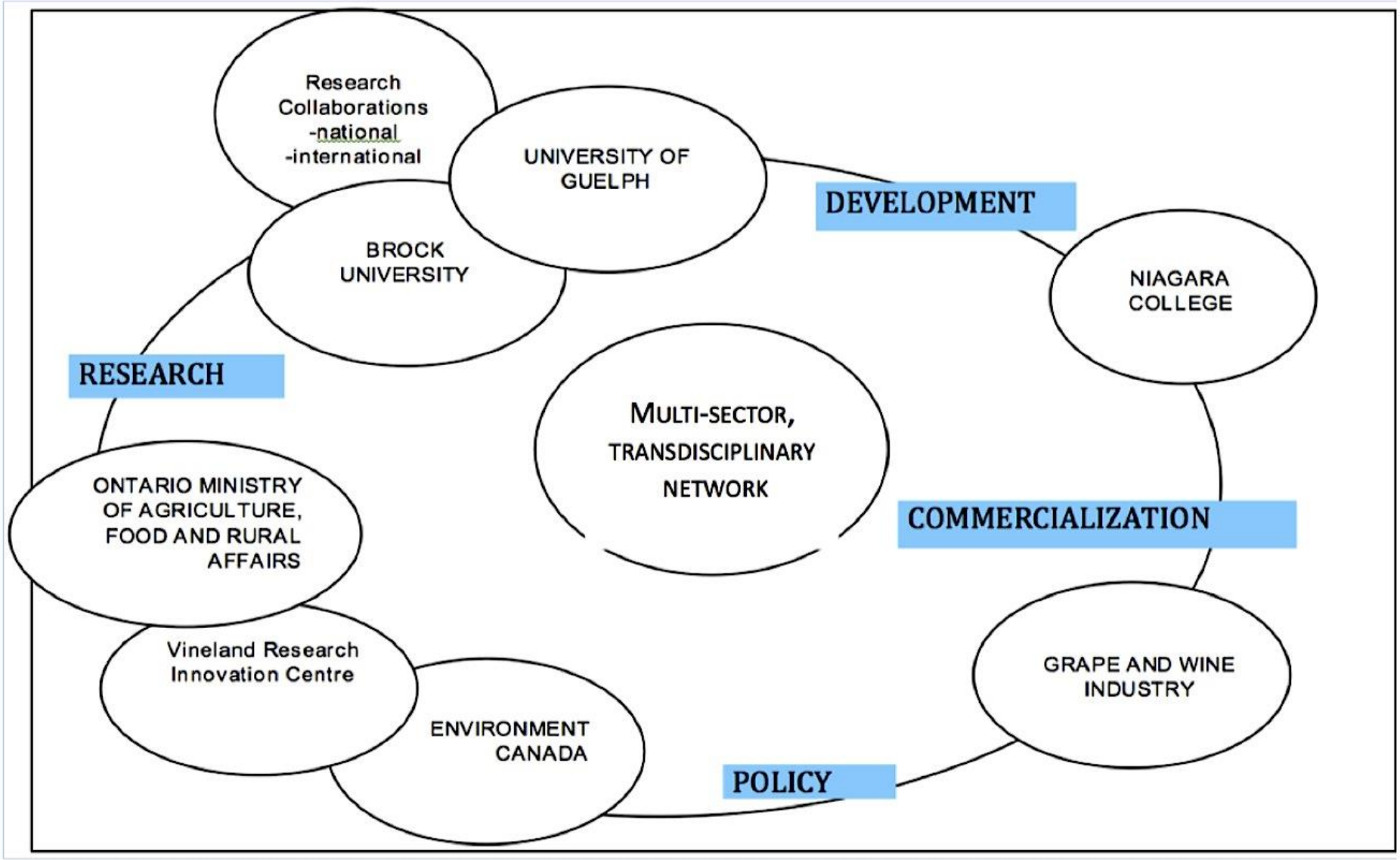
Climate change: not just warming trends

Volatility of weather conditions

- Extreme temperature highs during the growing season – fruit quality, vine survival
- Extreme cold events during the winter that threaten vine survival
- Lack of rain or excessive rain, both compromise vine health, fruit quality
- Warmer than normal winters, but with cold events mixed in threatens vine survival

- **Ontario experiencing all of these conditions over the past few seasons and within seasons**

Ontario Grapevine and Wine Research Network



Six science themes and research teams

Viticulture and Climate 1: *The impact of climate change on Ontario's wine regions*

Team Leader: Tony Shaw (Brock)
Other researchers: Adam Fenech (U of PEI), Brad May (Brock), Andy Reynolds (Brock)

Viticulture and Climate 2: *Optimizing grapevine winter hardiness – acclimation/de-acclimation of grapevines and resulting stresses affecting it*

Team Leader: Andy Reynolds (Brock)
Other researchers: Mike Duncan (Niagara College), Kevin Ker (Brock/KCMS), Jim Willwerth (Brock), Wendy McFadden-Smith (OMAFRA), Helen Fisher (UoG)

Viticulture and Climate 3: *Development of plants & markers to breed for winter hardiness*

Team Leader: Annette Nassuth (U o G)
Other researchers: Darryl Somers (VRIC), Helen Fisher, Jim Willwerth

Oenology and Climate 1: *Methoxypyrazine remediation*

Team Leader: Gary Pickering (Brock)
Other researchers: Debbie Inglis (Brock), Gavin Robertson (NC), Belinda Kemp (Brock), Paul Zelisko (Brock)

Oenology and Climate 2: *Sparkling wine*

Team Leader: George van der Merwe (U o G)
Other researchers: Gary Pickering, Belinda Kemp

Oenology and Climate 3: *Appassimento-style wines*

Team Leader: Debbie Inglis
Other researchers: Gary Pickering, Vince DeLuca (Brock), Michael Brownbridge (VRIC), Belinda Kemp, Gavin Robertson

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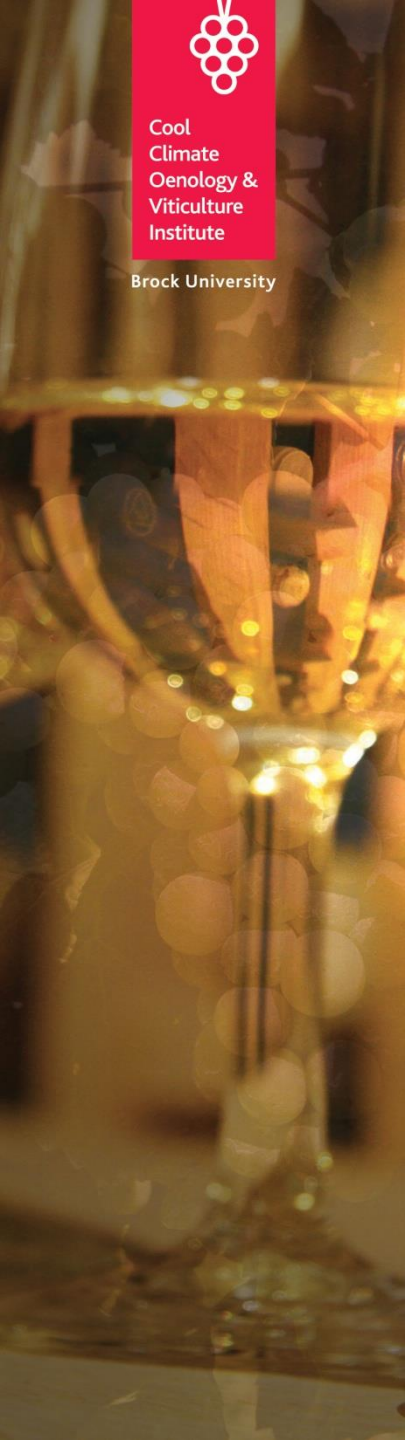


Sampling of approaches and outputs from the network

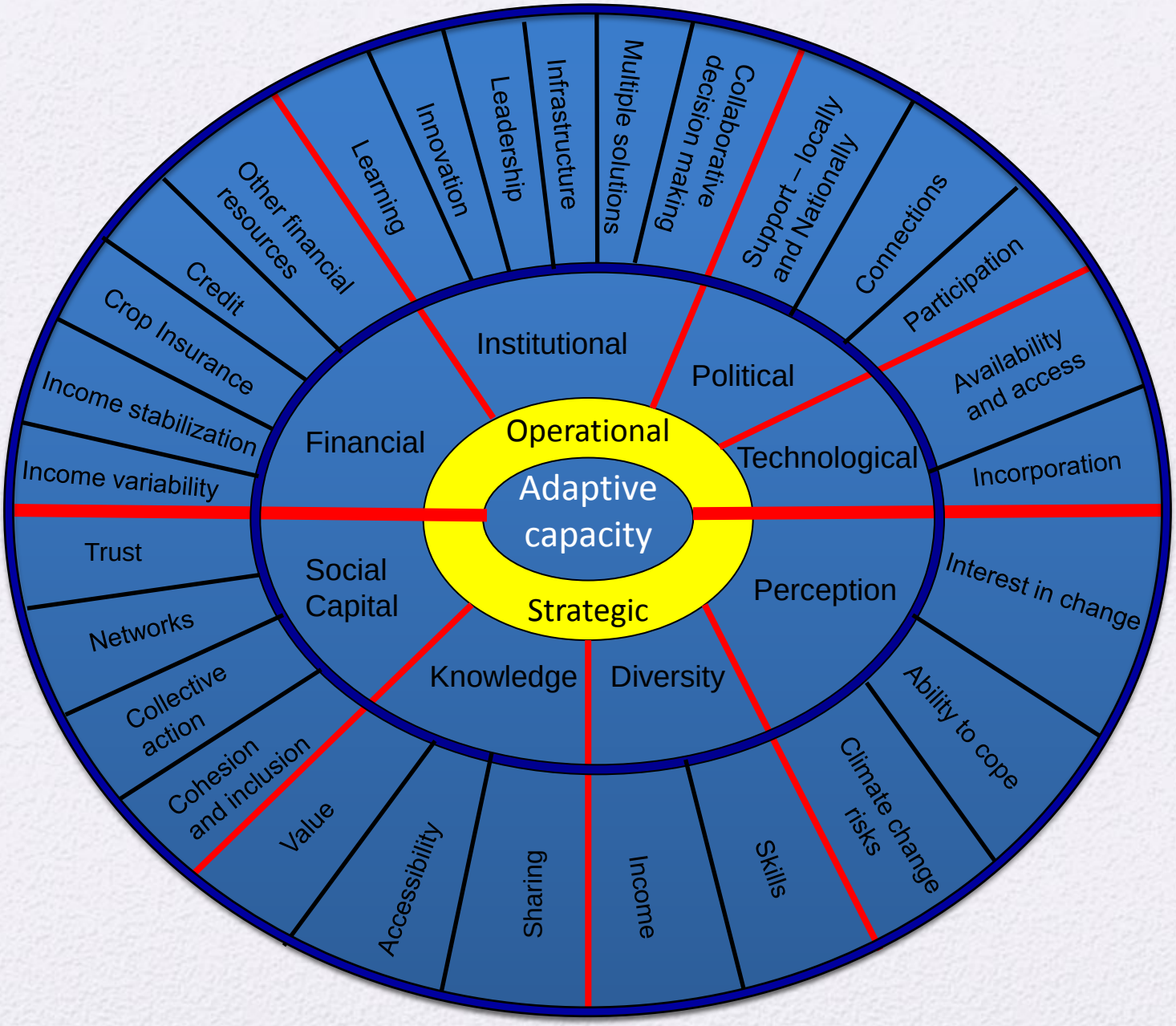
Determining adaptive capacity

Objectives

- to develop a framework to access the adaptive capacity of the Ontario Wine Industry

- to empirically assess the adaptive capacity of the OWI using the adaptive capacity framework

From: Pickering et al. (2015).
Int J Wine Res 6, 1-15.


Adaptive capacity
Operational
Strategic
Institutional
Political
Technological
Perception
Diversity
Knowledge
Social Capital
Financial
Learning
Innovation
Leadership
Infrastructure
Multiple solutions
Collaborative decision making
Support – locally and Nationally
Connections
Participation
Availability and access
Incorporation
Interest in change
Ability to cope
Climate change risks
Skills
Income
Sharing
Accessibility
Value
Cohesion and inclusion
Collective action
Networks
Trust
Income variability
Income stabilization
Crop Insurance
Credit
Other financial resources

Determinant	Adaptive capacity assessment
Financial	Limited use of crop insurance and stabilization plans. Perceive they have the financial resources to keep going.
Institutional	Limited policy options and access to infrastructure. Room for innovation and leadership.
Political	Limited political connections and support. Have political participation from stakeholders.
Technological	Higher incorporation of new technologies than is recognized.
Perception	High degree of perception of climate change and desire to learn new skills to manage impacts.
Diversity	High degree of diversity in skills and income.
Knowledge	High degree of access, sharing and valuing of local and scientific knowledge.
Social Capital	Trust, cooperation and collective action are well established. Social networks, inclusion and closeness to a lesser degree.

Adapt to erratic weather patterns

- **Optimizing grapevine cold hardiness for vines currently in production**

  - Measure how a vine acclimates/deacclimates to the cold temperatures during the dormant season

  - Share data with growers, develop best practices guide & early warning system ('VineAlert')

Canes with buds sampled from vineyard

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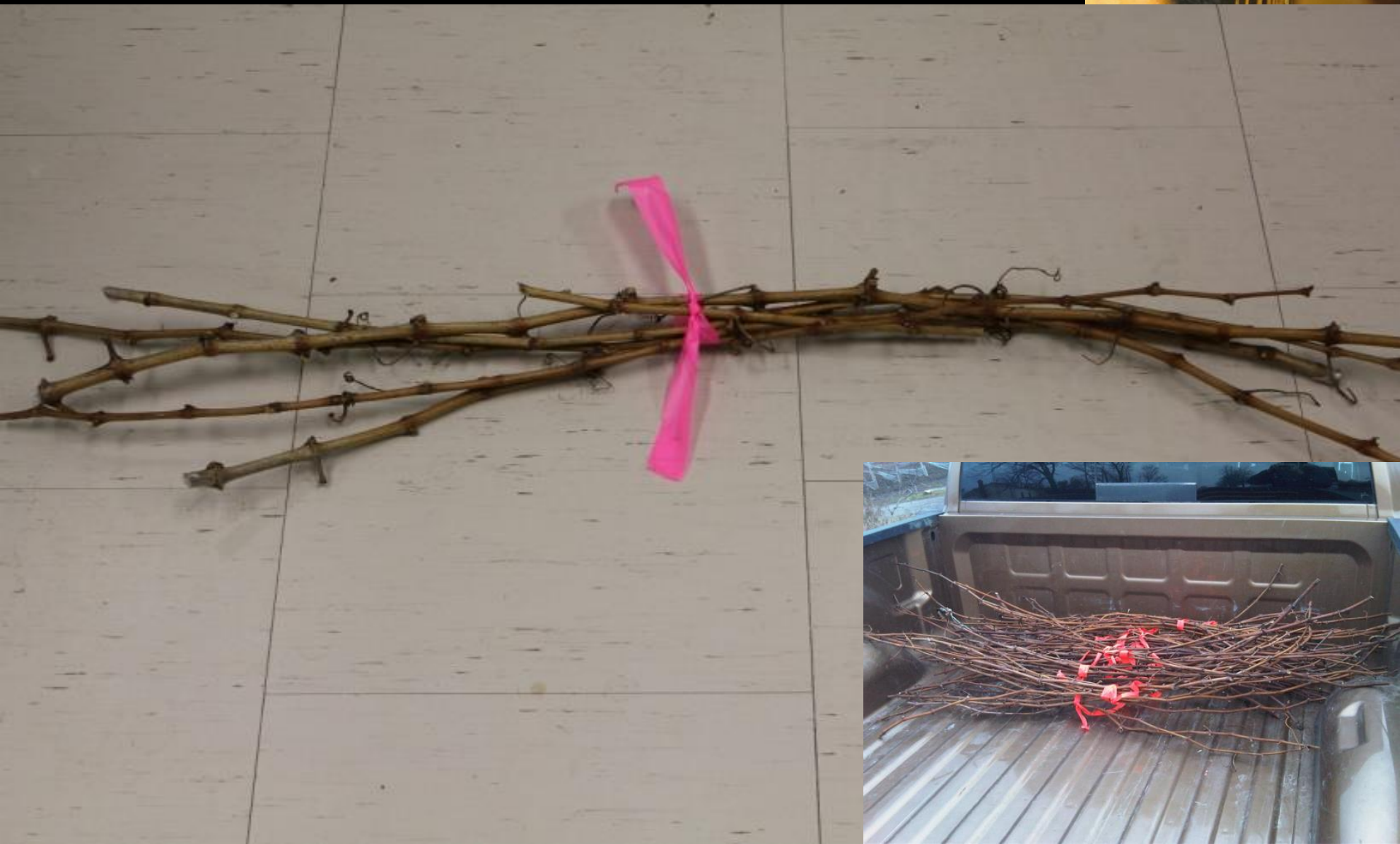
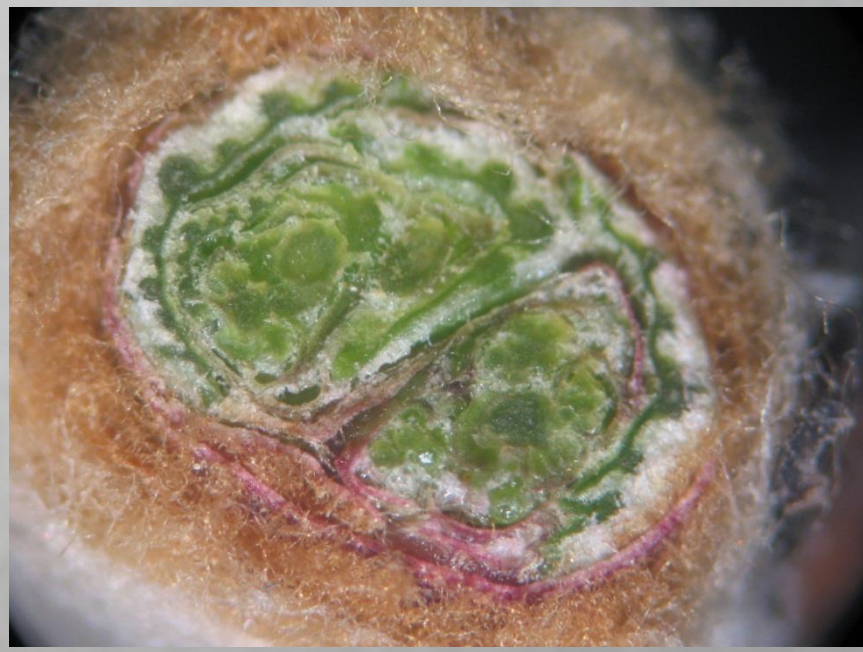


Individual bud on cane



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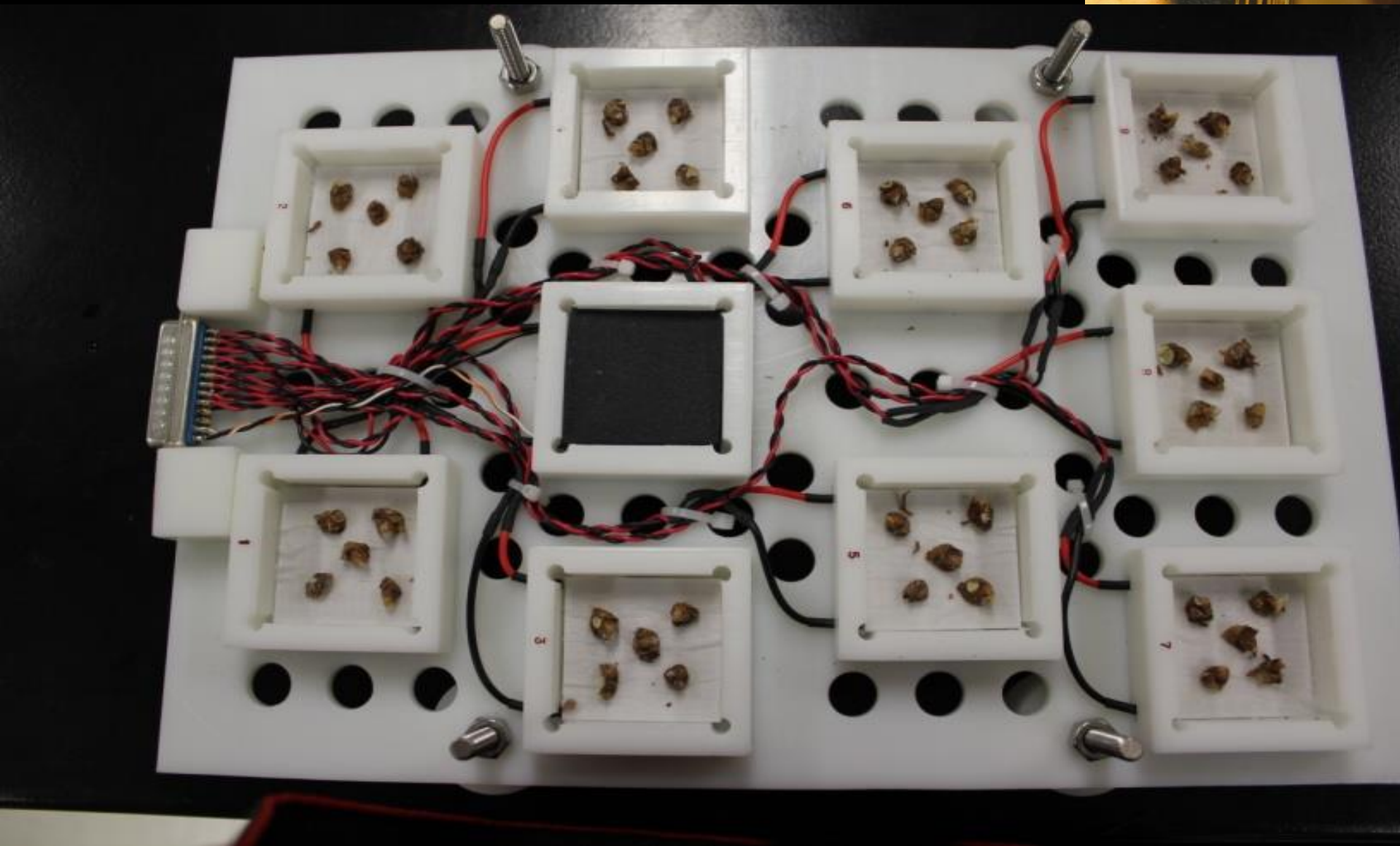
Buds placed on trays for cold hardiness testing in programmable freezers



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Programmable freezer with trays loaded with buds

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Temperatures will drop to mimic a cold event (4C/hr) to determine how cold hardy grapevine buds are

Results from Differential Thermal Analysis (DTA)
Small peaks indicate temperatures where buds were killed, calculate temp when 10, 50 or 90% buds die

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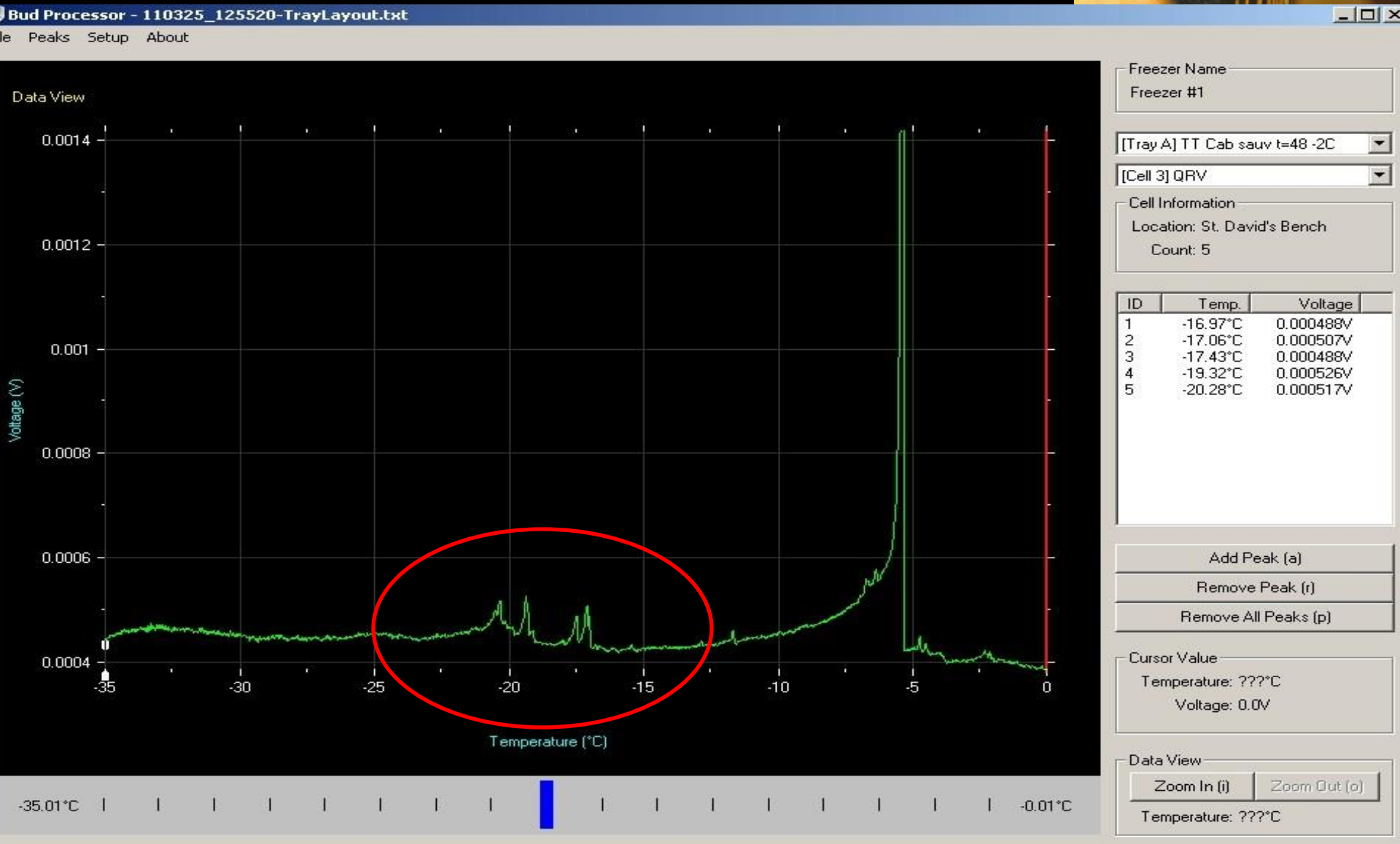


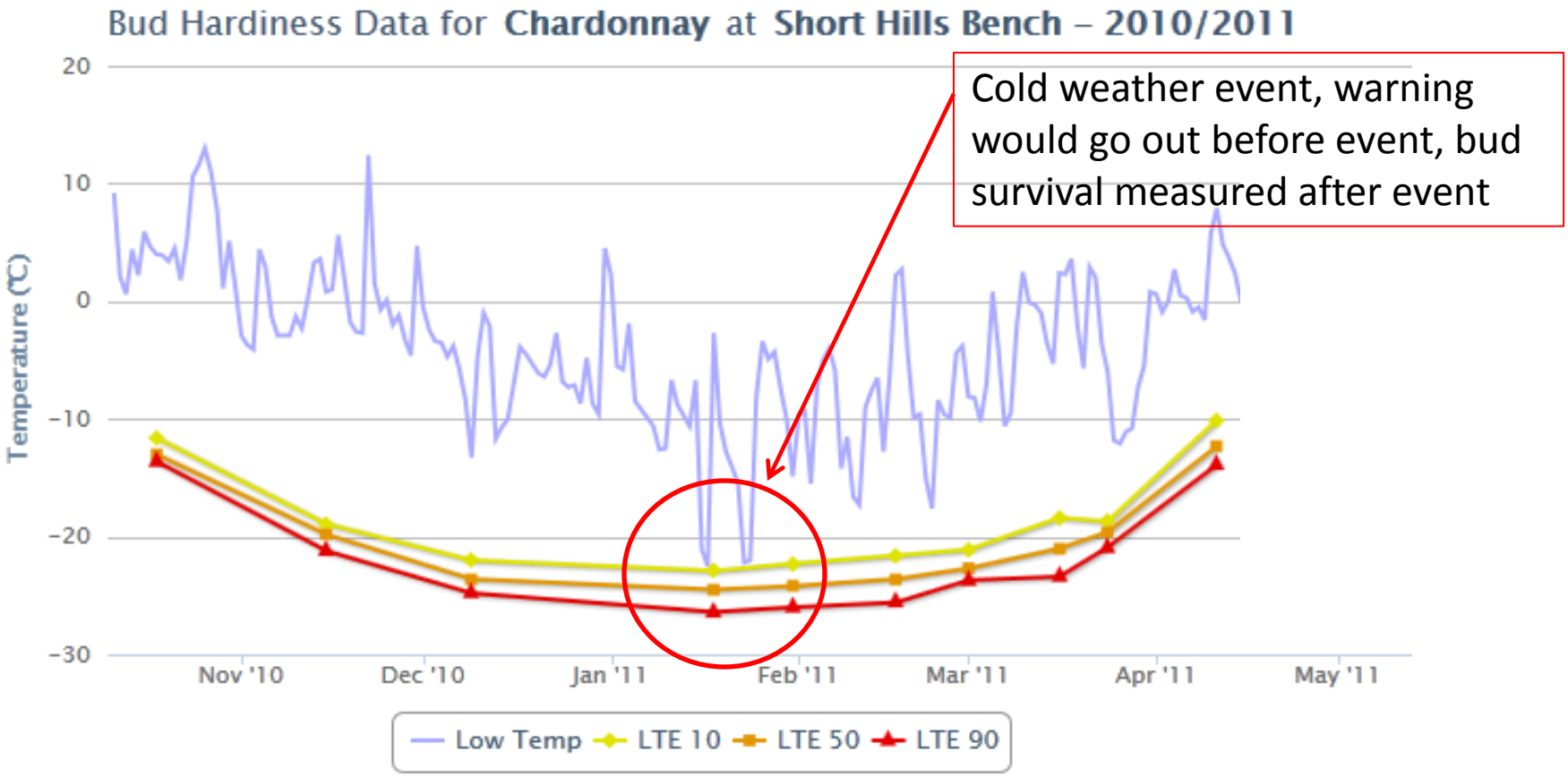
Development of “VineAlert” Risk Management program

- Measure grapevine bud cold hardiness and make the data available to grape growers on a web-based database – VineAlert

- Inform grape growers how hardy their vines are so they can protect them at vulnerable times when a cold weather event occurs

VineAlert indicating possible winter injury from cold weather events

Table | Comparison-Table | Chart | Comparison-Chart



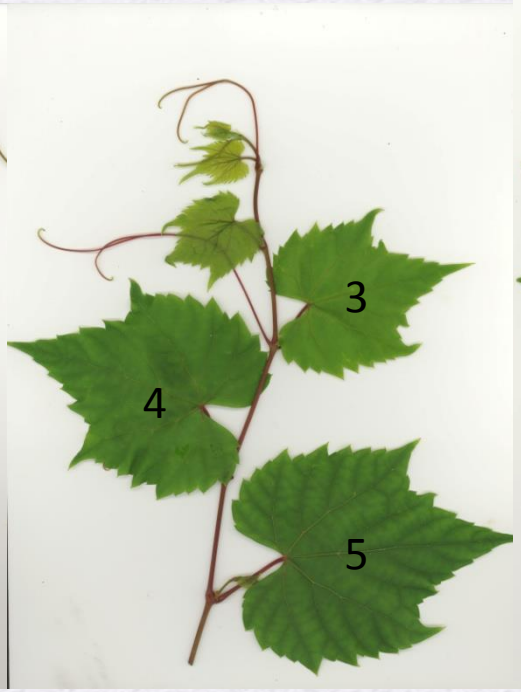
Wind Machines warm up the air & protect the vines from damaging cold temps

Longer term strategy: develop winter-hardy grapes

Method: Breed cold tolerance genes from wild grape into the winegrape

wild, freezing tolerant grape

freezing sensitive winegrape



Manitoba

Quebec

Chardonnay

Riesling

Annette Nassuth, University of Guelph

Which are the cold tolerance genes?

Method:

* Identify putative cold tolerance genes
* Introduce these gene and determine if plant now survives low temperature better

without gene

DEAD

with gene

ALIVE!

- Good cold tolerance requires more than one gene

Nassuth et al. (2014a). Plant Methods 10: 32.
Nassuth et al. (2014b). Acta Horticulturae 1046: 395-402.

Longer term oenology strategies

- **Develop alternative wine styles that will be more resilient to climate change and erratic weather**

Example: Appassimento

➢ Opportunity to produce full-bodied red wines if the fall weather sub-optimal (e.g. wet and cool)

The Appassimento Project

Comparative study of 5 techniques used to dry the grapes using Cabernet franc.

Vary: brix, yeast strain (including natural Niagara skin isolate), % *Botrytis cinerea*

Measure:
grape: biochemistry, microbial status

wine: fermentation kinetics, volatile/non-volatile chemistry, flavour profiles (chemical & sensory), consumer preference

Appassimento wines

On-vine

Drying chamber

Kiln

Barn

Greenhouse

Ontario Grapevine and Wine Research Network

- **Transdisciplinary team**
  - Basic and applied research
  - Natural and social sciences
- **Research across the value-chain**
- **Approaches that are practical**
  - But grounded in science
- **Networking and sharing resources**
- **Use expertise in climate science to develop adaptive strategies to remain competitive**
- **Proactive** - Preserve and grow the $3 billion industry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