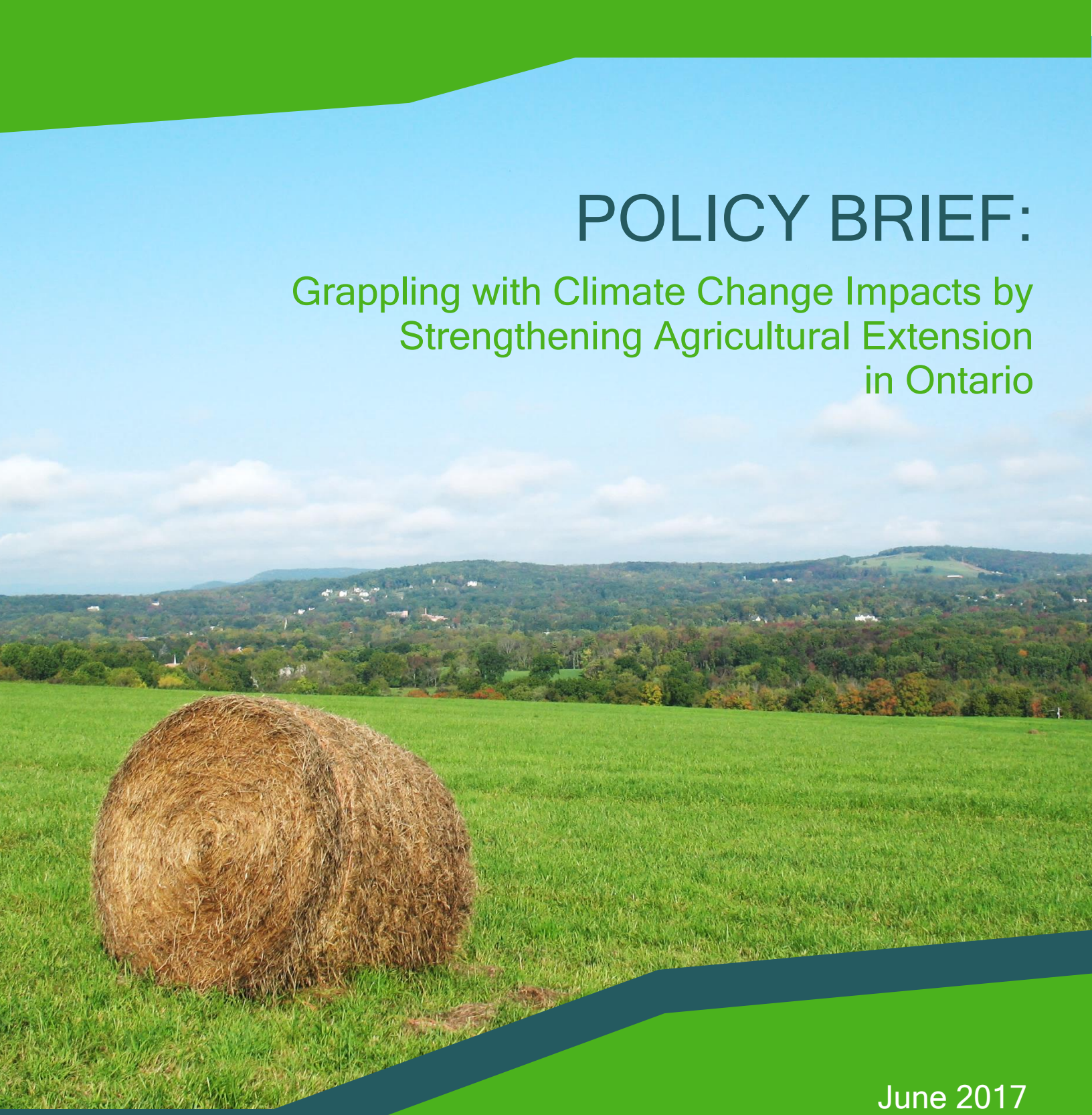
POLICY BRIEF:

Grappling with Climate Change Impacts by Strengthening Agricultural Extension in Ontario



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Box 1: Key Messages

- Climate change poses risks and opportunities for Ontario agri-food. The sector will need to adapt to maintain or enhance agricultural productivity, alongside other objectives like environmental protection, as the climate changes.
- Seasonal and longer-term decisions by Ontario producers should be informed by the best available knowledge of climate, water, adaptation options and agricultural practices.
- The Government of Ontario has a role to play in providing access to this knowledge. One strategy that holds promise is to strengthen agricultural extension services.

Introduction

Ontario producers are familiar with managing weather risks[1], but are they equipped to manage the risks and opportunities of a changing climate? Is knowledge on climate change, its impacts and options to adapt available, accessible, reliable and relevant to producers in the province?

This policy brief outlines the role of agricultural extension in stimulating the supply and uptake of climate science, impacts and adaptation research by Ontario producers. It draws on emerging ideas such as "climate information services" and climate knowledge brokering[2] as strategies to build the adaptive capacity of sectors and communities to cope with the impacts of climate change (see Box 2). Future considerations offer insights into how provincial policy advisors and program managers could integrate climate change impacts and adaptation into extension programming within the province.

This policy brief is an output of a two-year research project to develop and pilot the Ontario Climate and Agriculture Assessment Framework (OCAAF). The OCAAF is a spatially-explicit, decision-support tool for application at regional scales to assess baseline and future agro-climatic risks and opportunities.

The overall purpose of OCAAF is to inform the policy, program and management choices of key stakeholders in Ontario's agri-food sector, so as to maintain or enhance agricultural productivity under a changing climate. Funding support for its development and application came from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) through its New Directions Research Program.

Box 2: Key Terms

Climate change adaptation: adjustment in natural or human systems in response to actual or expected climate stimuli and their effects, which moderates harm or exploits beneficial opportunities.[3]

Climate information services: production, translation, transfer and use of climate knowledge and information in climate-informed decision-making and climate-smart policy and planning. Such services are intended to facilitate adaptation to climate variability and change.[4]

Improving Knowledge of Climate Change Risks and Opportunities to Ontario's Agriculture and Agri-food Sector

In Ontario and across the nation, farming and related industries are core to economic development and rural livelihoods.[5,6] A changing climate creates both risks and opportunities for the sector. In Ontario, growing seasons are becoming longer and warmer suggesting the potential for northward expansion and creating opportunities for new crop varieties.[7,8] However, warmer summers and increased heat units can also contribute to water stress, caused by an increase in evaporation and evapotranspiration.

Extreme events, such as hail, intense downpours and drought, are likely to become more frequent and/or intense in the future. In areas presenting poor drainage and soil structure, a gradual rise in average spring precipitation may combine with the occurrence of intense downpours and rain-on-snow events to exacerbate risks related to soil health, erosion control and nutrient runoff.

Since the specific risks and opportunities of climate change on agriculture are locally variable, understanding the relative vulnerability of different crops and production systems across sub-regions in Ontario is important. Spatially-explicit tools to assess landscape-climate interactions and inform strategic adaptation choices are in short supply and do not yet include the most recent climate science. The Ontario Climate and Agriculture Assessment Framework (OCAAF) helps address this gap (see Box 3).

Box 3: What is the OCAAF?

The OCAAF is a spatially-explicit, decision-support tool to assess baseline and future agro-climatic risks and opportunities. It uses outputs of Global Climate Models (GCMs) to understand future crop suitability, as measured in growing degree days (GDD), crop heat units (CHU), potential evaporation (PE) and yield.

By building on the Land Suitability Rating System (LSRS) developed by Agriculture and Agri-Food Canada the OCAAF can also give a land suitability rating score. The LSRS is a well-established system that assesses the suitability of land for crop production, based on measurable qualities of three key factors: climate, soil and landform. The OCAAF updates the climate factors component of the LSRS and takes into account climatic-developmental requirements of the two crops studied.

The initial design of the OCAAF was tested and refined through application to two distinct areas and production systems in Ontario:

1) Forage-based beef production in Ontario's Great Clay Belt, specifically looking at timothy grass; and
2) Corn production in southwestern Ontario, specifically looking at eco-district 7E-1.

Its pilot application to two distinct areas and production systems show how attributes of climate change may affect agricultural opportunities and productivity in the 2020s, 2030s, 2040s and 2050s. See Table 1 for a summary of the OCAAF results for the 2050s, aggregated to the sub-regional level (full results are available online at: www.climateontario.ca/p_OCAAF.php).

Table 1: Summary of OCAAF results for the 2050s, aggregated to the sub-regional level

Indicator	Timothy (*Phleum pretense*) in the Great Clay Belt	Grain corn in southwestern Ontario (eco-district 7E-1)
Projected temperature for the 2050s, compared to a 1981-2010 baseline.	• Annual: +2.9°C • Winter: +4.7°C • Spring: +3.2°C • Summer: +3.2°C • Autumn: +3.3°C	• Annual: +3.3°C • Winter: +3.6°C • Spring: +2.8°C • Summer: +3.2°C • Autumn: +3.1°C
Projected precipitation for the 2050s, compared to a 1981-2010 baseline.	• Annual: +9% • Winter: +19% • Spring: +15% • Summer: +1% • Autumn: +7%	• Annual: +6% • Winter: +13% • Spring: +13% • Summer: no change • Autumn: +3%
Growing season length for the 2050s, compared to current season length.	+50 days	+28 days
Growing Degree Day 5 for the 2050s, compared to a 1981-2010 baseline.	+566 40% increase Triple cutting possible	n/a
Crop heat units for the 2050s, compared to a 1981-2010 baseline.	n/a	+390 25% increase
Potential evaporation between May and September for the 2050s, compared to a 1981-2010 baseline.	+58mm 13% increase	+88mm 16% increase
Land Suitability Rating System (LSRS) score for the 2050s, compared to a 1981-2010 baseline.	Shift from mostly Class-5 (very severe limitations) to Class-3 (moderate limitations)	Decrease from Class-1 (no limitations) to Class-2 (slight limitations)
Yield (kg/ha) for the 2050s, based on the historical relationship between yield and growing degree days (for timothy), and yield and crop heat units (for corn).	+2,160 30% increase	+3,300 41% increase

There is interest in extending this research to other Ontario sub-regions and production systems, and ensuring its wide dissemination across the agriculture and agri-food sector to increase knowledge of climate change risks and opportunities. The OCAAF research project developed a suite of adaptation options for each sub-region and production system studied.[9] Supporting agricultural research, knowledge exchange and dissemination of information was a cross-cutting need identified. Stakeholder discussions during two outreach workshops over the course of the OCAAF research project confirmed that improving the generation and dissemination of information similar to that created through the OCAAF, and on a systematic basis, was relevant. Further outreach and communication to increase the impact of the OCAAF results is a short-term action OMAFRA should consider. However, a broader effort to integrate climate science, knowledge of climate change impacts and adaptive options into extension programming and services merits close attention as well.

Examining the role of extension services in providing climate change-related information to support adaptation by Ontario producers is timely. The Canadian federal budget 2017 allocates $73.5 million to create a new Canadian Centre for Climate Services, and consultations are ongoing as to what this centre could look like and how it could operate.[10] As well, a new province-wide Climate Change Adaptation Action Plan is imminent.[11] It will likely include a commitment to establish a Climate Modelling Consortium, which would enable users to take climate change impacts into account in their decision-making.[12] The agriculture sector is one of the identified user groups.

Extension and how it helps with Climate Change Adaptation

Agricultural extension services helps to ensure that university-generated science and subject-matter knowledge is extended to farmers and rural communities. Extension staff play important roles in disseminating new information, practices and technologies and enabling their adoption.[13] Extension staff have technical knowledge, are able to work with researchers and others to produce new knowledge, are skilled at communicating with farmers and other rural stakeholders, and are involved in non-formal education.[14] According to the International Food Policy Research Institute, agricultural extension includes a range of “organizations that support people engaged in agricultural production and facilitate their efforts to solve problems; link to markets and other players in the agricultural value chain; and obtain information, skills, and technologies to improve their livelihoods.”[15]

A growing body of research points to the importance of knowledge brokers, including extension and advisory services, in enabling consideration of climate change impacts in agricultural decisions. Research shows that farmers are hesitant to use forward-looking climate information in their decision-making because they perceive it to be inaccurate (spatially and temporally) with high levels of uncertainty, and it is unavailable when and how they need it.[13] However, understanding of how to increase the usefulness and usability of climate-related information is increasing.[16]

Users' perceptions of whether information suits their needs, the interplay between new and existing knowledge, and the quality of interactions between generators and users of information are three factors that shape willingness to access climate-related information. Added to this are organizational (e.g., incentives to try new things) and individual (e.g., risk perception) factors. For example, certified crop advisers in the US Corn Belt are more inclined to share climate information with their clients if it does not conflict with their for-profit activities.[13]

Agricultural extension can assist producers and rural communities adapt to a changing climate in at least three ways:

1. **Informing specific decisions through communication of climate science and sharing of context-specific knowledge.** This includes a range of activities to communicate climate change information and encourage the adoption of agricultural practices and technologies that reduce vulnerability to climate variability and change or enhance opportunities. Globally, a range of initiatives are underway to understand effective approaches to develop and target communication of new climate change information and tools (e.g., CARE's Adaptation Learning Program in Africa[17] and the USDA-supported Useful to Usable project in the US Corn Belt[18]). Examples of specific decisions include whether to: switch to crops with greater tolerance to emerging climate change stressors; supplement rain-fed systems with irrigation; install tile drainage to handle excess soil moisture.[19] Additionally, more attention is now being placed on the "co-production" of knowledge between those who generate and those who use it.[20] This involves fostering high-quality interactions between both sides, such that respective needs, motivations and limitations are revealed.

2. **Preparing for sustained adaptation through capacity development and learning.** Adapting to climate change is a continuous process. Effective adaptation, including adaptation at the farm level, requires the capacity to: anticipate changes in future climate and plan for uncertainty; maintain the requisite flexibility to react to changes as they occur; and continuously review implementation in light of shifting vulnerabilities and opportunities. Encouraging learning across individuals and ways of knowing, harvesting transferable lessons from other contexts (e.g., past experience, current analogues, research using climate futures), and facilitating reflection on what is working and what is not are all possible contributions by extension services. Additionally, producers and extension staff may need to build new skills (e.g., use of new climate-related decision-support tools, development of so-called soft skills such as competencies in participatory facilitation techniques).

3. **Linking to other scales for collective action.** Producers have a reputation for being self-reliant; however, a changing climate will likely test producers' adaptive capacity, even in cases where financial resources and technological solutions are available. The reason for this is because adaptive capacity is also a function of healthy ecosystems, connections to local institutions, and cooperation with governments and non-government organizations at different scales.[21] A possible role exists for extension to bring

together producers, rural communities and other stakeholders to help identify conflicts and facilitate collective action.[15]

Agricultural Extension in Ontario Today

Agricultural extension in Ontario has changed significantly since it started over 100 years ago.[14] Low farmer participation rates and a one-way flow of information characterized initial activities, giving way to efforts to deploy expertise and undertake non-formal education. Extension services were public until the 1980s, when support for public funding declined on grounds of low effectiveness. A number of factors contributed to the contraction of public extension services, including: the changing nature of producers (e.g., increased levels of education, decrease in the number of fulltime farmers); challenges proving value for money; technological advances; the loss of political support for pro-rural policies; and the evolution of the university system toward a focus on research and teaching, which undermined the value of service and outreach.[22] At the same time, the demand from producers for specialized information and reliance on private sector advisers (i.e. Certified Crop Advisers, agronomists and consultants) increased.

Public extension shifted from personalized service to a more passive one-to-many approach. Aside from provision of factsheets, guides on best management practices and other Internet information, little personalized public extension has taken place since the 1990s, when OMAFRA suffered significant staff cuts. Universities have the greatest capacity to undertake demand-driven agricultural research and the past few years have seen an emphasis on knowledge translation and transfer as an approach to put research into use.

Large Ontario producers can pay for highly-specialized agricultural information but some research suggests that small producers may be underserved with current forms of extension.[14] To a degree, extension staff from the Ministry of Natural Resources and Forestry and Conservation Authorities make up for the shortfall of OMAFRA extension. Yet, small farmers often face challenges in obtaining useful information and making sense of the vast amount of resources and information available; two common challenges that climate knowledge brokers seek to overcome in the context of climate information.[23]

Future Considerations

"*Extension, in general, has not yet developed a coordinated effort to identify priority investments at the intersection of climate and agriculture at state and regional levels*."[18]

This is a conclusion of a multi-year climate change project on the US Corn Belt's capacity to adapt agriculture to the impacts of climate change. It applies equally to Ontario. With evolving organizational structures and investments flowing into augmenting climate information services federally and provincially, the opportunity exists to strengthen Ontario's agro-climate extension.

In integrating climate science, knowledge of climate change impacts and adaptive options into extension programming within OMAFRA along with other provincial ministries, Conservation Authorities and private-sector

partners would do well to consider the following:[24]

- The need to understand factors and conditions that drive or constrain Ontario producers' willingness and ability to integrate climate change information into their agricultural decision-making.
- The feasibility and desirability of personalized one-on-one contact with producers. Individualized interactions are important but OMAFRA need not do this directly; it is important to identify producer's trusted advisors, strengthen relationships with them, and build their capabilities to be effective climate knowledge brokers. Adopting a train-the-trainer model and adding climate-related topics to advisor certifications are two avenues for this.
- The need to increase knowledge and capacity of extension staff and advisors on the effects of climate change on agricultural outcomes (e.g., interpreting and synthesizing results from climate models.
- Partnerships with experts in different aspects of climate and agricultural science that could serve as resources and partners for extension and outreach. In particular, strengthening connections among climate scientists, educators, conservationists and crop and livestock specialists.
- Appropriate framing of the issues and use of terminology. Producers may be less willing to engage in conversations about climate change than about agricultural vulnerabilities to increased weather variability. Conversations can shift gradually from local weather to the impacts of changing temperature and precipitation trends on different aspects of farm operations and producer decisions to trends over time, like the relationship between climate and soil health.
- Gaps in tailored information and tools for farm-level decision-making. Producers are action-oriented and tools that assist them with exploring options and finding solutions that fit their situation will be valuable.
- Investments in field-level research to demonstrate effectiveness of options to reduce vulnerability to climate change and pilot innovative approaches, as well as social science research to understand barriers and enablers to adoption of adaptive practices, for example.
- The need to evaluate the effectiveness and cost-efficiency of agro-climatic extension. Tracking implementation lessons and the return on investments in extension services is an effective way to demonstrate accountability to tax payers and service beneficiaries.
- Climate action also includes reducing greenhouse gas (GHG) emissions and enhancing carbon storage. Ontario's Climate Change Action Plan addresses the need to maximize carbon storage in agricultural soils and in other natural systems[12], and extension services could help to deliver on these GHG mitigation commitments.

Conclusion

There is a role for agricultural extension in supporting adaptation to climate change in Ontario. Extension agents can play the role of climate knowledge brokers and offer climate information services to help Ontario

producers manage current weather risks and equip them with the knowledge and tools needed to manage the risks and opportunities that future climate change presents.

Creating access to reliable and relevant climate information, such as the results from the OCAAF, will help to build the adaptive capacity of Ontario's agriculture sector to prepare and cope with the impacts of a changing climate.

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24. This list includes recommendations stemming from U2U (Wright Morton et al., 2016)

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