POLICY BRIEF:

Managing Water for Agriculture under Ontario's Changing Climate

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Box 1: Key Messages

- Agricultural producers in Ontario will need to adapt to both periods of wet conditions and potential drought events during the growing season and increase their adaptive capacity to cope with a more variable climate.
- The Government of Ontario has a role to play in improving agricultural water management under climate change by continuing/updating programs on drainage and water efficiency and conservation and also by identifying entry points for improved water management in other policies and programs.
- Facilitating decision-making under uncertainty and supporting knowledge dissemination are also key aspects for improving the long-term management of water in the agricultural lands of Ontario.

Introduction

Water is essential for agricultural production. Changing climatic conditions can lead to imbalances between rainfall and crop needs and can have a significant impact on yield and the quality of agricultural products.[1] Faced with this changing context, agricultural management practices in Ontario, both in irrigated and rain-fed crops and livestock systems, will need to adapt.

This policy brief provides key policy considerations for the management of agricultural water in a changing climate, specifically addressing the anticipated problems of seasonal excess and/or lack of water and the challenge of managing water under increasingly variable weather. This policy brief is an output of a two-year research project to develop and pilot the Ontario Climate and Agriculture Assessment Framework (OCAAF).

Box 2: Key Terms

Agricultural water management means using water in a way that provides crops and livestock the amount of water they need while enhancing productivity, and conserving natural resources for the benefit of downstream users and ecosystems.[2]

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.

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.[3,4] 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.[5] 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).

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).

From Table 1, we can see that historical precipitation has been increasing in both regions and this trend is expected to continue into the future, particularly during the winter and spring. During the summer, the model results indicate dryer conditions compared to the 1981-2010 baseline, which could affect water availability, especially at the local farm level, when coupled the projected increased evapotranspiration.

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.

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

While some aspects of climate change such as increased temperature may bring benefits to agriculture in Ontario, there may also be a range of adverse impacts, including reduced water availability during critical periods for the crops and more frequent extreme weather events that could lead to increased erosion and hinder certain agricultural operations.

Given these projections of future climate change, farmers will need to adapt to both periods of wet conditions and potential drought events during the growing season, and increase their adaptive capacity to cope with a more variable climate. Long-term changes in the historical climate (e.g., changes and shifts in rainfall regimes) over timespans of several decades present a major challenge to agricultural systems both from the perspectives of policy and science.[6]

The Government of Ontario has a role to play in helping Ontario farmers strengthen their agricultural water management practices and face the potential risks of excess or deficit water conditions that could occur more frequently as a result of climate change.

Coping with Excess Water

An increase in winter and spring precipitation and intense rain events during the growing season can lead to waterlogged soil conditions which are not optimal for planting crops, harvesting crops, or for crop development. In these conditions, draining soils of excess water is one of the best management practices to maintain and/or increase yields and improve crop quality. In Ontario, the Agricultural Tile Drainage Installation Act (R.S.O. 1990) regulates the installation of agricultural tile drainage systems which are installed by drainage contractors licensed by OMAFRA. Through the Tile Loan Program[7] and the Agriculture Drainage Infrastructure Program[8], Ontario provides loans to agricultural property owners to help them finance tile drainage projects.

Understanding how future climate will affect excess water and the effectivity of drainage systems and other water management practices to cope with this excess water should be at the basis of all policy developments dealing with this issue. The following policy considerations provide options for enhancing or expanding tile drainage in Ontario agricultural lands and managing for excess water conditions:

- **Promote/expand land under drainage**. This type of intervention would be especially effective in the clay soils of the Great Clay Belt. For example, the Ministry of Northern Development and Mines (MNDM) could sustain or increase the funding available through the Northern Ontario Heritage Fund Corporation (NOHFC) Economic Infrastructure Program and continue to support the Regional Tile Drainage/Land Clearing Program[9] administered by the Northern Ontario Farm Innovation Alliance (NOFIA). This program finances 50% of land clearing and/or tile drainage installation costs for farmers in Northern Ontario.

- **Map out drainage needs and current practices**. In order to make effective policy and program decisions, it is vital to fully understand the potential needs for further drainage and document or review the current practices (and their effectiveness) in agricultural drainage. This step of reviewing current practice before promoting or supporting a specific technology or adaptation measure has been proposed as part of agricultural

policies updates in other Canadian jurisdictions.[10]

- **Promote incentives for best management practices with positive effects on drainage**. Environmental Farm Plans (EFPs) are voluntary assessments conducted by farmers to increase their environmental awareness. Through this process, farmers identify environmental concerns and develop action plans and projects to improve environmental conditions on their farms. Environmental cost-share programs are available to farmers implement these projects. Excess moisture in soils could be ameliorated with environmental best practices[11] identified for EFPs, such as buffer strips, artificial wetlands, etc. Identifying and implementing these best practices that could also help agricultural managers increase their resiliency for future climate conditions could be eligible as part of the cost-share program.

Preparing for Water Deficits

As of 2010, the province of Ontario comprised 13% of the irrigated farms in Canada.[12] This number has experienced a reduction of 50% since 2007 due to the amount of rainfall received by the province in that period. Although the recent trend has been a decrease in the surface area under irrigation, OCCAF projections suggest increasing summer temperatures coupled with minimal changes in average summer precipitation will lead to more evaporation, increasing the risk of drought conditions.

Most agricultural water use in Ontario is concentrated in the southwestern part of the province where water demand from municipalities, golf courses, and other water users is high.[13] Climate change, population dynamics, and economic development are likely to affect the future availability of water resources for agriculture in different regions. Thus, the demand for, and the supply of, water for irrigation will be influenced not only by changing hydrological regimes, but also by competition for water for non-agricultural uses. The following policy considerations provide options for coping with potential water deficits in Ontario's agriculture sector:

- **Promote climate-smart water infrastructure**.[14] This type of infrastructure may involve promoting water-efficient irrigation technologies (e.g., drip), supporting water sources (e.g., revegetation and canopy management to conserve moisture) and storage (e.g., artificial wetlands) infrastructure at the regional and/or farm level as appropriate). As with other best practices, this type of interventions could be part of the Environmental Farm Plan and be eligible for the environmental cost-sharing program.
- **Promote programs focused on water conservation and efficiency**. For example, the Water Resource Adaptation and Management Initiative (WRAMI)[15] took place in 2013-2014 and involved funding of various pilot-scale programs showcasing water efficiency and conservation techniques, such as sub-surface drip irrigation for corn production in Ontario. The cost of these interventions is usually high but by funding a few selected pilot studies, these technologies can be progressively introduced without assuming high investment risks.
- **Improve access to information on water resources**. Ensure there are drought early

warning systems in place that inform agricultural producers of seasonal risks. These warning systems must integrate precipitation data with other data such as streamflow, snowpack, ground water levels, reservoir and lake levels, and soil moisture in order to assess drought and water supply conditions. Integrated water and climate monitoring and forecasting capabilities could make substantial contributions to sustainably managing water resources for agriculture.[16]

Managing Water under Increased Variability

As mentioned above, farmers will be exposed to increasingly variable weather as a result of climate change, including periods of wet conditions in the spring and periods of dry conditions in the summer. In this context, promoting resilient and flexible water management approaches will be key to mitigate these risks.

An option could be to provide information and promote the adoption of flexible water management practices (i.e., management practices that adapt to both excess water and drought situations). An example of these practices is controlled drainage. This type of drainage prevents, through a system of valves, excess moisture from damaging crops while simultaneously conserving moisture for periods of aridity. It therefore serves the dual purpose of adapting to dry and excess moisture conditions. The cost and complexity of installing controlled drainage systems can be significant[17] and there might be restrictions, such as not enough depth in the existing drainage system, to the installation of this technology. The Ontario Soil and Crop Improvement Association (OSCIA) is working with the University of Ottawa and Agriculture and Agri-Food Canada on a tool that will assist producers in predicting crop yield benefits from controlled tile drainage versus conventionally drained systems under varying weather scenarios. This tool could help producers make better informed decisions by evaluating potential costs and benefits prior to making the investment decision.

Through the development and dissemination of water management planning tools agricultural producers can analyse significant water issues and opportunities and identify resilient strategies for future water management. The Farm Water Planning Toolkit[18] developed by the BC Agriculture & Food Climate Action Initiative is a good example of this type of resource.

Other Considerations

Other cross-cutting policy recommendations which do not address a specific water problem but could be implemented for the overall improvement of agricultural water management under a future climate include the following:

- **Cross-cutting themes and entry points in other policies**. Agriculture is sensitive to the responses in other sectors, particularly water management, industry and biodiversity conservation. Introducing considerations regarding agricultural water management and climate change into existing policy tools is an opportunity for mainstreaming adaptation of this particular aspect and building on ongoing initiatives. For instance, the discussion

document *Sustaining Ontario's Agricultural Soils: Towards a Shared Vision*[17] has recently been developed by OMAFRA to initiate a process to develop a strategy that will sustain and support healthy agricultural soils. At the watershed scale, water management in Ontario is the responsibility of conservation authorities who regularly develop watershed management plans and other planning tools. In watersheds with a significant presence of agricultural land, questions regarding water management and climate change could be explored and at least be partly addressed through these water management activities. Perhaps a more holistic, regional approach to water management would be beneficial in the face of a changing climate.

- **Knowledge mobilization and exchange of best practices**. Farmers have historically adapted their farming practices to the prevailing climate conditions and evolving technology (e.g., some farmers might have installed drip irrigation to adapt to dryer conditions while others might have tested conservation tillage or no-till to promote water conservation in soils[14]). There is a potential source of knowledge that could be shared in a more structured and targeted manner to address the gaps and barriers preventing effective adaptation of water management. The series of climate change adaptation workshops[19] developed and delivered by the Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR) and OMAFRA in 2011 are a good example of a forum for knowledge and best practice exchange. Ensuring that Best Practice Management series[20] (e.g., water management, irrigation, etc.) developed by OMAFRA are easily available online through *ServiceOntario* could also support the dissemination of existing knowledge.

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