Climate Change Adaptation and Agriculture: Addressing Risks and Opportunities for Forage-based Beef Production in Ontario’s Great Clay Belt

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About this Document

The Ontario Climate and Agriculture Assessment Framework (OCAAF) is a decision-support tool for application at regional scales to assess baseline and future agroclimatic risks and opportunities. The goal of OCAAF is to inform policy, program and management choices of key stakeholders in Ontario’s agri-food sector so as to maintain or enhance agricultural productivity in a changing climate.

As part of a pilot study, the OCAAF was applied to two different regions and production systems:

1) Forage-based beef production in Ontario’s Great Clay Belt, specifically looking at timothy (*Phleum pretense*).
2) Corn production in southwestern Ontario, specifically looking at eco-district 7E-1.

Application of the OCAAF provides insights into how attributes of climate change may affect agricultural opportunities and productivity in the 2020s, 2030s, 2040s and 2050s. Results can be used by decision-makers to:

- Reduce Ontario production systems’ susceptibility to climate change-related hazards now and into the future;
- Realize the yield potential of Ontario production systems now and into the future;
- Equip producers for the adoption of novel crop species; and
- Consider the expansion of warm climate crops to more northerly regions.

With improved knowledge of the impacts of climate change and other factors on productivity, adaptation options were developed to manage climate change-related risks and opportunities for forage in the Clay Belt. Consultation with project advisors and other stakeholders led to the identification of 15 adaptation options that promote increased resilience to climate change in the agriculture sector.

This document outlines these 15 adaptation options, which are organized into the following objectives:

1. Intensify forage-based beef production in the Clay Belt
2. Ensure proper management of water at the farm-level
3. Ensure proper management of land at the farm-level
4. Support agricultural research and dissemination of information in the Clay Belt
5. Implement adaptive measures to account for the impacts of climate change at the farm-level
Several adaptation options are interconnected and build on each other; therefore, some sequencing of options might be necessary. Please see Appendix 1 for a summary of the 15 adaptation options.

Developing the Adaptation Options

Development of the adaptation options involved the following steps:

1. Identify key management issues. Results of the OCAAF assessment in the Clay Belt highlighted the various risks and opportunities that climate change will bring for timothy production (see Page 3). With these results, key management issues that target future policy options were identified.

2. Conduct research. Research was conducted into the current state of agriculture in the Clay Belt and on possible adaptation options that would either reduce the risks that climate change presents, or take advantage of opportunities. This involved extensive online research, creating a compendium of adaptation options, and discussions with advisors and stakeholders.

3. Develop adaptation options. Using the compendium of adaptation options and key management issues as a guide, adaptation options were drafted. Smit and Skinner¹ suggest that agricultural adaptation can fall under four categories: technological developments, government programs and insurance, farm production practices, and farm financial management. The adaptation options presented here mainly address the goal of adapting agriculture to climate change. Other considerations would factor into evaluating alternative options, such as environmental benefits/costs and the potential to increase greenhouse gas emissions or enhance carbon sinks.

4. Validate adaptation options. The adaptation options were presented to regional advisors and representatives of agricultural organizations in a workshop setting. The objective was to receive feedback and validation that the adaptation options would be useful and practical for agricultural stakeholders in the Clay Belt region.

5. Revise adaptation options. Based on feedback from stakeholders, the adaptation options were revised (if necessary) and finalized.

Who Is This Document For?

The main audience for the adaptation options in this document are provincial policy advisors and program managers from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), as well as other ministries dealing with natural resource management (e.g. Ontario Ministry of Northern Development and Mines, Ontario Ministry of Natural Resources and Forestry).

It is expected that the adaptation options will broker dialogue with other government agencies, agricultural organizations, farmers and local communities, thus further extending the goal of adaptation. The options presented here mainly address the goal of adapting agriculture to climate change. Other considerations would factor into evaluating alternative options, such as environmental benefits/costs and the potential to increase greenhouse gas emissions or enhance carbon sinks.

Overview of OCAAF Results

The following presents a summary of the key results from the application of OCAAF to timothy in the Clay Belt:

- **It will be warmer.** Historical temperatures have been increasing and this trend will continue into the future. Temperature projections for the Clay Belt in the 2050s, relative to a 1981-2010 baseline, are as follows:
  - Annual: +2.9°C
  - Winter: +4.7°C
  - Spring: +3.2°C
  - Summer: +3.2°C
  - Autumn: +3.3°C

- **It will be wetter.** Historical precipitation has been increasing and this trend will continue into the future. Precipitation projections for the Clay Belt in the 2050s, relative to a 1981-2010 baseline, are as follows:
  - Annual: +9%
  - Winter: +19%
  - Spring: +15%
  - Summer: +1%
  - Autumn: +7%

- **The growing season will be longer.** Growing season length will increase from approximately 130 days (current season length) to approximately 180 days by the 2050s.

- **Growing Degree Days will increase.** Growing Degree Day 5 (GDD5) will increase from 1413 to 1979 which means that double cutting could become commonplace, and the GDD5 requirement for triple cutting will be possible by the 2050s.

- **Better land suitability scores.** The Land Suitability Rating System (LSRS) is an existing tool developed by Agriculture and Agri-food Canada. It 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 landscape. OCAAF was designed around the LSRS and results show that, based on the climate factor alone, the Clay Belt will see a shift from mostly Class-5 (very severe limitations) to Class-3 (moderate limitations).

- **Yield will increase.** Currently, the relationship between timothy dry matter yield and GDD5 is 7100 kg/ha. As a result of climate change, this number could increase by 30% by the 2050s to 9260 kg/ha (see Figure 2).

For a full summary of the OCAAF results, please visit: [www.climateontario.ca/p_OCAAF.php](http://www.climateontario.ca/p_OCAAF.php).

Figure 2: Given our historical relationship between GDD5 and timothy yield, we can see how yield (kg/ha) changes into the future as a result of climate change (source: Risk Sciences International).
Adaptation Options for Forage in Ontario’s Clay Belt

Objective I: Intensify Forage-based Beef Production in the Clay Belt

OCAAF results show that the Clay Belt will see continuously improved growing conditions for timothy as we move into the 2050s, with warmer temperatures, longer growing seasons, increasing growing degree days, better land suitability scores, and a potential increase in yield of 30%. These results suggest that there is opportunity for agriculture in the Clay Belt, and efforts to intensify existing forage-based beef production systems or to expand the industry in the area would help take advantage of the opportunities that climate change brings. The following four adaptation options will help to intensify agricultural production in the area.

Adaptation Option 1
Create an incentive program to attract new beef farmers to the Clay Belt.

An option to encourage further agricultural development in the area is to develop an incentive program that attracts new beef farmers to the Clay Belt. This includes providing the loans and financing necessary to put new or existing agricultural land into production. A program for Ontario could be created that is similar to Quebec’s Financial Support for Aspiring Farmers Program, which helps young producers establish themselves on an existing farm or start a new agribusiness.

The new incentive program could build on the Northern Ontario Heritage Fund Corporation (NOHFC) Northern Business Opportunity Program, by including training/education, a mentorship program from established farmers in the area, tours of existing farms, support for each stage of the settlement process, information on available funding programs, and support from local agri-food organizations and government advisors.

Adaptation Option 2
Create a marketing strategy and communication plan.

To effectively communicate agricultural opportunities in the Clay Belt as a result of climate change, a marketing strategy and communication plan should be developed to promote forage-based beef production in the region. The communication pieces might

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include key messages about warming temperatures in the area resulting in better growing conditions; more affordable land than in southern Ontario; the programs and financial assistance already in place to help establish new farms in the area; as well as the social aspects of moving to the Clay Belt such as health care, education, recreation, and religious institutions. This will not only encourage farmers to consider the Clay Belt as a settlement area due to the favourable growing conditions, but will also encourage entire families to move to the area.

Communication efforts could be targeted to those residing in the southern part of the province or in neighbouring provinces who may not be aware of the agricultural potential in Northern Ontario. This could include targeted communication efforts through agricultural organizations, associations and groups. Communication could be delivered through articles in farming magazines, newspaper articles, fact sheets, newsletters, videos, webinars, social media (Twitter, Facebook, YouTube), as well as presentations at colleges, universities, agricultural conferences and community events, including guided tours of existing farms in the area.

This work could align closely with promotions by the Northern Ontario Farm Innovation Alliance (NOFIA) and Beef Farmers of Ontario (BFO), building on their existing websites www.farmnorth.com and www.beefnorth.com. These websites provide information to existing farmers and those interested in farming in Northern Ontario that helps them make operational and investment decisions.

Adaptation Option 3
Sustain/increase funding to support infrastructure development in the Clay Belt.

To accommodate the expansion of forage-based beef production in the Clay Belt, it will be important to ensure there is adequate infrastructure; thus, sustaining or increasing available funding to support infrastructure development is essential. This can include investment in new road networks, bridges, culverts and drains, as well as investing in the expansion of broadband internet to improve reliable access to Internet services. Some of these infrastructure projects could be supported by the NOHFC’s Strategic Economic Infrastructure Program, the Ontario Community Infrastructure Fund, or OMAFRA’s Agricultural Drainage Infrastructure Program.

Adaptation Option 4
Ensure there are adequate OMAFRA extension services for farmers in the Clay Belt.

Ensuring extension, outreach, knowledge transfer and advisory services within the Clay Belt will be beneficial in helping to expand the agriculture sector in the area. There is currently an OMAFRA office located in the Timiskaming District that offers extension services to the area, however with the potential expansion of forage-based beef production in the Clay Belt, it will be valuable

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5 www.ontario.ca/page/infrastructure-funding-small-communities
6 www.omafra.gov.on.ca/english/landuse/facts/adip_admin.htm
to develop an additional OMAFRA office within the Cochrane District.

**Objective II: Ensure Proper Management of Water at the Farm-level**

OCAAF results show that by the 2050s, the Clay Belt will be wetter, particularly during the winter and spring, while the summer months are more likely to experience dryer conditions, as compared to the 1981-2010 baseline. These results indicate that moisture availability will not be a large issue for timothy crops in the Clay Belt, however it will be important for farmers to manage water appropriately to handle both periods of wet and drought conditions during the growing season. The following three adaptation options will help farmers manage water appropriately at the farm-level.

**Adaptation Option 5**

**Sustain/increase financial support for farmers to clear land and install tile drainage.**

Due to the clay soils and projections for increased precipitation in the area, installing tile drainage in the Clay Belt is crucial to ensure the proper drainage of excess water from fields. Thus, it is important to sustain or increase financial support to help farmers clear their land and install tile drainage, as this is often an activity that comes at a high cost (approximately $1000/acre). For example, the Ministry of Northern Development and Mines (MNDM) could sustain/increase the funding available through the NOHFC Strategic Economic Infrastructure Program and continue to support the Regional Tile Drainage/Land Clearing Program\(^7\) administered by NOFIA. As well, OMAFRA could sustain their Tile Loan Program\(^8\), which helps farmers finance the installation of tile drainage.

As well, financial support programs to clear land for agricultural use should include stipulations that the land being cleared has the potential to be productive, and that any merchantable timber on the land is harvested for use.

**Adaptation Option 6**

**Promote the installation of controlled drainage systems.**

Climate change is expected to increase the variability of weather in Ontario, resulting in periods of extremely wet conditions in the spring, and periods of very dry conditions in the summer. In order to manage water at the farm-level during times of both high and low water conditions, controlled drainage systems could be installed. These systems are characterized by a metal bar that adjusts an underground box containing a series of dams that control the water level underneath fields (see Figure 4). With this controlled system, farmers can adjust the water table under fields, making swings from flood to drought less of a factor. When water is released from the field it can flow into a nearby wetland to help absorb any remaining nutrient runoff and prevent the water from rushing into streams.

These systems have been proven to increase yields, conserve water and reduce nutrient

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\(^7\) [www.nofia-agri.com/technology](http://www.nofia-agri.com/technology)

\(^8\) [www.omafra.gov.on.ca/english/engineer/facts/07-061.htm](http://www.omafra.gov.on.ca/english/engineer/facts/07-061.htm)
loss and should be encouraged where appropriate in the Clay Belt. They work best on flat terrain with slopes of less than 1%, which would require only one control structure; if multiple drainage structures are installed, the practice could be used in fields with greater slopes but at a higher cost.

![Controlled Drainage](image)

Figure 4: Depiction of a controlled drainage system (Photo credit: Agricultural Drainage Management Coalition)

**Adaptation Option 7**

Provide incentives for the installation of on-farm water harvesting and storage infrastructure.

Historically, moisture availability has not been a limiting factor for agriculture in the Clay Belt; however, increasing summer temperatures coupled with little increase in summer precipitation will likely lead to more drought conditions. Providing incentives for the installation of on-farm water harvesting and storage infrastructure will help adapt to water shortages associated with climate change.

Water storage involves capturing and holding water on the farm that might ordinarily be lost as runoff or in-stream flow, making it available for later use in agricultural production. This can include the capture and storage of water from tile-drained lands into holding ponds, which could then be used to irrigate fields during dry summers, resulting in water reuse and conservation and prevention of nutrient loading in local waterways. It can also include the capture and storage of water falling on farm buildings. For example, farmers can add eavestroughs to the roofs of buildings and collect water in rain barrels, small-scale earth-banked water reservoirs, or direct the water to natural wetlands.

**Objective III: Ensure Proper Management of Land at the Farm-level**

Analysis with OCAAF suggests that climate change will result in more suitable growing conditions in the Clay Belt. Efforts are being made by governments and agricultural organizations to increase agricultural production in the area. As a result, it will be important to ensure the land transformation process considers environmental and social impacts alongside economic ones. For example, land transformation should be efficient from a farmer’s perspective but also effective in conserving natural features that have both adaptive and mitigative qualities. The following three adaptation options will contribute to ensuring proper management of land at the farm-level.

**Adaptation Option 8**

Modify land-clearing practices to consider protection of natural features.

Natural features such as shelterbelts, hedgerows, wetlands and woodlands help to lessen some of the impacts of climate change on agriculture while minimizing losses in
biological diversity, ecological processes and functions, as well as in the storage and sequestration of carbon. For example, shelterbelts help to protect crops and livestock from wind and heat, create wildlife habitat and biodiversity retention, offer fence-line erosion control, reduction of evaporation of water storage ponds, and soil moisture retention. Wetlands and woodlands provide water management features and help to filter and retain tile drained water, while hedgerows are a great source of wild pollinators.

As arable land in the Clay Belt is cleared for forage-based beef production, it will be beneficial for farmers to conserve natural features that not only provide adaptive benefits but also help to sequester carbon.

**Adaptation Option 9**
Create a program to help facilitate the land transformation process.

In order to better facilitate the land transformation process from forested land to agricultural land in the Clay Belt, a program could be created to help modernize and streamline the regulatory and approvals process. By facilitating the land transformation process, this program would help to increase the production of farmable land in the area, leading to sustainable local food sources for Northern Ontario residents, a priority for the Northern Ontario Growth Plan\(^9\).

This program would need to be conscious of the potential decline in carbon storage with an attempt to minimize loss of carbon sinks, as removing trees removes their ability to sequester carbon. However, the Clay Belt contains a lot of land that was previously cleared for agricultural use and then abandoned. Therefore, the program could target those previously cleared lands and bring them back into production.

**Adaptation Option 10**
Recognize the importance of achieving greenhouse gas emission reduction goals alongside or through adaptation.

With Ontario’s new Cap and Trade system, it will be important for the agriculture sector to ensure that agricultural lands are managed in a way that is efficient, sustainable, and will enhance the removal or storage of carbon from the atmosphere. Thus, measures to adapt the agriculture sector to climate change in the Clay Belt should work towards climate change mitigation objectives and carbon storage opportunities.

**Objective IV: Support Agricultural Research and Dissemination of Information in the Clay Belt**

As a result of climate change, the Clay Belt could see an average annual temperature increase of 3°C by the 2050s. With this warming, further research will be needed to identify the types and varieties of crops with the potential to grow well in the area. The following three adaptation options are focused on supporting agricultural research in the Clay Belt and disseminating that information to those who will use it for their long-term decision making.

\(^9\) [www.placetogrow.ca](http://www.placetogrow.ca)
Adaptation Option 11
Increase the stability of long-term funding for ongoing northern-based agricultural research stations.

Northern-based agricultural research stations such as the New Liskeard Agriculture Research Station (a partnership between the University of Guelph and OMAFRA), the Thunder Bay Agricultural Research Station, as well as the Université du Québec en Abitibi-Témiscamingue have undertaken important agricultural research to further develop and diversify the agricultural industry in northern Ontario. They conduct studies on different crops and varieties, as well as on best management practices to improve agricultural production in the region.

As a result of climate change and changing growing conditions in the Clay Belt, it will be important for these research stations to have continued support and long-term, stable funding. Research priorities could be focused on new crops varieties that would do well in the area as a result of climate change, demonstrating to producers how they can take advantage of climate change.

An important component of this research will be communicating the findings to the agricultural community. This could include the development of a program to support novel crop demonstrations in the Clay Belt and disseminating those results to the people likely to act on that information. Undertaking and disseminating research focused on northern climatic and environmental conditions is outlined as a priority in the Northern Ontario Growth Plan.

Adaptation Option 12
Research and promote the awareness and use of best management practices for adaptation at the farm-level.

To help farmers prepare for the impacts of climate change, there is value in researching best management practices for climate change adaptation at the farm-level and promoting their awareness and use. Some examples of best management practice to reduce the risks associated with climate change include: adjusting the timing of farm operations to account for the changing nature of growing seasons and associated shifts in temperature and moisture; shifting the management of livestock grazing to avoid heat stress of the animals during the summer; limiting grazing during extremely wet periods; and promoting the use of intensive rotational grazing to reduce soil erosion. As well, the Clay Belt will likely see less fall-hardening and more winter-thaw, thus research is needed into best management practices for the protection of forage crops during freeze/thaw events.

Adaptation Option 13
Improve access and dissemination of information related to climate change impacts and adaptation.

Increasing technical scientific knowledge and data on climate change forecasts and expected impacts on the sector will increase adaptive capacity and help to inform long-term decision-making for various agri-food stakeholders. Thus, there is a need to improve access to critical climate change data and information on adaptation and disseminating that information throughout northern agri-food organizations, business, government departments and producers to help increase the adaptive capacity of the region. Communication methods could include a website, newsletter, listserv, or an online Community of Practice where members can log on, share information with one another, and participate in online
discussions about climate change and implications for agriculture in the Clay Belt.

**Objective V: Implement Adaptive Measures to Account for the Impacts of Climate Change at the Farm-Level**

OCAAF results show that the Clay Belt could see better growing conditions as we move into the 2050s; therefore, there are opportunities for farmers to implement adaption options that will not only take advantage of the better growing conditions, but also reduce the risks associated with a changing climate. The following two adaptation options will help to promote and encourage adaptive action at the farm-level.

**Adaptation Option 14**
Create a program to encourage adaptation in the agriculture sector and reward early adopters.

To encourage implementation of adaptive measures in the agriculture sector, a program should be created that rewards early adopters of adaptive actions that reduce their vulnerability to climate risks. One such program has been launched by the Government of British Columbia, called the Farm Adaptation Innovator Program with funding from Growing Forward 2. It provides direct financial assistance (between 80 and 100% of the project costs) to projects that promote innovation in farm practices, approaches and technologies that support climate change adaptation; demonstrate farm practices that reduce weather related production risks; and develop information and knowledge sharing resources to support adaptation.

These projects can include applied research, pilots and demonstrations that specifically increase the capacity of farmers to adapt to climate change and weather-related production risks and impacts. Applied in Ontario, a similar program could encourage the implementation of measures to increase adaptive capacity throughout the Clay Belt.

**Adaptation Option 15**
Promote and encourage farmer uptake in income stabilization and crop insurance programs.

Income stabilization and crop insurance programs have been proven to be successful in reducing the risk of income loss due to climate-related events and variability. This climate variability, along with weather extremes, is expected to increase into the future; thus, there is a need to promote and encourage farmer participation in income stabilization and crop insurance programs.

For example, farmers could be encouraged to diversify their household income sources (e.g. off-farm employment, adding another farm enterprise), participate in income stabilization programs (e.g. Agricorp’s AgriStability program), and participate in established subsidized crop insurance programs (e.g. Agricorp’s Production Insurance or Risk Management Program).

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10 [www.bcgclimateaction.ca/farm-level/adaptation-innovator-program](http://www.bcgclimateaction.ca/farm-level/adaptation-innovator-program)

Conclusion

The future success of Ontario’s agri-food sector depends on knowledge of future weather and climate implications. The OCAAF was developed to help address this need, as it is a spatially explicit and adaptable risk-opportunity assessment framework incorporating the most recent climate science.

The results of the application of OCAAF to forage-based beef production in the Clay Belt has expanded the knowledge of climate risks and opportunities for the area. Warmer temperatures, longer growing seasons, increasing growing degree days, better land suitability scores, and a potential increase in yield of 30% by 2050 indicate that growing conditions will continue to improve. However, there will also be agricultural risks in the region as a result of a warming climate (e.g. warmer winters, wetter springs).

With this information, the agriculture sector can make more effective policy and program decisions that increase its resilience to climate change and effectively promote economic development in rural and northern communities. The 15 options listed in this document are meant to inform adaptation 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. This list of adaptation options is not exhaustive, but represent a selection of adaptation options that could be developed and implemented.

Provincial policy advisors and program managers dealing specifically with agriculturally-related policies and programs should consider climate change adaptation in order to:

- Reduce the susceptibility of the Clay Belt’s forage-based beef production systems to weather and climate change-related hazards now and into the future; and
- Maintain or enhance agricultural yield potential for forage in the Clay Belt under the influence of climate change.
Appendix 1: Summary of Adaptation Options

Table 1: Summary of the 15 adaptation options to manage risks and opportunities for forage-based beef production in the Clay Belt as a result of climate change.

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<th>Objective I:</th>
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