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Cc: Kalff, Sarah
Subject: Agriculture Working Group update
Attachments: Agriculture Working Group meeting notes Dec 15.docx; Agriculture Working Group meeting notes Dec 15-f.docx

Follow Up Flag: Follow up
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Hello Agriculture Working Group Members,

Happy new year! We are hoping to hold our next meeting in early March and will send a scheduler when details have been confirmed. As well, we are working on a series of questions for our information-gathering exercise. If you are interested in reviewing or helping to develop these questions, please contact Robin directly.

The meeting notes from our December 15 meeting are attached and can also be found on the Adaptation Platform Agriculture Working Group Site here:
http://adaptationplatform.ca/workinggroups/agriculture/documents/teleconferences__meetings/december_15_2014/agricultureworkinggroupmeetingnotesdec15docx

All documentation for this group is on the workspace and we encourage you to visit it. If you have any issues logging in, please let us know.

Thanks,
Robin, Sarah and Drew
Agriculture Working Group Secretariat and Co-Chairs

Adaptation Platform Agriculture Working Group

Meeting notes

December 15, 2014

Participants

Tom Goddard (Alberta Agricultre)
Fawn Jackson (Canadian Cattlemen's Association)
Anne Boswell (Farm Credit Canada)
Ron Eley (Saskatchewan Agriculture)
Paul Thoroughgood (Soil Conservation Council of Canada/Ducks Unlimited)
Matthew Weins (Manitoba Agriculture)
Heather Watson (Farm Management Canada)
Mary Ann Wilson (Natural Resources Canada)
Bruce Kinnie (New Brunswick Agriculture)
Carl Esau (Nova Scotia Agriculture)
Sarah Kalff, Robin MacKay (AAFC) - co-chair
Drew Black (Canadian Federation of Agriculture) – co-chair

1. **Discussion on *Building Resilience in the Agriculture Sector to a Changing Climate* paper**

The paper was drafted as a background document for the October 2014 Fed-Prov-Territorial Deputy Minister retreat. It was intended to provide DMs with an understanding of anticipated climate change-related impacts and risks to the sector, and begin a discussion among DMs on government's role in building resilience to climate risks.

Comments

- A member asked if the paper could be distributed. This paper can be shared with the understanding that it is not an official position or report from AAFC or the Government of Canada and intended to be a discussion paper only. We would prefer if the paper were distributed to only those who work in this subject area.

- The paper could be improved by adding the following pieces:
    - More detail on precipitation and temperature changes and departures from normal to refine the information in Table 1
    - More detail/information on climatology and distribution of rainfall, and more refined projections
    - Wind impacts and projections
    - Projections that are focused on the agriculture sector

- Paper is heavily focused on crop sector; there is less discussion about livestock despite opportunities for resilience in this sector (shifts in perennial species, winter crops, grazing management) and risks (lyme ticks)

- The paper talks about building resilience, and should also emphasize maintaining the resilience that has been gained by good practices up to now.

Debrief of DM discussion (AAFC)

- The intent of the DM discussion was to raise a common understanding of the issue and risks to the sector among DMs.
- Guest presenters (Scott Vaughan, CEO of International Institute of Sustainable Development (IISD), and Barbara Turley-McIntyre, Sr. Director, The Co-Operators) highlighted that this is not an environmental issue, but rather an economic and a social one.
- DMs acknowledged that more information is needed on risks and costs of extreme events, and there is a need to be able to provide information to the sector.
- Speakers highlighted that there are many uncertainties in terms of impacts and costs, but this cannot be a reason to delay action as we will never have total certainty.
- DMs were interested in understanding the costs of action and the cost of inaction (costs associated with pests, disease, repeated flooding, coastline damage and erosion).
- DMs asked who should be responsible for costs associated with action on the ground
- Drainage/wetlands were issues raised by IISD.
- DMs indicated a desire for having the 'right' information. Suggested a platform where the information can be planned or accessed.
- The discussion focused on BRM programming, specifically if there is anything that is acting as a disincentive to adaptation? If so, what can be done to remove the disincentive?
- Suggested looking at the capacity of BRM programming to cope with climate change.

3. Agriculture Working Group Terms of Reference

- The working group approved the Terms of Reference, which has been posted on the Adaptation Platform site.

4. Program of Work and Forward Agenda

A draft Program of Work and Forward Agenda was circulated to the group. We see three types of work being undertaken: 1) information gathering, 2) analysis and 3) information sharing and discussion. Information gathering logically precedes the other two steps, so we will focus on type 1 at this time and build towards analysis.

The goal for this fiscal year is to identify one work item for the group, and gather existing information from participants. AAFC will compile information sent by members across the country into an inventory or report.

Members raised a number of ideas for a work item, including:

- Compile information on what is being done on agricultural adaptation across the country
- Develop an inventory of adaptation-related research in the agriculture sector across Canada. Also adaptation research being conducted in universities.
- Understanding information/data available. What kind of data is being collected at monitoring stations? Do we have enough stations? Beyond Statistics Canada collecting environment data.
- Vulnerability assessments
    - Understanding/identifying risks in different regions
    - Tools/resources to conduct vulnerability assessments
    - Presence or absence of vulnerability assessments across the country
    - How have risk assessments been undertaken across the country?

Note: BC has offered to present their adaptation-related work, which includes an extensive series of vulnerability assessments. This may be a more appropriate venue for this discussion, where WG members can get a sense of the complexity of this type of work.

Additional comments in the discussion

- If the objective is to do a gap assessment on adaptation activities, risks need to be identified so gaps in activities can be identified. Without knowing the risks, it is difficult to identify gaps.
- Do universities have this capacity?
- Lots of work on the range of tools/capacity for predictive models to forecast impacts to the sector occurring in the private sector/industry
- We should think about what is practical and what is important to build upon. Also what the objective of collecting the information is.
- The work should be scoped appropriately before we undertake it.
- NRCan to send information on AdapTool
- There is an advantage to seeing what other jurisdictions are doing.
- Can identify where gaps are and establish priorities. E.g., possible gaps to be identified – the farm building code is weather related and behind regular building codes. Might put it on the radar to update the farm building code.
- Without an adaptation strategy in a region, how to distinguish between what an adaptive practice is and a regular practice?
- People who worked on the national assessment food chapter might have a good idea of what the risks are.

Forward Agenda

We plan on holding another meeting before the end of the fiscal year, and propose to have a presentation by a member on their activities/experiences, pending availability.

Upcoming presentations:

- BC to present on BC's Climate Action Secretariat work, including a series of risk assessments in agricultural regions in British Columbia and subsequent pilot projects on adaptation. BC has applied the IISD's ADAPTool to its agricultural programs and policies.
- Ouranos to present on a synthesis of knowledge of key climate change impacts and forecasts for the agriculture sector in Quebec.
- AAFC Research Scientist Dr. Erin Smith (AAFC Kentville, NS) to present on AgWeather Atlantic, an online tool that provides climate and weather information for farmers in Atlantic Canada.

Other potential presentations

- Environment Canada's data/forecasting group to present on their work.

MEMBER UPDATES (round table)

- Agriculture Policy Conference in Ottawa January 28-30

- Canadian Climate Forum

  This group is hoping to have their second symposium in the spring, focused on food production and the food system. CFA sits on the Board, and Drew Black will update group with more information when it becomes available.

- CFA attended a conference in Washington, DC on the Renewable Natural Resources Foundation called 'adapting food production to a changing climate'.

  The conference was academic and US focused; looked at how different areas will benefit or be challenged by climate change, and identified tools to adapt to climate change.

- World Bank has a risk-management framework that is described in the report Building Resilience: integrating climate and disaster risk into development. They also have a data portal

- Adaptation Platform Plenary
  - The biannual meeting of the Plenary was held in Charlottetown, PEI in October, 2014. The focus of the meeting was on the work of the Economics Working Group.
  - Many of the projects being undertaken by the Economics group are in progress so there were not many results to share.

- There was a discussion about IDF curves and how a lot of them are out of date; EC is hoping to update
- Looking for stories to put in newsletter
- NRCan is hoping to have a wrap-up workshop in the next fiscal year

- Farm Management Canada held an Agricultural Excellence Conference in November, 2014.
  - Session on risk management for farmers. The session was broad, and included managing risks such as HR, disaster risk, price and markets.
  - Launched a comprehensive guide to risk management, intended to mitigate negative risks and look for opportunities. Trying to get farmers to look at all risks on their farms, including human resources, markets, production, disasters.

NEXT STEPS

Next Meeting: tentatively scheduled for the week of March 2, 2015.
Proposed topic: a presentation on adaptation-related work in the agriculture sector, followed by a discussion. Members are encouraged to submit agenda items to Robin.MacKay@agr.gc.ca.

Action Items:

- AAFC (Robin) to develop a template and questions to be used to gather information for first inventory/compendium, to be sent to AWG for review (by February 6)
- AAFC (Robin) will update the *Building Resilience in the Agriculture Sector to a Changing Climate* paper to increase emphasis on the livestock sector. WG members with information on risks from wind and more refined data on projections are encouraged to send to Robin for incorporation (by February 27)

Groupe de travail sur l'agriculture de la Plateforme d'adaptation

Compte rendu de réunion

Le 15 décembre 2014

Participants

Tom Goddard (ministère de l'Agriculture de l'Alberta)
Fawn Jackson (Canadian Cattlemen's Association)
Anne Boswell (Financement agricole Canada)
Ron Eley (ministère de l'Agriculture de la Saskatchewan)
Paul Thoroughgood (Conseil de conservation des sols du Canada/Canards Illimités Canada)
Matthew Weins (ministère de l'Agriculture du Manitoba)
Heather Watson (Gestion agricole du Canada)
Mary Ann Wilson (Ressources naturelles Canada)
Bruce Kinnie (ministère de l'Agriculture du Nouveau-Brunswick)
Carl Esau (ministère de l'Agriculture de la Nouvelle-Écosse)
Sarah Kalff, Robin MacKay (AAC) – coprésidence
Drew Black (Fédération canadienne de l'agriculture) – coprésidence

1. **Discussion sur le document *Pour une plus grande résilience du secteur agricole face aux changements climatiques***

Ce document d'information a été rédigé pour la séance de réflexion fédérale-provinciale-territoriale des sous-ministres d'octobre 2014. Il visait à donner aux SM une idée des impacts prévus des changements climatiques sur le secteur agricole et des risques connexes et à amorcer une discussion entre les SM sur le rôle du gouvernement en ce qui concerne le renforcement de la résilience par rapport aux risques climatiques.

Commentaires

- Un participant demande si ce document peut être distribué. Il peut l'être dans la mesure où il n'est pas considéré comme une position ou un rapport officiel d'AAC ou du gouvernement du Canada et utilisé uniquement comme document de travail. Nous préférons que ce document soit distribué seulement aux personnes qui travaillent dans ce domaine.

- On pourrait améliorer le document en ajoutant ce qui suit :
    - Plus de précisions sur les changements liés aux précipitations et aux températures, ainsi que les écarts par rapport à la normale dans le Tableau 1;
    - De l'information plus détaillée sur la climatologie et la répartition des pluies, ainsi que des projections plus précises;

- Des projections liées aux vents et les impacts des vents;
- Des projections axées sur le secteur agricole;
- Le document est beaucoup axé sur le secteur des cultures. Il aborde moins le bétail malgré les possibilités de renforcement de la résilience dans ce secteur (changements dans les espèces vivaces, les cultures d'hiver, la gestion du pâturage) et les risques (tiques porteuses de la maladie de Lyme).

- Le document, qui porte sur le renforcement de la résilience, devrait aussi mettre l'accent sur le maintien de la résilience que nous avons développée jusqu'à maintenant grâce à de bonnes pratiques.

Compte rendu de la discussion des SM (AAC)

- La discussion des SM avait pour but d'amener ceux-ci à avoir une compréhension commune des enjeux et des risques liés au secteur.
- Les présentateurs invités (Scott Vaughan, PDG de l'Institut international du développement durable International [IIDD], et Barbara Turley-McIntyre, directrice principale chez Co-Operators) ont précisé que la question à l'étude n'était pas une question environnementale, mais plutôt une question socioéconomique.
- Les SM ont reconnu qu'il faut plus d'information sur les risques et les coûts liés aux événements extrêmes et qu'il faut être en mesure de fournir de l'information aux gens du secteur.
- Les conférenciers ont souligné qu'il reste bien des incertitudes en ce qui concerne les impacts et les coûts, mais que cela ne justifie pas de retarder la prise de mesures, car nous n'aurons jamais de certitudes absolues.
- Les SM voulaient comprendre les coûts liés au fait d'agir ou de ne pas agir (les coûts liés aux organismes nuisibles, aux maladies, aux inondations récurrentes, à l'érosion de la côte et aux dommages subis par celle-ci).
- Les SM ont demandé à qui devrait incomber les coûts liés aux mesures prises sur le terrain.
- L'IIDD a soulevé la question du drainage et des terres humides.
- Les SM ont indiqué qu'ils voulaient la « bonne » information. Ils ont suggéré la création d'une plateforme où l'information peut être planifiée et consultée.
- La discussion a porté sur les programmes de GRE, plus précisément, on s'est demandé s'il existait des freins à l'adaptation et comment les éliminer le cas échéant.
- On a suggéré d'examiner la capacité des programmes de GRE de composer avec les changements climatiques.

3. Mandat du Groupe de travail sur l'agriculture

- Les membres du groupe de travail approuvent le mandat, qui a été affiché dans le site de la Plateforme d'adaptation.

4. Programme de travaux et ordre du jour des prochaines réunions

Les ébauches du programme de travaux et de l'ordre du jour des prochaines réunions sont distribuées aux membres du groupe. Nous voyons que trois types de travaux sont entrepris : 1) collecte de renseignements; 2) analyse; 3) échange de renseignements et discussion. Logiquement, la collecte de renseignements précède les deux autres étapes, alors nous nous concentrerons sur le type 1 pour l'instant en vue de l'analyse.

L'objectif du présent exercice consiste à choisir un élément de travail pour le groupe et à recueillir l'information existante auprès des participants. AAC compilera l'information envoyée par les membres du groupe dans un rapport ou un répertoire.

Les membres du groupe suggèrent un certain nombre d'éléments de travail, dont les suivants :

- Compiler l'information sur ce qui se fait à l'échelle nationale en ce qui concerne l'adaptation agricole;
- Créer un répertoire des recherches sur l'adaptation qui sont menées dans le secteur agricole canadien, ainsi que dans les universités;
- Comprendre les données disponibles. Quels types de données sont recueillis par les stations de contrôle? Avons-nous suffisamment de stations? Au-delà des données environnementales recueillies par Statistique Canada;
- Évaluations des vulnérabilités :
    - Compréhension/recensement des risques dans diverses régions,
    - Ressources/outils nécessaires pour effectuer les évaluations des vulnérabilités,
    - Présence ou absence d'évaluations des vulnérabilités au pays,
    - Comment les évaluations des risques ont-elles été entreprises au pays?

Remarque : La C.-B. offre de présenter ses travaux sur l'adaptation, qui comprennent une importante quantité d'évaluations des vulnérabilités. Ce pourrait être un bon point de départ pour la discussion; les membres du GT pourraient avoir une idée de la complexité de ce type de travail.

Autres commentaires formulés pendant la discussion

- Si le but est d'effectuer une évaluation des lacunes des activités d'adaptation, il faut tout d'abord cerner les risques. Si on ne connaît pas les risques, il est difficile d'évaluer les lacunes.
- Les universités ont-elles cette capacité?
- Beaucoup de travaux sont effectués par le secteur privé/l'industrie sur les outils/la capacité en vue d'établir des modèles permettant de prévoir les impacts sur le secteur.
- Nous devrions réfléchir aux éléments sur lesquels il est pratique et important de faire fond et déterminer l'objectif de la collecte de renseignements.
- Nous devons délimiter les travaux de manière appropriée avant de les entreprendre.
- RNCan enverra de l'information sur ADAPTool.
- Il est avantageux d'examiner ce qui est fait par d'autres administrations.
- On peut déterminer où se trouvent les lacunes et établir des priorités, p. ex. lacunes pouvant être cernées – le code de construction des bâtiments agricoles est lié aux conditions météorologiques et

est en retard sur les codes du bâtiment. Cela pourrait faire ressortir le besoin de mettre à jour le code de construction des bâtiments agricoles.

- Si une région n'a pas de stratégie d'adaptation, comment peut-on faire la distinction entre une pratique adaptative et une pratique normale?
- Les personnes qui ont travaillé au chapitre sur l'évaluation nationale des aliments pourraient avoir une bonne idée des risques.

Ordre du jour des prochaines réunions

Nous prévoyons organiser une autre réunion avant la fin de l'exercice et demander à un membre du groupe de faire une présentation sur ses activités/son expérience, selon la disponibilité.

Présentations à venir :

- La C.-B. présentera les travaux de son Climate Action Secretariat, y compris une série d'évaluations des risques effectuées pour diverses régions agricoles de la C.-B. et des projets pilotes subséquents sur l'adaptation. La C.-B. a appliqué l'outil ADAPTool de l'IIDD à ses programmes et politiques agricoles.
- Ouranos présentera une synthèse des connaissances sur les impacts des changements climatiques et les prévisions connexes pour le secteur agricole au Québec.
- Une scientifique d'AAC, M^{me} Erin Smith (AAC à Kentville, N.-É.), fera une présentation sur Agrométéo Atlantique, un outil en ligne qui fournit des données climatiques et météo aux agriculteurs du Canada atlantique.

Autres présentations possibles

- Présentation par le groupe des données/prévisions d'Environnement Canada sur ses travaux.

COMPTES RENDUS DES MEMBRES (table ronde)

- Conférence sur les politiques agricoles à Ottawa du 28 au 30 janvier

- Forum canadien du climat

  Ce groupe espère organiser son deuxième symposium au printemps sur la production et le système alimentaires. La FCA siège au conseil, et Drew Black transmettra de plus amples renseignements au groupe dès qu'il en aura.

- La FCA a participé à une conférence à Washington D.C. sur la Renewable Natural Resources Foundation intitulée « Adapting food production to a changing climate ».

La conférence était axée sur le milieu universitaire et les États-Unis. Elle portait sur la façon dont les changements climatiques profiteront à certains domaines et en mettront d'autres à l'épreuve et présentait des outils pour l'adaptation aux changements climatiques.

- La Banque mondiale dispose d'un cadre de gestion des risques qui est décrit dans le rapport intitulé Building Resilience: integrating climate and disaster risk into development. De plus, elle a un portail de données.

- Séance plénière de la Plateforme d'adaptation
    - La réunion plénière semestrielle a eu lieu à Charlottetown (Î.-P.-É.) en octobre 2014. La réunion était axée sur le travail du groupe de travail sur l'économie.
    - Comme un grand nombre de projets entrepris par le groupe sur l'économie sont en cours, il y avait peu de résultats à communiquer.
    - On a discuté des courbes IDF et du fait qu'un grand nombre d'entre elles sont désuètes. EC espère les mettre à jour.
    - On cherche des histoires à publier dans le bulletin.
    - RNCan espère avoir un atelier de synthèse au cours du prochain exercice.

- Gestion agricole du Canada a tenu une Conférence sur l'excellence en agriculture en novembre 2014.
    - Séance sur la gestion des risques pour les agriculteurs. La séance comprenait la gestion des risques liés notamment aux RH, aux catastrophes, aux prix et aux marchés.
    - L'organisation a procédé au lancement d'un guide complet sur la gestion des risques visant à atténuer les risques et à accroître les possibilités. Elle tente d'amener les agriculteurs à examiner tous les risques pour leur exploitation agricole, y compris ceux liés aux RH, aux marchés, à la production et aux catastrophes.

PROCHAINES ÉTAPES

Prochaine réunion : Prévue pour la semaine du 2 mars 2015.
Sujet proposé : Une présentation sur le travail d'adaptation dans le secteur agricole suivie d'une discussion. Les membres sont invités à proposer des points à l'ordre du jour à Robin.MacKay@agr.gc.ca.

Mesures de suivi :

- AAC (Robin) élaborera un modèle et des questions qui serviront à recueillir de l'information pour le premier répertoire/compendium, qui seront examinés par le GTA (d'ici le 6 février).
- AAC (Robin) mettra à jour le document *Pour une plus grande résilience du secteur agricole face aux changements climatiques* pour mettre davantage l'accent sur le secteur du bétail. Les membres du GT qui détiennent de l'information sur les risques liés au vent et des données précises sur les projections sont invités à les transmettre à Robin en vue de leur intégration (d'ici le 27 février).

Climate Stressor Scenarios: Final Report

Regional Economic Impact of Climate Change in B.C. Examined Through Scenario Analysis

December 2014

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B.C. Ministry of Agriculture

Growing Forward 2
Pacific Institute for Climate Solutions
Knowledge. Insight. Action.
British Columbia
Canada

Acknowledgements

Collaboration and consultation with Ministry of Agriculture staff was invaluable to the development of the climate stressor scenarios and the author's knowledge about B.C. agriculture. Information and guidance provided by the regional agrologists and industry specialists Geneve Jasper, Wayne Haddow, Lori Vickers, Julie Robinson, Jim Campbell, and Carl Withler was especially appreciated. Climate scientist Trevor Murdock of the Pacific Climate Impacts Consortium provided regional climate data, interpretation and project design support. Emily MacNair, adaptation program manager with the B.C. Agriculture and Food Climate Action Initiative, provided expertise related to regional agricultural adaptation in B.C. Guidance and resources were also provided, in the scoping stages, by Jennifer Pouliotte, adaptation advisor with the B.C. Climate Action Secretariat, and by Jim Johnston, economist emeritus, Ministry of Forests, Lands and Natural Resource Operations. Economic modelling support was provided by Dr. Cornelius van Kooten, Dr. David Scoones and Dr. Allen Mehlenbacher of the University of Victoria, Department of Economics. Key information on scenario planning was provided by Tom Goddard, Alberta Ministry of Agriculture and Rural Development. Kari Tyler facilitated the scenario planning workshop. Adaptation specialist Stephen Tyler provided useful guidance and comments.

Project funding provided by

This project was funded in part through the internship program of the Pacific Institute for Climate Solutions. This project was also supported by the Ministry of Agriculture through *Growing Forward 2*, a federal-provincial-territorial initiative.

Definitions

Adaptation: actions taken to reduce the negative impact or benefit from changes in the external environment.

Adaptive capacity: ability of a system to change when the external environment in which it is operating is changing.

Anthropogenic climate change: changes in the earth's climate caused by human emissions of greenhouse gases and land use changes.

Autonomous adaptations: adjustments individuals make in response to climate change in the absence of government incentives or action. For example, a producer may choose to upgrade his or her irrigation infrastructure to improve the farm's productivity or pilot a new variety of crop which they judge to be better suited to the regional climate.

Planned adaptations: adaptive actions taken by government to provide public goods or incentives to motivate action by the private sector. Governments may choose to participate in planned adaptation because certain adaptation actions have benefits that cannot be captured by private individuals, resulting in under-investment. Some examples would include development of new irrigation infrastructure, land-use arrangements and property rights, water pricing and training for the private and public sector (capacity building)[1].

[1] Rosenzweig and Tubiello (2007)

Executive Summary

Background

Climate change projections indicate that over the coming decades B.C. agriculture will have to deal with very significant changing conditions. Projected climate impacts include: increases in the number of hot days, changes in precipitation patterns, more frequent and intense extreme weather events such as droughts, and associated effects such as flooding, erosion, excess moisture, wild fires and pest outbreaks. This will mean more risk and operational complexity for farmers, and will also impact Ministry of Agriculture programs such as Production Insurance and Agricultural Emergency Management. The scale and rate of climate change is anticipated to go beyond anything previously experienced and will require concerted adaptations for the B.C. agriculture sector to maintain growth and profitability. To begin addressing these needs, the Ministry of Agriculture, through the Growing Forward 2 program, is funding programming to direct and support agriculture sector adaptation at the regional and farm levels.

Without government involvement in adaptation programming, producers will make some adjustments to practices in response to climate and market forces. Adaptations that are beyond the scope of an individual producer may be neglected until there is a climate event that highlights the weakness the adaptation seeks to fortify. Investment in innovative practices that mitigate the impacts of climate change and have benefits beyond an individual producer's profitability, such as industry resilience, will be underfunded by private interests.

This report discusses illustrative scenarios in which agricultural regions of B.C. are faced with conditions consistent with climate projections for the 2030s. The analysis is intended to indicate what might be at stake in terms of reduced industry revenues if no adaptive actions are taken by government or private stakeholders. This analysis is not an evaluation of specific adaptive actions (e.g. improved farm drainage), but rather shows the benefit of planning and preparation similar to the Ministry's adaptation programming.

Approach

The analysis technique used was chosen following a comprehensive literature review of climate change, economic analysis, agriculture and adaptation (separate report, completed in November 2014). More technical and complex methods were not chosen due to time constraints, data availability, and modelling capacity limitations. Scenario analysis is a practical approach that enables decision makers to analyze how critical uncertainties will evolve under a set of assumptions, and to determine how best to proceed in that particular state of the world. The scenarios presented in this document were developed collaboratively with experts in the fields of agrology, climate science, adaptation and economics. The scenarios pertain to the Cowichan, Cariboo, Peace, and Okanagan regions.

Adaptations reduce the negative impact of a climate stressor on farm cash receipts and three cases (low, medium, and high) are presented to show a range of implementation extent and adaptation effectiveness. The economic benefit of adaptation is calculated as the difference between industry revenues (or farm cash receipts) with adaptation and without adaptation when a climate stressor event occurs in the year 2035. The values presented are for industry revenues in a single year (2035) but the

economic benefit of adaptation is a constant share of industry revenues in each case (with the exception of the Cariboo Region).

The "without adaptation" scenario is an illustrative "bookend" that must be qualified by the fact that adaptation work has already begun through knowledge dissemination and planning. Even without direct government involvement producers will continue to adapt to challenging conditions, although potentially not to the degree necessary to cope with the unprecedented changes anticipated due to climate change. Similarly, the complete adaptation scenario is unlikely, since not all adaptations are suited to unique production systems and it will not be possible to anticipate all climate change vulnerabilities. For this reason, the case with adaptation still depicts negative impacts of undesirable weather conditions.

Results

In the Okanagan Valley, the benefit of adaptation to extreme heat and drought ranges from $58 million in the case in which there is low effectiveness or implementation of adaptation to $154 million in the case with high effectiveness. Drought and water availability is also an issue in the Cowichan Valley; in this scenario economic benefits of adaptation are between $5 million and $14 million. In the Peace region, the impact of cumulative years of drought and extreme precipitation during the fall harvest demonstrates an economic benefit of adaptation between $19 million and $37 million. Through adaptation to changing precipitation patterns in the Cariboo, the economic benefit for the cattle industry is between $24 million and $65 million.

Table 1: Economic Benefit of Climate Change Adaptation – All Regions

Region	Commodities	Climate Stressors	Adaptations	Case	Benefit of Adaptation ($M)
Cowichan	mixed: dairy, poultry, cattle, vegetables, berries, wine grapes	less winter snow summer drought	regional water planning, increased water storage, irrigation efficiency	Low Medium High	**$5** **$9** **$14**
Cariboo	beef cattle, forage crops	increased spring and fall precipitation and summer dry spells	management Intensive grazing, surface water management, irrigation	Low Medium High	**$24** **$38** **$65**
Peace	grains, oilseeds	cumulative years of drought and extreme precipitation in the fall	conservation tillage, pest monitoring, improved drainage	Low Medium High	**$19** **$25** **$37**
Okanagan	apples, grapes and 96% of B.C.'s soft fruit. Sweet cherries, B.C. VQA wines	severe drought reducing water availability	water storage and planning, increase irrigation efficiency	Low Medium High	**$58** **$96** **$154**
Total		major climate event in all 4 regions	effective implementation of all feasible agricultural adaptations	Low Medium High	**$105** **$169** **$270**

Notes

1. Low, medium and high cases reflect the effectiveness of adaptation. Low effectiveness mitigates the negative impact of the climate stressor by less than high effectiveness.
2. Total does not represent the full provincial total due to regions missing from the analysis (e.g. Fraser Valley).

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1. Introduction

Climate change projections indicate that over the coming decades B.C. agriculture will have to deal with very significant changing conditions. Projected climate impacts include: increases in the number of hot days, changes in precipitation patterns, more frequent and intense extreme weather events such as droughts, and associated effects such as flooding, erosion, excess moisture, wild fires and pest outbreaks. This will mean more risk and operational complexity for farmers, and will also impact Ministry of Agriculture programs such as Production Insurance and Agricultural Emergency Management.

The scale and rate of climate change is anticipated to go beyond anything previously experienced and will require concerted adaptations for the B.C. agriculture sector to maintain growth and profitability. To begin addressing these needs, the Ministry of Agriculture, through the Growing Forward 2 (GF2) program, is funding programming to direct and support agriculture sector adaptation at the regional and farm levels.[2]

This report discusses illustrative scenarios in which agricultural regions of B.C. are faced with conditions consistent with climate projections for the 2030s. The analysis is intended to indicate what might be at stake in terms of reduced industry revenues if no adaptive actions are taken by government or private stakeholders. This analysis is not an evaluation of specific adaptive actions (e.g. improved farm drainage), but rather shows the benefit of planning and preparation similar to the Ministry's adaptation programming.

1.1 Adaptation Program Overview

In 2008, in response to climate action by the B.C. government, the B.C. Agriculture Council and the Investment Agriculture Foundation of B.C. set up the B.C. Agriculture and Food Climate Action Initiative (CAI) to assist the agriculture sector with addressing the challenges, and acting on the opportunities associated with climate change. The CAI has been led by an advisory committee of agricultural producers, food processors and representatives from various government agencies.

In the spring of 2012, the CAI completed a climate change risk and opportunity assessment series for B.C. agriculture (*Adaptation Risk & Opportunity Assessment* report series).[3] Based on the findings of the assessments, the CAI has developed regional agricultural adaptation strategies with local partners in the Peace, Cowichan Valley, Delta, and Cariboo Regions. The CAI also completed a series of reports on six farm-level adaptation practices: water storage, drainage, shelterbelts, nutrient management, conservation tillage, and management-intensive grazing.

The Ministry of Agriculture is providing approximately $5.7 million for adaptation programming to be delivered by CAI over 2014-2018.[4] Three more regional adaptation strategies will be developed

[2] The Ministry of Agriculture's adaptation programming supports the B.C. government's 2010 climate change adaptation strategy, which has three focus areas: building a strong foundation of knowledge and tools; building collaborative partnerships with key stakeholders and taking action in climate sensitive sectors; and making adaptation part of B.C. Government's business.
[3] Crawford and MacNair (2012)
[4] The funding is provided through Growing Forward 2, a federal-provincial-territorial initiative.

and implemented (one for the Fraser Valley is currently underway and one for the Okanagan is planned to commence in 2015). Farm-level adaptation will be advanced through pilot and demonstration projects funded through the new Farm Adaptation Innovator Fund. . The regional strategies and the farm-level projects will contribute to greater adaptive capacity in the sector.

In addition to funding the programming delivered by CAI, the Ministry of Agriculture has completed a structured assessment of the adaptive capacity of 14 of its programs using the Adaptive Design and Assessment Policy Tool (ADAPTool). The Ministry initiated the ADAPTool pilot in 2013 to "provide the Ministry with a systematic assessment and understanding of the potential for its policies and programs to support climate change adaptation".[5] The ADAPTool report included recommendations for all the programs assessed, including priority actions for AgriStability, Production Insurance, Agricultural Emergency Management, and Invasive Alien Plant Program and Pest Management. The Ministry is developing an implementation strategy for the ADAPTool recommendations.

[5] Pilot Application: Adaptive Design & Assessment Policy Tool (ADAPTool) – Government of British Columbia Agriculture Programs. International Institute for Sustainable Development. 2013.

1.2 The Value of Climate Change Adaptation

This report estimates the economic value of climate change adaptation in the B.C. agriculture sector. However not all the benefits of adaptation are captured in this analysis. Climate change has the potential to negatively impact agricultural productivity through more frequent and severe extreme weather events, water management complexity, and the changing distributions of pests and diseases.[6] Agricultural productivity is the level of output that is generated from each unit area of land, and productivity growth is the driver of long-run economic growth. Innovation, or technological change, is a key driver of productivity growth, along with improved management practices to better combine resources. Adaptation to climate change protects agricultural productivity from the anticipated adverse effects of climate change. Innovative adaptations enable producers to capitalize on opportunities, increase productivity and drive economic growth.

There are also non-economic benefits to climate change adaptation, such as reducing psychological stress for producers who are aware of the potential impacts and have management plans in place. In the event of a major climate event, having functioning plans in place reduces costs by improving response times and establishing decision making and co-ordination channels. Avoiding interruptions in food supply chains carries economic and non-economic benefits.

Adaptations that provide a clear benefit to producers are likely to be undertaken by producers themselves ("autonomous adaptation"). However, there may also be broader benefits to the agriculture sector, government, or society in general, and if these broader benefits cannot be captured by the individual producers making the decision about how much adaptation to undertake, then there may be under-investment in adaptation from a societal perspective. This provides an economic rationale for government to provide incentives for adaptation or to provide the adaptation directly. Furthermore, there are adaptations which cannot feasibly be undertaken by individual producers acting alone, such as dikes, emergency preparedness and evacuation planning, and infrastructure like water storage and transportation. The benefits of these adaptations may be considerable, but without government involvement there may not be the collective action needed to realize these benefits.

[6] For more information on anticipated climate change impact on the B.C. agriculture sector, please see the Climate Action Initiative Risk and Opportunity Assessments and the Regional Adaptation Strategy series.

2. Literature Review: Economic Impact of Climate Change and Benefit to Adaptation

The literature review explored many different analysis techniques to determine the economic impact of climate change and adaptation in B.C., finding three promising methodologies. These methodologies are Ricardian analysis, Integrated Modelling Systems (or Integrated Assessment Models) and scenario analysis. These analysis techniques are discussed below.

a. **Ricardian models, or hedonic pricing models,** are used to answer the questions: What is the economic impact of climate change, and in some cases, How is this reduced by adaptation? In this approach, hedonic pricing models are used to isolate the price effects of various characteristics, for example, the amount by which a nearby green space increases the value of a home. Applied to this project, Ricardian analysis would be used to quantify the costs of climate change by isolating the impact of various weather indicators on the price of land. The parameters derived from this technique would be used with climate projections to determine future farm land values.

   Advanced Ricardian regression techniques have used multinomial probability distributions to determine the probability that an Agro-Ecological Zone (a proxy for productivity developed by the Food and Agriculture Organization) will be present in a given district.[7] Different Agro-Ecological Zones have different net revenues and crop suitability. As these zones shift across the continent due to climate change, net revenue and crop choice will change in a given district. This method allows for one type of adaptation (changing crop mix in response to climate change) but requires advanced econometrics. The results of this study found that there would be fewer high-value Agro-Ecological Zones in Africa, resulting in a negative economic impact of climate change on the African economy.

   Ricardian analysis captures autonomous adaptations by assuming that farmers will maximize the value of land subject to climate conditions. It does not provide a good framework to evaluate planned adaptation or the impact of knowledge generating programs designed to encourage adaptation to climate change that may not immediately increase profits and as a result land values. Further research could be done by developing the necessary data which pairs detailed land use with land values. Preliminary attempts have been made using B.C. Assessment data and Land Use Inventories compiled by the Ministry of Agriculture. Several issues emerge when combining these complex data sets, so a focused research project would be necessary to complete this work.

b. **Integrated modelling systems (IMS)** in which several models work together to generate economic impacts of climate change on agriculture are the new standard in this area of analysis. The IMS approach is common at the global scale[8], and has also been used in regional climate

[7] Kurukulasuriya and Mendelsohn (2008)
[8] Tan 2003, Rosegrant (2008)

adaptation studies.[9] Climate scenarios, crop simulations, and economic models are common components of IMS used to measure impacts of climate change adaptation (Figure 1). In the figure below, the baseline scenario would model the outcome of climate change on the agriculture sector without adaptation. A representative farmer economic model would show which adaptations would be selected by allowing farmers to choose different crop types or management techniques (such as higher efficiency irrigation). A partial equilibrium (PE) economic model would demonstrate the aggregate impact on the agriculture sector. The IMS can be tailored to suit the research question through the choice of the economic model.

The IMS is created by linking several distinct models together by matching outputs of one model to inputs of another. Climate change scenarios produce future projections of daily, monthly or annual temperature and precipitation. This information is an input into hydrology models and crop simulations, which produce estimates of water availability and crop growth respectively. Based on projected crop yields and water availability, economic outcomes are estimated with farm level decision making or sector level PE models.

An integrated modelling system in which climate, water, agricultural and economic models are linked allows for the greatest amount of flexibility and specificity in modelling climate change adaptation economics. However, these models have only just begun to incorporate adaptation.[10] Most major modelling exercises use downscaled climate data in the integrated modelling approach. Developing the expertise to work with models from several different disciplines and finding or creating linkages between these models is the most difficult aspect of the analysis.

In Figure 1, each blue box represents an individual model, arrows represent outputs from one model and inputs into the next, and the final outcome is in the green box.

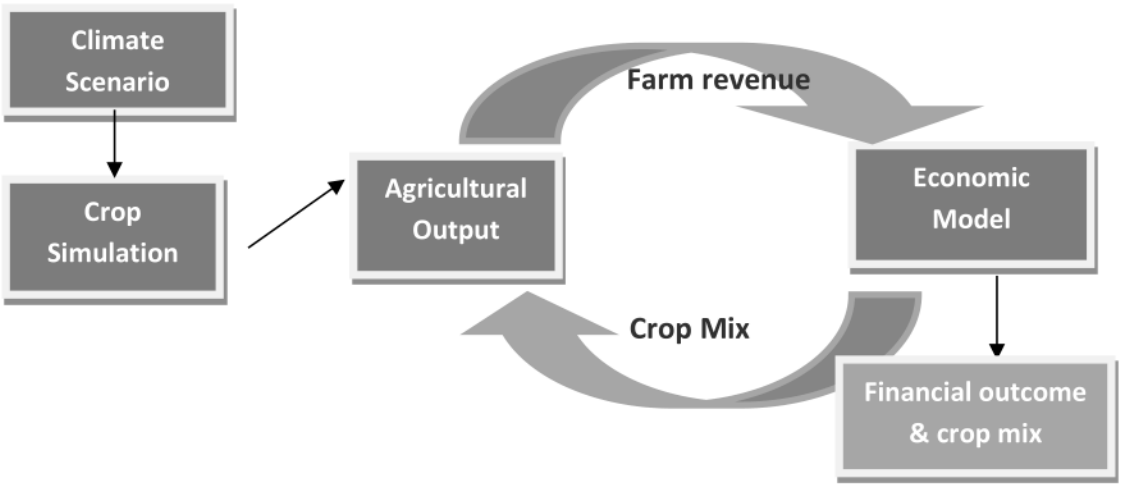

Figure 1. Integrated modelling system (Adapted from the World Bank 2010)

[9] World Bank (2008), Rosegrant (2012)
[10] Gordon et al (2014) , and work underway at AAFC Agri-Environmental Policy Research

c. **Climate scenarios** model a specific impact of climate change. Climate stressors such as sea level rise, more frequent floods, and droughts are often cited as consequences of climate change. However a great deal of uncertainty surrounds the extent, timing, and location of these climate stressors. In order to plan for these hazards without exact data on frequency or magnitude, climate stressor scenarios are built using reasonable assumptions. This approach works best with information that is currently available from the Ministry of Agriculture. Scenario analysis is a practical approach that enables decision makers to analyze how critical uncertainties will evolve under a set of assumptions, and to determine how best to proceed in that particular state of the world. The collaborative development of the scenarios has the benefit of fostering an ongoing dialogue within the Ministry about the costs and benefits of adaptation to climate change.

3. Scenario Planning for Adaptive Policy

Scenario analysis allows participants to identify major uncertainties so that the consequences of today's decisions can be evaluated. A strength of scenarios is their ability to change the assumptions decision makers have about the way the world works. For that reason, the process of scenario development is as important as the final product.[11] Scenario analysis opens up discussions about key assumptions and uncertainties and allows decision-makers to consider the impacts of several different visions of the future.

The scope and scale of climate change impacts are anticipated to exceed anything previously experienced. The scenarios presented in this document go beyond historical experiences to describe two versions of the world: one in which no adaptive actions are taken and one in which there is a concerted effort to proactively adapt to changing conditions. An agricultural producer's ability to adjust practices and management techniques on their own is described as autonomous adaptation in the economics literature. While autonomous adaptations will play an important role in adaptation to climate change, it is difficult to model individual responses to an uncertain future. Producers may lack adequate information on climate change impacts to make informed investments.

There may be broader benefits to the agriculture sector and if these broader benefits cannot be captured by the individual producers making autonomous adaptations, then there may be under-investment in adaptation from a social perspective. Some investments may be beyond the scope of a single producer and cannot work together without government involvement. There may also be distributional issues in which the producers at highest risk from climate change have the fewest resources available to adapt. This provides an economic rationale for government to provide incentives for adaptation or to provide the adaptation directly. The government's role in climate change adaptation is both to facilitate the large scale adaptations that cannot be undertaken at the farm level and to provide information and encouragement for farmers to take adaptive actions to anticipated climate stressors. Investment in adaptation may also align with other specific policy goals such as food security and increasing industry resilience.

Scenario analysis is an important step in integrated and forward-looking analysis, in which key factors that affect policy performance are identified.[12] Scenarios are internally consistent stories describing paths from the present to the future.[13] They enable decision makers to analyze how critical uncertainties will evolve under a set of assumptions, to determine how best to proceed in that particular state of the world. The scenarios in this report map quantitative climate projections to anticipated agricultural impacts. Potential adaptations to respond to the agricultural impact are discussed and a range of economic consequences are calculated.

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[11] Brummell, A., and G. MacGillivray. *Introduction to Scenarios*. Scenarios to Strategy Inc., 2007.
[12] Swanson, D., Bhadwal, S. *Creating adaptive policies: a guide for policy-making in an uncertain world* (2009). The authors explain how integrated and forward looking analysis is a key characteristic of adaptive policy making and program design.
[13] Brummell, A. and Greg MacGillivray *Introduction to Scenarios and Scenario Planning* Scenarios to Strategy Inc.

The analysis indicates what might be at stake in terms of industry revenues if no adaptive actions are taken on the part of public or private stakeholders. It is not meant as a valuation of specific adaptive actions, but rather to show the benefit of planning and preparation compared to the status quo[14]. The economic benefit of climate change adaptation is calculated as the difference between industry revenues (or farm cash receipts) with adaptation and without adaptation when a climate stressor event occurs in the year 2035. The benefit to adaptation is a constant share of industry revenues each year, with the exception of the Cariboo Region in which economic benefits grow as adaptation progresses over time.

The baseline scenario allows farm cash receipts to grow at their long run historical (or most reasonable) rates of growth. The economic impact of the climate stressor without adaptation was discussed with regional agrologists as a percentage reduction in farm cash receipts from the baseline. The without adaptation scenario is somewhat unrealistic for two reasons: adaptation work has already begun through knowledge dissemination and planning, and even without direct government involvement producers will continue to adapt to challenging conditions, although perhaps not to the degree necessary to cope with the unprecedented changes anticipated due to climate change. Complete adaptation is also unlikely, since not all adaptations are suited to unique production systems and it will not be possible to anticipate all climate change vulnerabilities. For this reason, the true economic benefit is between zero and the values calculated in this report. Within the scenarios, high, medium and low cases were created to offer a range of possible outcomes depending on the degree of implementation and the effectiveness of the adaptations presented. The medium case was developed in collaboration with the regional agrologists based on their experience with significant weather events in the past.

[14] In an economic analysis of specific adaptations, for example farm drainage improvements, the results would provide decision makers with metrics such as returns on investment, benefit cost ratios and net present value.

4. Climate Stressor Scenarios

4.1 Introduction to the Climate Stressor Scenarios

Climate change is expected to cause an increase in extreme weather events and stressors for agriculture in key regions of B.C., and adaptation actions can reduce the impact on the agriculture sector. The purpose of the climate stressor scenarios presented here is to highlight the risks and vulnerabilities in four agricultural regions of B.C. (Cariboo, Peace, Cowichan and Okanagan) and show the importance of adaptation that reduces the negative impacts of climate change. The regional approach was necessary because of the diversity of agriculture and climate change impacts across B.C. The regions chosen were based on the availability of adaptation information, economic significance, stage of adaptation planning and degree of regional commodity specialization. The analysis notably lacks the largest agricultural economic region, the Fraser Valley, for which a regional adaptation strategy is currently being developed. A recently published report by CAI discussed the economic impacts of the major climate stressor, flooding, in the Fraser delta region[15]. The adaptation investments go beyond the scope of projects currently underway in B.C. and are meant to illustrate the importance of further investment in adaptation programming generally. The analysis is not an evaluation of the economics of specific adaptive actions.

The scenarios present combined impacts of several climate stressors and the economic consequences associated with these impacts. The climate projections were presented to regional agrologists to determine what the expected economic impact of the climate stressor would be without adaptation. A reasonable reduction in farm cash receipts caused by the climate stressor was derived through consultations with each regional agrologist. The high, medium and low cases change the effectiveness of the adaptations presented. In the low case, adaptation has a low effectiveness against the climate stressor and farm cash receipts fall by the highest percentage. In the high case, the adaptations are highly effective at mitigating the negative impacts of climate change and farm cash receipts fall by the lowest percentage. In the Cariboo region, the without adaptation scenario shows the cattle industry continue at the long run historical rate of decline. With adaptation to climate change, producers are able to capture benefits from climate change and increase forage production and cattle sales. Again, the high, medium and low cases explore the effectiveness of the adaptations in mitigating the negative impacts of climate change.

These scenarios for Cariboo, Peace and Cowichan regions are written in such a way as to be consistent with data from the North America Regional Climate Change Assessment Program (NARCCAP) on extreme weather events. [16] This data is based on climate projections for the 2050s (with a simple adjustment applied to what they would approximately apply to in the 2030s), and is derived from 11 regional climate models following the A2 emissions scenario.[17] This information was provided by the

[15] Robbins, M and Tatebe, K (2014)

[16] The North American Regional Climate Change Assessment Program (NARCCAP) is an international program to produce high resolution climate change simulations in order to investigate uncertainties in regional scale projections of future climate and generate climate change scenarios for use in impacts research.

[17] The A2 emissions scenario is often referred to as "business as usual" and is based on the assumption of: relatively slow demographic transition; relatively slow convergence in regional fertility patterns; relatively slow convergence in inter-regional GDP per capita differences;

Pacific Climate Impacts Consortium (PCIC) at the University of Victoria and interpreted with the help of PCIC climate scientist Trevor Murdock. Additional information was gathered from PCIC's Plan2Adapt online tool for the Okanagan Valley.[18]

Regional climate model projections indicate increases in temperature and precipitation compared to historical 30-year averages. However, these will not be evenly distributed due to increased climate variability. Climate variability and extreme weather are a greater concern for agriculture than changes in annual averages. These scenarios explore situations in which past extreme weather events are further aggravated by climate change. The qualitative impact descriptions were drafted using information from the Risk and Opportunity Assessments and the Regional Adaptation Strategies produced by the CAI.

The climate stressor scenarios were then developed collaboratively with Trevor Murdock (PCIC), Emily MacNair (CAI), and Ministry of Agriculture regional agrologists representing the four regions: Geneve Jasper (Cariboo), Julie Robinson and Lori Vickers (Peace), Carl Withler and Jim Campbell (Okanagan), and Wayne Haddow (Cowichan). This approach enabled the scenarios to be consistent with the climate projections and for the climate projections to be effectively communicated to the group directly by a climate scientist. The scenarios were verified for accuracy through discussion with regional agrologists about the implications of the climate stressors, uncovering the details of how the climate stressor would impact agriculture in their regions. The adaptations presented are considered appropriate actions to address the climate stressors. The most important benefit of this approach is that it continues a dialogue within the ministry about the anticipated impacts of climate change and the potential benefits of adaptation.

4.2 Cowichan Valley

The Cowichan Valley Regional District (CVRD) stretches from the Malahat to just south of Nanaimo, and from the southern Gulf Islands to the west coast of Vancouver Island, covering approximately 3,473 square kilometres.[19]

Agricultural production in the CVRD is extremely diverse, including: dairy, poultry, cattle, greenhouse vegetables and an array of field and horticulture crops ranging from vegetables to berries to wine grapes. There are also many mixed farms in the region.[20]

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relatively slow end-use and supply-side energy efficiency improvements (compared to other storylines); delayed development of renewable energy; and, no barriers to the use of nuclear energy.

[18] http://www.pacificclimate.org/analysis-tools/plan2adapt

[19] Cowichan Valley Regional District. 2010 State of the Environment Report. June 2010, p..15. http://www.12things.ca/12things/uploads/FinalReportJune2010.pdf

[20] Crawford, E.; MacNair, E. and K Tatebe *Cowichan Regional Adaptation Strategy* (2012)

Climate Stressor Description

Stressor scenario: Less snow in winter, drought in the summer. An intense summer drought is caused by longer warm spell durations and less summer precipitation.

2030s normal climate context:

- Annual temperatures warmer by over 1^{o}C (on average), with larger increases in summer than winter.
- Longer periods without any precipitation occur, primarily in the summer, and **consecutive dry spells are 10 days longer** than the recent past.
- **Warm spells**[21] increase in frequency by a factor of 4
- Winter precipitation is more rain than snow, resulting in lower river flow in the Koksilah, Cowichan and Chemainus rivers earlier in the summer.

Agricultural Impact

- Severely reduced water availability due to lack of precipitation and low river flow. The lack of precipitation will reduce forage crop yields, which will increase feed costs for livestock producers.
- The hot, dry summer will also reduce surface water available for livestock. In response, producers will reduce breeding stock by not buying calves from other parts of the province causing a reduction in herd size. The decline would be comparable to levels seen after the 2003 Bovine Spongiform Encephalopathy (BSE) issues, approximately a **30% reduction in herd size**.
- The final forage cut will be eliminated due to lack of irrigation water at the end of the season, which would **reduce total forage yield by 20%** if producers average three cuts per year.
- The extended warm spell may cause corn to ripen early, which would **reduce the maize yield by 10%.**

Possible Adaptations

- Regional water planning and increases in water storage.
    - On-farm water management can be expensive and require government support unless it is funded by a dedicated investor.
    - There are some opportunities for regional water storage in Cowichan Lake.
    - Producers could use water recycled for agriculture – but this would require a large infrastructure investment to move the heated water closer to agriculture.
    - Increase water storage to supply adequate water for irrigation. This will allow farmers to switch to alternative crops from dry land forage when there is less precipitation in future.
- Irrigation efficiency improvements also play an important role in water planning. Efficiency gains can extend the irrigation period or increase irrigated area if less water is wasted

[21] Warm spells throughout the climate stressors refer to the "Warm Spell Duration Index" from the CLIMDEX index of climate extremes which reflects the number of warm spells of minimum 6-day duration. Warm refers to a day being in the 90th percentile for that day of the year and warm spells in the WSDI index can occur at any time of year.

Economic Impact of Adaptation

- **Without adaptation:** Due to the diverse nature of agriculture in the Cowichan Valley, the combined effects of reduced herd size, forage production and maize yield are represented by a **decrease of 15% for total farm cash receipts from the region**.
- **With adaptation:** Regional water planning and on-farm irrigation efficiency improvements are the best suited adaptations to cope with lower river stream flow and summer precipitation. If plans are created to manage these situations and use water most efficiently during a drought**,** and irrigation use is expanded in the region, **total farm cash receipts will only drop by 5%**[22] for those dry land producers who rely on precipitation.

Benefit of Adaptation

The economic benefits of adaptation are shown in Table 2, below. In all cases the impact of the climate stressor without adaptation reduces farm cash receipts by 15%. The table depicts three adaptation cases; the low case has low implementation or effectiveness of adaptation while in the high case adaptation is widely implemented or very effective.

- **Low:** With adaptation there is still inadequate water to meet the needs of local producers and farm cash receipts fall by 10% during the drought. The benefit of adaptation is then $4.7 million.
- **Medium:** Water planning and storage is better able to mitigate the negative impacts of the climate stressor, farm cash receipts fall by 5%.
- **High:** If adaptation is able to completely mitigate the negative impacts of reduced summer precipitation long warms spells, farm cash receipts are not affected by these changing conditions. The benefit of adaptation is $14 million.

Table 2: Economic Impact of Climate Change Adaptation – Cowichan Valley

Cowichan Valley	**Low**		**Medium**		**High**	
Climate Impact	**w/o Adaptation**	**With Adaptation**	**w/o Adaptation**	**With Adaptation**	**w/o Adaptation**	**With Adaptation**
Commodity	Total Farm Cash Receipts		Total Farm Cash Receipts		Total Farm Cash Receipts	
Revenue Reduction	15%	10%	15%	5%	15%	0%
Revenue in 2035 ($M)	$80	$84	$80	$89	$80	$94
Benefit of Adaptation ($M)	**$5**		**$9**		**$14**	

Notes

1. Revenues are measured by total farm cash receipts for 2013, the share of farm cash receipts in the Cowichan Valley from the 2011 Census of Agriculture, which increase by the 20-year compound annual growth rate (3%) until they are shocked by a revenue reduction in 2035.
2. Farm cash receipts are from Statistics Canada Table 002-0001
3. Regional shares of production and farm cash receipts from 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000

[22] Of the potential agricultural land (33,200 ha) only 2,465 ha (7.4%) are currently irrigated. *Cowichan Regional Adaptation Strategy* p.3

4.3 Cariboo Region

Much of the Cariboo Region is high, rolling plateau (with multiple mountain ranges). The Fraser River winds through the region, where forage crops are produced on the benches of the river and its tributaries. The capability of the soils in much of the region are a limiting factor, but areas with better river bench soils are able to produce high quality forage as well as root vegetables and potatoes. Some valleys soils have high clay content but with careful management, can produce a range of forage and field crops.

The beef cattle sector makes up about 27% of the agricultural operations in the region (farms where beef cattle contribute more than 50% of the estimated farm income), and forage crops make up 93% of the total cropped area (50,449 hectares).[23] Crown rangeland provides about 40% of the annual forage requirements of the ranching industry. As has been the case across B.C., there has been a significant reduction in the numbers of beef cattle in the region since the early 2000s (from 57,015 in 2006 to 39,430 in 2011). [24, 25]

This scenario is structured differently than the others. Rather than a single climate event at the end of the scenario horizon, producers must actively adapt to changing climate and precipitation patterns over the next 15 years. If they are able to successfully adapt, the rate of growth for regional farm cash receipts is changed. If they are unable to adapt, the cattle industry continues in a 20-year decline of 1.6% per year. While this decline was influenced by market conditions in the early 2000s, climate change presents a similar challenge to producers.

Climate Stressor Description

Stressor scenario: increased moisture in spring and fall with higher temperatures and longer dry spells in the summer. A warm, wet winter and spring are followed by a hot, dry summer in which warm spells last longer than before and there are significantly more extremely hot days.

2030s normal climate context:

- Increased annual precipitation by over 10% is experienced as **heavier precipitation in the winter, spring and fall.** The wettest days in November and May are on average **10% wetter than they were from 1971-2000.**
- Rains subside in June, and the three months of July, August, and September are hot and dry.
- Warm spells[26] increase in frequency by a factor of 4.
- Temperature reaches up to 40 ^{o}C for one day, which used to occur only once in 25 years on average, and which now occurs almost every second year.

[23] Statistics Canada, 2011 Census of Agriculture, Farm & Farm Operator Data, catalogue no. 95-640-XWE; and Dobb, Allen 2013. Forage Production & Export Potential in BC's Central Interior. Report prepared for the BC Forage Council.
[24] Ministry of Agriculture. Cariboo Regional District Agriculture in Brief Fact Sheet. 2013.
[25] Charlton, S.; Crawford, E.; MacNair, E.; Dobb, A. and K. Tatebe. *Cariboo Regional Adaptation Strategy* (2012).
[26] Warm spells throughout the climate stressors refer to the "Warm Spell Duration Index" from the CLIMDEX index of climate extremes which reflects the number of warm spells of minimum 6-day duration. Warm refers to a day being in the 90th percentile for that day of the year and warm spells in the WSDI index can occur at any time of year.

Agricultural Impacts

- The wet spring results in lush green grass sooner in the season and earlier turn out to pasture. A wet, warm October increases grazing opportunities in the fall if frost is delayed, overall increasing the length of the grazing season on both ends.[27]
- Increased moisture in May/June, with higher temperatures, will result in favourable forage yields.
- The long warm spell causes the second cut hay forage yield to decrease. However, the first cut is above average. Farms with irrigation capacity can also benefit from the hot summer by increasing forage yield.
    - Note: There is variable irrigation use in the Cariboo Region: the Fraser River corridor is irrigated; east to Quesnel is dry land forage; the 100 Mile House area is mixed irrigation and dry land operations.
    - In the Cariboo Region, average yield for forage crops is 4 tonnes/acre when irrigated and 2 tonnes/acre for dry land crops.
- Extreme heat causes heat stress to cattle and reduces available surface water. It will take longer to finish the cattle, delaying the sale of the animals and increasing producer costs. Water constraints compound heat stress – when there is not enough water, animals are not hungry.
- Benefits from a longer grazing season, due to early turn-out to pasture and increased grazing opportunities in the fall, require additional surface water. If water and forage are not available due to extreme heat, producers will decrease the herd size, reducing their final sales revenues.

Possible Adaptations

- **Widespread adoption of Management Intensive Grazing (MiG)**, which includes planning for extreme heat by using highest elevation pastures at the peak of the summer and allows adequate rest for forage crops.
    - One producer reported that the practice with daily cattle movements increased grazing by two weeks and resulted in 25% to 100% forage yield increases.
    - Planning to maximize increased grazing opportunities if re-growth occurs in October due to delayed frosts.
    - Planning for water storage needs at higher elevations when moving cattle out of higher temperature zones.
- **Water infrastructure for irrigation and surface water**. Earthen dams are common for water storage and surface water for cattle. The current challenge is dam decommissioning due to the high costs of dam inspection and upgrades. This reduces surface water availability for cattle and irrigation at a time when producers should be increasing water storage.
    - It may be possible to expand irrigation capacity in the Fraser River Corridor and in the 100 Mile House area.
    - On-farm water storage is preferable to regional irrigation infrastructure. However, dams need to be secure enough to withstand extreme precipitation and meet stringent safety requirements.

[27] Note: temperature in the spring is a key determinant of the timing to turn cattle out to pasture; cool, wet weather delays turnout, and warm, wet weather accelerates turn out.

Economic Impact

- **Without adaptation**: The industry continues along its historical trajectory. Some producers benefit from favourable spring and fall conditions, but are also scrambling to deal with water shortages and heat stressed animals during the heat spells in the summer.
    - The result is that **farm cash receipts for cattle sales continue to fall by 1.6% annually over the next 20 years**.
    - Forage receipts remain unchanged as increases in first cut yields are offset by decreases in second cut yields.
- **With adaptation**: Encouraging the adoption of Management-intensive Grazing that considers climate change will improve planning for plant and animal heat stress. Water use planning will ultimately form a part of effective management planning, for forage production and cattle surface water needs. Increasing irrigation capacity can allow farms to benefit from the higher average temperatures and summer warm spells, overall increasing their forage yields. Together, these practices should mitigate the negative impact from drought and extreme heat caused by climate change. By planning for climate change, producers are able to capture benefits: **forage revenues increase by 5% and revenues from cattle sales grow by 3%.**

Benefit of Adaptation

The economic benefits of adaptation are shown in Table 3, below. Without adaptation the cattle industry continues to contract at an annual rate of 1.6% and the forage industry remains constant, consistent with long run industry growth trends. The table depicts three adaptation cases:

- **Low:** Adaptation has a modest impact on industry revenues and farm cash receipts for forage and cattle sales in the Cariboo, with an increase of 2% per year.
- **Medium:** Adaptation has a more significant impact on forage production, and additional forage produced can be sold to international buyers. With adaptation farm cash receipts for forage and cattle increase by 5% and 3% respectively.
- **High:** Adaptation has a positive impact on forage and cattle production and farm cash receipts, with an increase of 5% annually until 2035 for both industry segments.

Table 3: Economic Impact of Climate Change Adaptation – Cariboo Region

Cariboo	Low				Medium				High			
Climate Impact	w/o Adaptation		With Adaptation		w/o Adaptation		With Adaptation		w/o Adaptation		With Adaptation	
Commodity	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle
Annual Growth	0%	-2%	2%	2%	0%	-2%	5%	3%	0%	-2%	5%	5%
Revenue in 2035 ($M)	$3	$18	$5	$41	$3	$18	$10	$50	$3	$18	$10	$77
Benefit of Adaptation	**$24**				**$38**				**$65**			

Notes

1. Revenues are measured by farm cash receipts for forage and cattle for 2013, the share of farm cash receipts in the Cariboo from the 2011 Census of Agriculture, which increase by the growth rate outlined in each case until 2035.
2. Farm cash receipts are from Statistics Canada Table 002-0001.
3. Regional shares of production and farm cash receipts from 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000.

4.3 Peace River Region

The Peace River Regional District is the largest regional district in B.C.[28] The topography of the region is varied, with mountainous areas in the south and west and the bulk of the agricultural land located in the relatively flat northeastern portion of the region; adjacent to a similarly productive agricultural area of Alberta.

The primary agricultural commodities of the Peace Region include grains, oilseeds, forage seed, and cattle and forage. Many producers are involved in some combination of these commodities. Overall, 60% of B.C. grain and oilseeds acreage is seeded in the Peace Region.[29] While the number of cattle has dropped in recent years, the Peace Region remains a proportionally significant cattle production area in BC.[30]

Climate Stressor Description

Stressor scenario: Cumulative years of drought with excess moisture in the fall. Although annual precipitation increases by 20% on average, there continue to be dry years such as 2003 - 2008. Increased precipitation is concentrated in extreme rain events (days of heavy rain and consecutive days of rainfall) in the spring and the fall. This scenario depicts the third consecutive year of hot, dry summers in the Peace region during the 2030s and a fall with extreme rain events. The Peace Region is a large and diverse agricultural area and not all farmers will face uniform conditions.

2030s normal climate context:

- Warmer summer and an increase in frequency of warm spells[31] by a factor of 4 results in **agricultural drought** due to reduced soil moisture.
- The dry summer is aggravated by **high average temperatures.**
- Following the hot, dry summer, **precipitation in the fall comes as extreme rain events and consecutive days of rain.**
- Most precipitation occurs on the wettest days: **nearly 50% more days would classify as the wettest day of the month** from the historical record. These extreme precipitation events are most likely to occur in the spring and the fall.

Agricultural Impacts

- The cumulative impact of several years of drought **reduces average crop yield by two-thirds**, reducing it from 30 bushels per acre to 10 bushels per acre.
- Pest outbreaks are worsening and warmer winters and longer frost free periods will contribute to this problem. Grasshopper outbreaks can cause losses of **20-30% of canola plants at the beginning of the season.**

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[28] Peace River Regional District: Our History http://prrd.bc.ca/about/
[29] 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000
[30] Crawford, E.; MacNair, E. and K. Tatebe. *Peace Regional Adaptation Strategy* (2012)
[31] Warm spells throughout the climate stressors refer to the "Warm Spell Duration Index" from the CLIMDEX index of climate extremes which reflects the number of warm spells of minimum 6-day duration. Warm refers to a day being in the 90th percentile for that day of the year and warm spells in the WSDI index can occur at any time of year.

- Heavy fall rains reduce grain quality, from Grade 1 (human consumption) to Grade 3 (animal consumption), which results in a $2 per bushel reduction in the price of wheat and a $0.5 per bushel reduction in the price of oats and barley.

Possible Adaptations

- Conservation tillage to improve soil moisture retention during the drought. This practice is widely used with anywhere from 60% to 80% of producers already using this technique, in which they till their fields one out of every 10 years. While this practice is not right for all producers, encouraging those who can benefit to adopt the practice would increase the adaptive capacity of producers in the region.
- Pest outbreaks can be detected and mitigated or controlled through better monitoring and management practices. Better monitoring will allow for more proactive use of insecticides and other management practices before outbreaks seriously affect yields.
- Improved drainage for excess rain through field topography modification. There is high potential to expand this practice in the Peace Region. At present, only a few producers have laser levelled their fields. Better drainage allows farmers to get onto the fields faster after a major rain event, reducing the negative impact on grain quality.

Economic Impact of Adaptation

- **Without adaptation**: Cumulative years of drought reduce soil moisture and total production of grains falls by 60%. Pest outbreaks impact several small areas, reducing sub-regional grain yields by up to 80%. Heavy rains in the fall damage some crops and reduce the grade of the harvested grains. Overall impact**: farm cash receipts from grains and oilseeds fall by 40%.**
- **With adaptation**: Even with adaptation actions climate change will present considerable challenges to the agriculture industry. Strongly encouraging conservation tillage techniques to maximize soil moisture retention, implementing regional pest monitoring and management information, and encouraging better drainage systems for extreme precipitation events will reduce the Peace region's exposure to climate risks. However, the combined impacts of cumulative years of drought, extreme precipitation, and pest outbreaks will still negatively impact the agriculture sector, as not all farms will be able to anticipate or adapt to all impacts. The overall impact on the economy with adaptation**: farm cash receipts from grains and oilseeds fall by 20%.**

Benefit of Adaptation

The economic benefits of adaptation are shown in Table 3, below. Drought and extreme precipitation events across the region reduce farm cash receipts for grains and oilseeds by 40% to $75 million in 2035 without adaptation. The table depicts three adaptation cases:

- **Low:** Conservation tillage, pest monitoring and better drainage have limited effectiveness or the practice cannot be expanded in the region. With adaptation the economic impact of climate

change is somewhat mitigated and results in a decline of 25%, to $93 million. The benefit of adaptation is $18.6 million.

- **Medium:** Adaptation is more effective in this scenario; with adaptation farm cash receipts fall by 20%, to $99 million. The benefit of adaptation is $25 million.
- **High:** Adaptation is highly effective and widely implemented and results in a decline of 10%, to $112 million. The benefit of adaptation is $37 million.

Table 4: Economic Impact of Climate Change Adaptation – Peace Region

Peace Region	Low		Medium		High	
Climate Impact	w/o Adaptation	With Adaptation	w/o Adaptation	With Adaptation	w/o Adaptation	With Adaptation
Commodity	Grains and Oilseeds		Grains and Oilseeds		Grains and Oilseeds	
Revenue Reduction	40%	25%	40%	20%	40%	10%
Revenue in 2035 ($M)	$75	$93	$75	$99	$75	$112
Benefit of Adaptation ($M)	**$19**		**$25**		**$37**	

Notes

1. Revenues are measured by farm cash receipts for grains and oilseeds from 2013, the share of farm cash receipts in the Peace Region from the 2011 Census of Agriculture, which increase by the 20-year compound annual growth rate (6%) until they are shocked by a revenue reduction in 2035.
2. Farm cash receipts are from Statistics Canada Table 002-0001.
3. Regional shares of production and farm cash receipts from 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000.

4.5 Okanagan Valley

Apples, grapes and 96% of B.C.'s soft fruits are grown in the South-Central Okanagan. Further north in the Kelowna-Vernon area, apples are the main tree-fruit crop. There has been a general shift away from many types of tree fruit (apples, pears, peaches, plums and apricots) in recent years, largely due to challenges with profitability. Contrary to this trend, sweet cherry production has increased substantially.

Acreage has been shifting into wine grapes and there are now almost 4,000 hectares in grape production across the region.[32] The North Okanagan has well established cattle and dairy industries and its poultry production has grown in recent years.[33]

Climate Stressor Description

Stressor scenario: drought severely impacts water availability for agriculture. Because the scope, scale and rate of climate change is expected to be more severe than anything previously experienced, this scenario models a drought in which water is so severely restricted that perennial crops such as grapes and tree fruits are affected by water shortages. The key features are:

- A warm winter causes the majority of the precipitation in winter to fall as rain.

[32] British Columbia Grape Growers Association. 2011 BC Grape Acreage Report. http://www.grapegrowers.bc.ca
[33] Crawford, E and Emily MacNair Okanagan Region Risk and Opportunity Assessment 2012

- The little snow that falls melts quickly in the spring.
- The summer is hot and dry, with an increase in consecutive dry days above the historical record.
- During the summer there are more extremely hot days compared to the period from 1970-2000.

Agricultural Impacts

- Early and rapid winter run-off combined with a hot, dry summer severely reduces water availability. Due to requirements to ensure downstream water flow, domestic and agricultural water use is severely restricted.
- Water use for irrigation has been restricted for forage and annual crops in the past; however this drought is more severe than any previous droughts. Some irrigation districts are more strongly impacted than others and have to restrict water for all agricultural producers. The lack of consistent water metering also means that there is disparity among agricultural producers in how the restrictions are implemented.
- Extreme heat causes stress to white wine grapes and tree fruits. Elevated temperatures cause the stomata on the grape leaves to close and berry development is halted for a period of a few days to a few weeks after the extreme heat event. This can reduce the berry quality if photosynthesis does not properly resume.[34] Grapes may not achieve the desired acid levels which in turn affects wine flavour. B.C. wines must compete globally, leaving them subject to "double exposure": when climate factors reduce product quality this reduces the price premium and/or may limit sales.[35]
- Tree fruits can be negatively affected by extreme heat, including suffering from sun scald. [36]

Possible Adaptations

- Increase irrigation efficiency by encouraging the adoption of the highest efficiency delivery systems, water metering, and monthly reporting.
- Increase water storage capacity to retain winter rainfall and spring run off for summer irrigation when there is not adequate precipitation. Some water purveyors are already voluntarily increasing water storage, but additional incentives may need to be put in place to encourage these private not-for-profit entities to ensure there is adequate water available in the future.
- Overhead irrigation is often used to reduce the impact of heat scald by cooling the tree fruits. Adequate water supply is crucial for dealing with the impacts of extreme heat and extended droughts. Some netting and shade clothing can be used for tree fruits, but orchards need to be reorganized to accommodate this adaptation, which involves significant planning and investment.
- In the long run, when extreme heat and long warm spells become more common, producers will adapt by changing grape and tree fruit varieties better suited to hot climates similar to those of other wine growing regions. These high value crops will still be vulnerable to extreme weather and variable conditions.

[34] Belleville et all (2006)
[35] ibid.
[36] Crawford, E. and Emily MacNair. Wine Grape and Tree Fruit Production Risk and Opportunity Assessment (2012).

Economic Impact

Without adaptation: If water storage capacity does not increase and irrigation efficiency remains the same, water restrictions during a hot, dry summer will negatively impact all regional agriculture. In the past, water shortages have resulted in restrictions on lower value crops, such as forage or annual crops, in order to protect high value perennials such as tree fruits and grapes**. In this scenario, tree fruits and grapes are affected: farm cash receipts for tree fruits and grapes are assumed to decrease by 10% and B.C. VQA wine sales decline by 10%.**

With adaptation: Adequate planning and efficiency gains can reduce the water restrictions. However, most adaptations for extreme heat require additional water to cool fruit. It is assumed that even with these adaptations, **farm cash receipts for tree fruits fall by 5% and B.C. VQA wine sales fall by 5%** due to price reductions caused by lower grape quality.

Economic Benefit of Adaptation

The economic benefits of adaptation are shown in Table 5, below. Climate change stressors reduce cash receipts for tree fruits, wine grapes, and wine by 10%. The table depicts three adaptation cases:

- **Low:** Adaptation measures have low effectiveness, reducing the decline in revenue to 7%. The resulting benefit of adaptation is $57.8 million.
- **Medium:** Adaptation measures are more effective and implemented more widely, the decline in industry revenues is 5%. The resulting benefit of adaptation is $96.3 million.
- **High:** Adaptation measures are highly effective and industry revenues decline by 2%. The resulting benefit of adaptation is $154.1 million.

Table 5: Economic Impact of Climate Change Adaptation – Okanagan Valley

Okanagan Valley	**Low**				**Medium**				**High**			
Climate Impact	**w/o Adaptation**		**With Adaptation**		**w/o Adaptation**		**With Adaptation**		**w/o Adaptation**		**With Adaptation**	
Commodity	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine
Revenue Reduction	10%	10%	7%	7%	10%	10%	5%	5%	10%	10%	2%	2%
Revenue in 2035 ($M)	$376	$1,358	$388	$1,403	$376	$1,358	$397	$1,434	$376	$1,358	$409	$1,479
Benefit of Adaptation ($M)	**$58**				**$96**				**$154**			

Notes

1. Revenues are measured by farm cash receipts for tree fruit and grapes from 2013 which increase by the 10-year compound annual growth rate (4%) until they are shocked by a revenue reduction in 2035. B.C. VQA wine sales from 2014 increase at the 10-year compound annual growth (9.4%) rate until revenues fall in 2035 due to drought and extreme heat conditions.
2. Farm cash receipts are from Statistics Canada Table 002-0001
3. Regional shares of production and farm cash receipts from 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000
4. B.C. VQA wine sales are from the B.C. Wine Institute http://www.winebc.org/press_room/statistics/

4.6 Factors Contributing to the Uncertainty of the Estimates

This analysis describes the potential impact on industry revenues of major climate stressors anticipated due to climate change. There is no attempt made to quantify the impact of climate change on producer costs, nor to evaluate the cost of various adaptations. Producers will evaluate farm-level adaptations for their cost effectiveness and government should evaluate individual adaptive actions in detail to determine their total costs, social benefits and distributional effects. This is a partial analysis and research should be pursued in more detail to fully explore the economic impacts of adaptation in the B.C. agriculture context.

Reasons Why the Analysis May Understate Impacts

Factors which might cause the estimates of the economic benefits of adaptation to be higher than calculated include the focus on revenues from farming activities, the choice of long run growth rates in revenues, global impacts and trade effects, and assumptions about the impact of extreme weather and increased weather variability. This report examined only impacts on farm cash receipts or direct wine sales. Processing, transportation, tourism and other indirect or induced impacts are excluded.

Long run historical growth rates were used to project farm cash receipts into the future. In some cases these growth rates were below recent industry growth, implying that the impact to a larger industry in 2035 would be more significant than shown here.

Climate change is anticipated to have strong impact on agriculture across the globe. All agriculture regions will be dealing with adaptation in the coming decades. If major international production regions, such as California, struggle with climate change, international agricultural prices and trade flows will be much different than they are today. If agricultural commodities are worth more in the future due to scarcity, the economic impacts will be larger.

In this analysis, the nominal value of farm cash receipts or wine sales continues to grow at the long run compound annual rate of growth until 2035 and is then shocked by a climate stressor event. The only exception to this is the Cariboo Region scenario, in which cattle industry revenues are assumed to continue a long run decline of 1.6 % per year. More recently, cattle industry revenues have fallen by 8% per year (between 2008 and 2013). However, year to year growth is highly variable. If the cattle industry continues to contract at the pace set more recently, economic benefits in 2035 could be much larger if adaptation helps reverse this trend.

Finally, because the climate is changing, the past is not a good guide to the future. Extreme weather and weather variability are anticipated to be much larger than those experienced in the past, according to climate projections. While the scenarios attempt to capture this, the agrological information provided is based on past professional experience in the agriculture sector and the analyst's own assumptions. These assumptions could significantly underestimate the actual impacts of extreme events in the future, since they rely on past experience. Examples where "surprises" have already occurred include the 2013 floods in southern Alberta, the devastation caused by Hurricane Sandy in New Jersey and New York in 2012, and the current extended drought in California. While these events are not direct evidence of

anthropogenic climate change, they are the types of extreme weather events projected to increase with climate change.

Reasons Why the Analysis May Overstate Impacts

Factors which may cause the estimates to overstate the economic impact of the climate stressors on the regional agriculture economy include: use of climate projections which assume no effective co-ordinated effort to significantly reduce greenhouse gas emissions, and the analyst's assumptions regarding economic impacts and choice not to discount the impacts to present value dollars.

The climate change projections provided by the PCIC for regional extreme weather and overall climate trends are based on Global Climate Models (GCMs) which use the A2 emissions scenario. If major global climate change agreements are reached and effectively implemented, the world would move onto a lower emissions trajectory and possibly reduce the impact of climate change. However, these positive results of a climate agreement are more significant for climate change occurring in the distant future, from 2070 to 2100. For the period considered in this analysis, up to 2035, existing carbon dioxide concentrations and current emissions are more significant. In other words, most of the change depicted here for the 2030s is the result of emissions already in the atmosphere now, and significant emission reductions made in future would only impact climate change beyond the time horizon of this analysis.

Regarding discounting and present values, it is noted that economic experts suggest the use of very low (or zero) discount rates in the case of climate change, where there are strong intergenerational impacts.[37] The scenarios presented here do not use any discount rate, which places upward pressure on the estimates, implying that the true value in present dollar terms could be lower. In the Okanagan, Peace, and Cowichan scenarios the economic benefits are a constant share of industry revenues in each adaptation case. For the Cariboo, economic benefits from adaptation grow over time as a share of industry revenues.

The economic impacts of the extreme climate events are based on agricultural professionals' knowledge and experience in the sector and the analyst's own economic assumptions. These could be over-estimates of the impact on industry revenues, but have been judged to be reasonable through the collaborative development of the scenarios.

The scenarios make no attempt to quantify the costs of specific adaptive actions. Additional costs borne by producers are only captured as lower revenues if producers were to choose to reduce the scale of operations in response to stressful conditions. Many of the consequences of climate change will be felt through increased producer costs. On-farm investments involve additional costs to producers to receive the benefits of adaptation while negative consequences such as erosion or replanting will result in higher input costs. Costs of adaptations may be borne by the producer or the government, depending on the scale of the adaptation. Impacts of climate change may also impose additional costs

[37] Stern, N. H. The Economics of Climate Change: The Stern Review. Cambridge, UK: New York : Cambridge University Press, (2007). Print

on either industry or government, depending on who is liable for the losses. There is also no accounting for the costs to government for yield loses which may trigger agricultural insurance payments.

5.0 Directions for Future Research

During the course of this project several areas of future research were identified. Some pertain to more detailed analysis of the questions addressed in this paper, while others address policy and research gaps regarding the implementation of adaptation in the B.C. agriculture sector.

In assessing the economic impact of climate change adaptation on the agriculture sector, the most prominent research gap was the lack of a partial equilibrium economic model of the B.C. agriculture sector. With the current focus on jobs and economic growth, there are more questions about the economic value of programs and policies. While the Ministry of Finance has a macro-economic model to simulate the provincial economy, this has little applicability to the agricultural sector, which is small relative to other major economic drivers in B.C. The diverse nature of the B.C. agriculture sector also warrants a specialized effort to develop a model that accurately reflects regional differences in production. The agriculture sector also has a wealth of data available through Statistics Canada, and specialized resources should be available to answer detailed questions about the state of the agriculture economy based on in depth knowledge of this data. Closer partnership with Agriculture and Agri-Food Canada, to improve the accuracy of the B.C. component of AAFC's partial equilibrium model of Canadian agriculture, is another way to address this knowledge gap. Access to a partial equilibrium model would facilitate the implementation of an Integrated Assessment Model to address climate change impacts.

Another under-utilized set of resources for economic information is the B.C. Agricultural Land Use Inventories. These rich data sources are primarily used for bylaw planning and information for municipalities. Combining these with B.C. Assessment data would be beneficial for both B.C. Assessment and the Ministry of Agriculture. This would provide detailed information about land values, as estimated by B.C. Assessment, and how the land is being used. While this has been attempted before, there are many discrepancies between the two data sets. A dedicated project would be necessary to properly match and clean the data, but in doing so would greatly increase the accuracy of the assessment information and add another layer of information to the Land Use Inventories. This type of data would be highly useful for a Ricardian analysis in which the price of land is decomposed into its various components and could help identify the value of certain adaptations such as drainage and irrigation.

With respect to research needed to successfully adapt to climate change, The Handbook on Climate Change and Agriculture lists water supply modelling as the top research priority. [38] Sufficient water supply, management and monitoring are identified in some way in all of the CAI risk and opportunity assessments as well as in the CAI regional adaptation strategies. Water supply modelling informs drainage planning and water storage for irrigation and livestock. The best available information on water availability is listed in the June 2010 Drought Response Plan as key knowledge to inform responses to

[38] Dinar, Ariel, and Robert O. Mendelsohn. *Handbook on Climate Change and Agriculture*. Cheltenham, Glos, UK ; Northampton, MA: Edward Elgar, (2011). Print

drought conditions. Other drought preparedness research listed in the Drought Response Plan, drafted for the Ministry of Environment (MoE), includes the following, to:

a. monitor and characterize streamflows and lake levels; (MoE in partnership with other organizations)
b. deliver seasonal volume forecasts based on meteorological, hydrometric and snowpack data and the use of hydrological models (MoE)
c. provide regular updates on streamflow and groundwater data on the internet (MoE)
d. develop, refine and maintain hydrological hazard and risk models to guide community planning and emergency response (MoE)
e. monitor water levels in priority aquifers through the Provincial Observation Well Network (MoE)
f. monitor snowpack conditions using automated and manual techniques to support streamflow forecasting (MoE)
g. monitor the Drought Code and Fire Danger Class (MoE to access Ministry of Forest Resource data)
h. maintain infrastructure and systems that support monitoring, data collection and data processing (MoE), and
i. conduct data quality assurance and auditing on water and snow related data collected using up-to-date standards (MoE).

A follow-up on the implementation of the Drought Response Plan would also be a worthwhile use of Ministry of Agriculture resources, since the agriculture sector is so exposed to drought risks.

6.0 Summary and Conclusions

6.1 Summary

This report summarizes the development of climate stressor scenarios used to estimate the economic impact of climate change on the B.C. agriculture sector. A comprehensive literature review revealed Ricardian analysis and Integrated Modelling Systems as preferred analysis techniques, but one which require a great deal of data and modelling complexity. Scenarios have been used to analyze the impact of particular climate stressors and to spark conversations about critical uncertainties and future preparedness.

The economic benefit of climate change adaptation is calculated as the difference between industry revenues (or farm cash receipts) with adaptation and without adaptation when a climate stressor event occurs in the year 2035. The values presented are for industry revenues in a single year (2035) but the economic benefit of adaptation is a constant share of industry revenues in each case (with the exception of the Cariboo Region). Adaptations reduce the negative impact of a climate stressor on farm cash receipts and three cases are presented for the extent of implementation and the effectiveness of the adaptation. In the Okanagan Valley, the benefit of adaptation to extreme heat and drought ranges from $58 million in the low effectiveness case to $154 million in the high effectiveness case. Drought and water availability are also issues in the Cowichan Valley, and in that scenario economic benefits of adaptation are between $5 million and $14 million. In the Peace Region, the impact of cumulative years of drought and extreme precipitation during the fall harvest demonstrates an economic benefit of adaptation between $18 million and $37 million. Through adaptation to changing precipitation patterns in the Cariboo, the economic benefit for the cattle industry is between $24 million and $65 million.

Factors that might cause the estimates to be higher than calculated include the focus on revenues from farming activities, the choice of long run growth rates in revenues, global impacts and trade effects, and assumptions about the impact of extreme weather and increased weather variability. Factors that may cause the estimates to overstate the economic impact of the climate stressors on the regional agriculture economy include:, use of climate projections which assume no effective co-ordinated global effort to significantly reduce greenhouse gas emissions, and the analyst's assumptions regarding economic impacts and choice not to discount the impacts to present value dollars.

The scenarios make no attempt to quantify the costs of specific adaptive actions. Additional costs borne by producers are only captured as lower revenues if producers choose to reduce the scale of operations in response to stressful conditions. Many of the consequences of climate change will be felt through increased producer costs.

Several research and policy issues were identified. If detailed answers to economic impact questions are of interest, more detailed data collection and analysis tools are necessary. Close collaboration between B.C. government agencies and with other levels of government would also facilitate adaptation efforts that provide benefits beyond individual producers or the agriculture sector.

6.2 Conclusions

The climate stressor scenarios provide an indication of what might be at stake if the sector is unprepared for the coming changes. When considering potential lost industry revenues due to extreme weather events, which are projected to be more frequent and more severe with climate change, there are considerable benefits to adaptation. The simple analysis conducted here echoes what other researchers have found when identifying agriculture as a sector of the economy particularly exposed to climate change.[39] More rigorous analysis of the economic impact of climate change and adaptation on the B.C. agriculture sector could be pursued further for more accurate and detailed results. While most adaptations will provide benefits beyond preparation to climate change, they are not costless and each investment must be evaluated individually.[40]

The process of developing the scenarios also had the substantial benefit of providing a platform to gather experts from the fields of climate science, agriculture, adaptation and economics to discuss the issue, evaluate the consequences of inaction, and continue an ongoing dialogue within the Ministry of Agriculture.

The value of the Ministry's climate change adaptation program is in supporting the agriculture sector and the Ministry to plan and prepare for anticipated climate changes. Current programs address regional and farm level planning for climate change through information sharing, planning, and pilot and demonstration projects. In the future, integrated collaboration with other natural resource sectors, other agencies, and other jurisdictions will continue to be required to move forward with adaptation planning and to address barriers to useful adaptations.

[39] Paying the Price: The Economic Impacts of Climate Change for Canada. 4 Vol. National Round Table on the Environment and the Economy (2011). Print.
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Appendix 1: Scenario Results

Economic Impact of Climate Change Adaptation – Cowichan Valley

Cowichan Valley	Low		Medium		High	
Climate Impact	w/o Adaptation	With Adaptation	w/o Adaptation	With Adaptation	w/o Adaptation	With Adaptation
Commodity	Total Farm Cash Receipts		Total Farm Cash Receipts		Total Farm Cash Receipts	
Revenue Reduction	15%	10%	15%	5%	15%	0%
Revenue in 2035 ($M)	$80	$84	$80	$89	$80	$94
Benefit of Adaptation ($M)	**$5**		**$9**		**$14**	

Notes

1. Revenues are measured by total farm cash receipts for 2013, the share of farm cash receipts in the Cowichan Valley from the 2011 Census of Agriculture, which increase by the 20-year compound annual growth rate (3%) until they are shocked by a revenue reduction in 2035.
2. Farm cash receipts are from Statistics Canada Table 002-0001.
3. Regional shares of production and farm cash receipts from 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000

Economic Impact of Climate Change Adaptation – Cariboo Region

Cariboo	Low				Medium				High			
Climate Impact	w/o Adaptation		With Adaptation		w/o Adaptation		With Adaptation		w/o Adaptation		With Adaptation	
Commodity	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle
Annual Growth	0%	-2%	2%	2%	0%	-2%	5%	3%	0%	-2%	5%	5%
Revenue in 2035 ($M)	$3	$18	$5	$41	$3	$18	$10	$50	$3	$18	$10	$77
Benefit of Adaptation	**$24**				**$38**				**$65**			

Notes

1. Revenues are measured by farm cash receipts for forage and cattle for 2013, the share of farm cash receipts in the Cariboo from the 2011 Census of Agriculture, which increase by the growth rate outlined in each case until 2035.
2. Farm cash receipts are from Statistics Canada Table 002-0001.
3. Regional shares of production and farm cash receipts from 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000.

Economic Impact of Climate Change Adaptation – Peace Region

Peace Region	Low		Medium		High	
Climate Impact	w/o Adaptation	With Adaptation	w/o Adaptation	With Adaptation	w/o Adaptation	With Adaptation
Commodity	Grains and Oilseeds		Grains and Oilseeds		Grains and Oilseeds	
Revenue Reduction	40%	25%	40%	20%	40%	10%
Revenue in 2035 ($M)	$75	$93	$75	$99	$75	$112
Benefit of Adaptation ($M)	**$19**		**$25**		**$37**	

Notes

1. Revenues are measured by farm cash receipts for grains and oilseeds from 2013, the share of farm cash receipts in the Peace Region from the 2011 Census of Agriculture, which increase by the 20-year compound annual growth rate (6%) until they are shocked by a revenue reduction in 2035.
2. Farm cash receipts are from Statistics Canada Table 002-0001.
3. Regional shares of production and farm cash receipts from 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000.

Economic Impact of Climate Change Adaptation – Okanagan Valley

Okanagan Valley	Low				Medium				High			
Climate Impact	w/o Adaptation		With Adaptation		w/o Adaptation		With Adaptation		w/o Adaptation		With Adaptation	
Commodity	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine
Revenue Reduction	10%	10%	7%	7%	10%	10%	5%	5%	10%	10%	2%	2%
Revenue in 2035 ($M)	$376	$1,358	$388	$1,403	$376	$1,358	$397	$1,434	$376	$1,358	$409	$1,479
Benefit of Adaptation ($M)	**$58**				**$96**				**$154**			

Notes

1. Revenues are measured by farm cash receipts for tree fruit and grapes from 2013 which increase by the 10-year compound annual growth rate (4%) until they are shocked by a revenue reduction in 2035. B.C. VQA wine sales from 2014 increase at the 10-year compound annual growth (9.4%) rate until revenues fall in 2035 due to drought and extreme heat conditions.
2. Farm cash receipts are from Statistics Canada Table 002-0001.
3. Regional shares of production and farm cash receipts from 2011 Census of Agriculture http://www29.statcan.gc.ca/ceag-web/eng/data-type-selection-type-donnees?geoId=590000000
4. B.C. VQA wine sales are from the B.C. Wine Institute http://www.winebc.org/press_room/statistics/

Appendix 2: Technical Notes

The tables and notes below show how the economic benefits of adaptation were calculated using a computational model.

Cowichan Valley Scenario

	Low		Medium		High	
	No Adaptation	With Adaptation	No Adaptation	With Adaptation	No Adaptation	With Adaptation
FCR Reduction	15%	10%	15%	5%	15%	0%
2014	$40,041,278	$42,396,648	$40,041,278	$44,752,017	$40,041,278	$47,107,386
2015	$41,375,430	$43,809,279	$41,375,430	$46,243,128	$41,375,430	$48,676,977
2016	$42,754,035	$45,268,978	$42,754,035	$47,783,922	$42,754,035	$50,298,865
2017	$44,178,574	$46,777,314	$44,178,574	$49,376,054	$44,178,574	$51,974,793
2018	$45,650,578	$48,335,906	$45,650,578	$51,021,235	$45,650,578	$53,706,563
2019	$47,171,629	$49,946,430	$47,171,629	$52,721,232	$47,171,629	$55,496,034
2020	$48,743,359	$51,610,616	$48,743,359	$54,477,872	$48,743,359	$57,345,129
2021	$50,367,459	$53,330,251	$50,367,459	$56,293,043	$50,367,459	$59,255,835
2022	$52,045,673	$55,107,184	$52,045,673	$58,168,694	$52,045,673	$61,230,204
2023	$53,779,805	$56,943,322	$53,779,805	$60,106,840	$53,779,805	$63,270,358
2024	$55,571,716	$58,840,640	$55,571,716	$62,109,565	$55,571,716	$65,378,489
2025	$57,423,333	$60,801,176	$57,423,333	$64,179,019	$57,423,333	$67,556,862
2026	$59,336,644	$62,827,035	$59,336,644	$66,317,426	$59,336,644	$69,807,817
2027	$61,313,706	$64,920,395	$61,313,706	$68,527,083	$61,313,706	$72,133,772
2028	$63,356,643	$67,083,504	$63,356,643	$70,810,365	$63,356,643	$74,537,227
2029	$65,467,648	$69,318,687	$65,467,648	$73,169,725	$65,467,648	$77,020,763
2030	$67,648,992	$71,628,344	$67,648,992	$75,607,697	$67,648,992	$79,587,049
2031	$69,903,016	$74,014,959	$69,903,016	$78,126,901	$69,903,016	$82,238,843
2032	$72,232,144	$76,481,093	$72,232,144	$80,730,043	$72,232,144	$84,978,992
2033	$74,638,876	$79,029,398	$74,638,876	$83,419,920	$74,638,876	$87,810,442
2034	$77,125,799	$81,662,611	$77,125,799	$86,199,423	$77,125,799	$90,736,234
2035 FCR ($M)	$79.7	$84.4	$79.7	$89.1	$79.7	$93.8
Benefit of Adaptation ($M)	$4.7		$9.4		$14.1	

Notes:

1. Total farm cash receipts (FCR) were used to capture the diverse agricultural production in the Cowichan Valley.
2. Cowichan Valley FCR were estimated from total B.C. FCR 1993-2013 (Statistics Canada Table 002-0001 http://www5.statcan.gc.ca/cansim/a05?lang=eng&id=0020001) to which is applied the 2% Cowichan Valley share derived from the 2011 Census of Agriculture.
3. The Cowichan Valley share of FCR was assumed to stay constant throughout the forecast period, and was applied to total B.C. FCR from 2011 onwards.
4. The compound annual growth rate in FCR (3%) was calculated for 1993 - 2013 and then applied to 2013 FCR to derive the 2014 - 2035 series shown in the table.
5. The Cowichan Valley FCR forecasts for 2014-2035 were then reduced by the percentages noted in the “No Adaptation” and “With Adaptation” columns.
6. Economic benefit of adaptation was calculated for 2035 as the difference between FCR with and without adaptation, shown in millions of nominal dollars.
7. Low, medium, and high cases show a range of adaptation implementation extent and adaptation effectiveness.

Cariboo Region Scenario

	Low				Medium				High			
	No Adaptation		With Adaptation		No Adaptation		With Adaptation		No Adaptation		With Adaptation	
Sector	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle	Forage	Cattle
FCR Increase	0%	-1.6%	2%	2%	0%	-1.6%	5%	3%	0%	-1.6%	5%	5%
2014	$3,250,112	$25,931,640	$3,315,114	$26,880,359	$3,250,112	$25,931,640	$3,412,617	$27,143,892	$3,250,112	$25,931,640	$3,412,617	$27,670,957
2015	$3,250,112	$25,516,734	$3,381,416	$27,417,966	$3,250,112	$25,516,734	$3,583,248	$27,958,208	$3,250,112	$25,516,734	$3,583,248	$29,054,505
2016	$3,250,112	$25,108,466	$3,449,045	$27,966,325	$3,250,112	$25,108,466	$3,762,411	$28,796,955	$3,250,112	$25,108,466	$3,762,411	$30,507,231
2017	$3,250,112	$24,706,731	$3,518,025	$28,525,652	$3,250,112	$24,706,731	$3,950,531	$29,660,863	$3,250,112	$24,706,731	$3,950,531	$32,032,592
2018	$3,250,112	$24,311,423	$3,588,386	$29,096,165	$3,250,112	$24,311,423	$4,148,058	$30,550,689	$3,250,112	$24,311,423	$4,148,058	$33,634,222
2019	$3,250,112	$23,922,440	$3,660,154	$29,678,088	$3,250,112	$23,922,440	$4,355,461	$31,467,210	$3,250,112	$23,922,440	$4,355,461	$35,315,933
2020	$3,250,112	$23,539,681	$3,733,357	$30,271,650	$3,250,112	$23,539,681	$4,573,234	$32,411,226	$3,250,112	$23,539,681	$4,573,234	$37,081,729
2021	$3,250,112	$23,163,046	$3,808,024	$30,877,083	$3,250,112	$23,163,046	$4,801,895	$33,383,563	$3,250,112	$23,163,046	$4,801,895	$38,935,816
2022	$3,250,112	$22,792,437	$3,884,184	$31,494,624	$3,250,112	$22,792,437	$5,041,990	$34,385,070	$3,250,112	$22,792,437	$5,041,990	$40,882,607
2023	$3,250,112	$22,427,758	$3,961,868	$32,124,517	$3,250,112	$22,427,758	$5,294,090	$35,416,622	$3,250,112	$22,427,758	$5,294,090	$42,926,737
2024	$3,250,112	$22,068,914	$4,041,105	$32,767,007	$3,250,112	$22,068,914	$5,558,794	$36,479,120	$3,250,112	$22,068,914	$5,558,794	$45,073,074
2025	$3,250,112	$21,715,812	$4,121,928	$33,422,347	$3,250,112	$21,715,812	$5,836,734	$37,573,494	$3,250,112	$21,715,812	$5,836,734	$47,326,728
2026	$3,250,112	$21,368,359	$4,204,366	$34,090,794	$3,250,112	$21,368,359	$6,128,570	$38,700,699	$3,250,112	$21,368,359	$6,128,570	$49,693,064
2027	$3,250,112	$21,026,465	$4,288,453	$34,772,610	$3,250,112	$21,026,465	$6,434,999	$39,861,720	$3,250,112	$21,026,465	$6,434,999	$52,177,717
2028	$3,250,112	$20,690,042	$4,374,222	$35,468,062	$3,250,112	$20,690,042	$6,756,749	$41,057,571	$3,250,112	$20,690,042	$6,756,749	$54,786,603
2029	$3,250,112	$20,359,001	$4,461,707	$36,177,424	$3,250,112	$20,359,001	$7,094,586	$42,289,299	$3,250,112	$20,359,001	$7,094,586	$57,525,933
2030	$3,250,112	$20,033,257	$4,550,941	$36,900,972	$3,250,112	$20,033,257	$7,449,316	$43,557,978	$3,250,112	$20,033,257	$7,449,316	$60,402,230
2031	$3,250,112	$19,712,725	$4,641,960	$37,638,991	$3,250,112	$19,712,725	$7,821,781	$44,864,717	$3,250,112	$19,712,725	$7,821,781	$63,422,341
2032	$3,250,112	$19,397,321	$4,734,799	$38,391,771	$3,250,112	$19,397,321	$8,212,870	$46,210,658	$3,250,112	$19,397,321	$8,212,870	$66,593,458
2033	$3,250,112	$19,086,964	$4,829,495	$39,159,607	$3,250,112	$19,086,964	$8,623,514	$47,596,978	$3,250,112	$19,086,964	$8,623,514	$69,923,131
2034	$3,250,112	$18,781,573	$4,926,085	$39,942,799	$3,250,112	$18,781,573	$9,054,690	$49,024,887	$3,250,112	$18,781,573	$9,054,690	$73,419,288
2035	**$3,250,112**	**$18,481,067**	**$5,024,607**	**$40,741,655**	**$3,250,112**	**$18,481,067**	**$9,507,424**	**$50,495,634**	**$3,250,112**	**$18,481,067**	**$9,507,424**	**$77,090,252**
2035 FCR ($M)	**$21.7**		**$45.8**		**$21.7**		**$60.0**		**$21.7**		**$86.6**	
Benefit of Adaptation ($M)	**$24.0**				**$38.3**				**$64.9**			

Notes:

1. Farm cash receipts (FCR) for forage production and cattle for years 1993-2013 were accessed from Statistics Canada Table 002-0001 http://www5.statcan.gc.ca/cansim/a05?lang=eng&id=0020001.
2. The Cariboo Region's share of B.C. FCR was calculated based on acreage shares (17% forage, 18% cattle) reported in the 2011 Census of Agriculture.
3. The compound annual growth rates in FCR were calculated for 1993 - 2013. Derived forage FCR were highly variable but had no overall growth between 1993 and 2013, while there was an average decline of 1.6% per year in derived cattle FCR during that period.
4. In the case without adaptation, it was assumed forage FCR and cattle FCR continue to follow the long run historical downward trends.
5. In the case with adaptation, modest annual growth rates were assumed, ranging from 2% to 5% as shown in the table.
6. Low, medium, and high cases show a range of adaptation implementation extent and adaptation effectiveness.
7. The 2035 FCR is the sum of the forage and cattle FCR projected for 2035.
8. The economic benefit of adaptation was calculated as the difference between the FCR with adaptation and with no adaptation.

Peace Region Scenario

	Low		Medium		High	
	No Adaptation	With Adaptation	No Adaptation	With Adaptation	No Adaptation	With Adaptation
FCR Reduction	40%	25%	40%	20%	40%	10%
2014	$20,638,651	$25,798,313	$20,638,651	$27,518,201	$20,638,651	$30,957,976
2015	$21,940,904	$27,426,130	$21,940,904	$29,254,539	$21,940,904	$32,911,356
2016	$23,325,327	$29,156,659	$23,325,327	$31,100,436	$23,325,327	$34,987,991
2017	$24,797,104	$30,996,380	$24,797,104	$33,062,805	$24,797,104	$37,195,656
2018	$26,361,747	$32,952,183	$26,361,747	$35,148,996	$26,361,747	$39,542,620
2019	$28,025,115	$35,031,394	$28,025,115	$37,366,820	$28,025,115	$42,037,673
2020	$29,793,438	$37,241,798	$29,793,438	$39,724,584	$29,793,438	$44,690,157
2021	$31,673,339	$39,591,673	$31,673,339	$42,231,118	$31,673,339	$47,510,008
2022	$33,671,857	$42,089,821	$33,671,857	$44,895,809	$33,671,857	$50,507,785
2023	$35,796,477	$44,745,596	$35,796,477	$47,728,636	$35,796,477	$53,694,715
2024	$38,055,156	$47,568,945	$38,055,156	$50,740,208	$38,055,156	$57,082,734
2025	$40,456,353	$50,570,441	$40,456,353	$53,941,804	$40,456,353	$60,684,529
2026	$43,009,060	$53,761,325	$43,009,060	$57,345,413	$43,009,060	$64,513,589
2027	$45,722,837	$57,153,546	$45,722,837	$60,963,782	$45,722,837	$68,584,255
2028	$48,607,847	$60,759,809	$48,607,847	$64,810,463	$48,607,847	$72,911,771
2029	$51,674,896	$64,593,620	$51,674,896	$68,899,861	$51,674,896	$77,512,344
2030	$54,935,468	$68,669,335	$54,935,468	$73,247,291	$54,935,468	$82,403,202
2031	$58,401,775	$73,002,219	$58,401,775	$77,869,034	$58,401,775	$87,602,663
2032	$62,086,799	$77,608,499	$62,086,799	$82,782,399	$62,086,799	$93,130,199
2033	$66,004,340	$82,505,425	$66,004,340	$88,005,786	$66,004,340	$99,006,509
2034	$70,169,068	$87,711,335	$70,169,068	$93,558,758	$70,169,068	$105,253,603
2035 FCR ($M)	$74.6	$93.2	$74.6	$99.5	$74.6	$111.9
Benefit of Adaptation ($M)	$18.6		$24.9		$37.3	

Notes:

1. B.C. farm cash receipts (FCR) for grains and oilseeds for 1993-2013 were from Statistics Canada Table 002-0001 http://www5.statcan.gc.ca/cansim/a05?lang=eng&id=0020001.
2. Compound annual growth rates for the period 1993-2013 were calculated.
3. The share of grain and oilseed production in the Peace Region was calculated based on the 2011 Census of Agriculture.
4. 2013 B.C. farm cash receipt for grains and oilseeds were assumed to grow by the 1993 - 2013 annual growth rate of 6% until 2035.
5. Peace Region shares were calculated as total grains and oilseeds FCR multiplied by share of total acreage in the Peace, which was 60% in 2011.
6. The forecast for 2014-2035 was then reduced by the percentage noted in the "No Adaptation" and "With Adaptation" columns.
7. Benefit of adaptation was calculated for 2035 as the difference between FCR with adaptation and without adaptation, shown in millions of nominal dollars.
8. Low, medium, and high cases show a range of adaptation implementation extent and adaptation effectiveness.

Okanagan Scenario

	Low				Medium				High			
	No Adaptation		With Adaptation		No Adaptation		With Adaptation		No Adaptation		With Adaptation	
Commodity	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine	Tree Fruit and Grapes	Wine
FCR Reduction	10%	10%	7%	7%	10%	10%	5%	5%	10%	10%	2%	2%
2014	$139,094,329	$204,419,832	$143,730,806	$211,233,827	$139,094,329	$204,419,832	$146,821,791	$215,776,490	$139,094,329	$204,419,832	$151,458,269	$222,590,484
2015	$145,676,899	$223,710,732	$150,532,796	$231,167,756	$145,676,899	$223,710,732	$153,770,061	$236,139,106	$145,676,899	$223,710,732	$158,625,957	$243,596,130
2016	$152,586,859	$244,822,095	$157,673,087	$252,982,831	$152,586,859	$244,822,095	$161,063,906	$258,423,322	$152,586,859	$244,822,095	$166,150,135	$266,584,059
2017	$159,841,342	$267,925,717	$165,169,386	$276,856,574	$159,841,342	$267,925,717	$168,721,416	$282,810,479	$159,841,342	$267,925,717	$174,049,461	$291,741,336
2018	$167,458,426	$293,209,604	$173,040,373	$302,983,258	$167,458,426	$293,209,604	$176,761,672	$309,499,027	$167,458,426	$293,209,604	$182,343,619	$319,272,680
2019	$175,457,181	$320,879,508	$181,305,754	$331,575,492	$175,457,181	$320,879,508	$185,204,802	$338,706,147	$175,457,181	$320,879,508	$191,053,375	$349,402,131
2020	$183,857,730	$351,160,593	$189,986,321	$362,865,946	$183,857,730	$351,160,593	$194,072,049	$370,669,515	$183,857,730	$351,160,593	$200,200,640	$382,374,868
2021	$192,681,307	$384,299,275	$199,104,017	$397,109,251	$192,681,307	$384,299,275	$203,385,824	$405,649,235	$192,681,307	$384,299,275	$209,808,534	$418,459,211
2022	$201,950,319	$420,565,222	$208,681,996	$434,584,063	$201,950,319	$420,565,222	$213,169,781	$443,929,956	$201,950,319	$420,565,222	$219,901,458	$457,948,797
2023	$211,688,419	$460,253,550	$218,744,700	$475,595,335	$211,688,419	$460,253,550	$223,448,887	$485,823,192	$211,688,419	$460,253,550	$230,505,167	$501,164,977
2024	$221,920,573	$503,687,228	$229,317,925	$520,476,802	$221,920,573	$503,687,228	$234,249,494	$531,669,852	$221,920,573	$503,687,228	$241,646,846	$548,459,426
2025	$232,673,138	$551,219,699	$240,428,909	$569,593,689	$232,673,138	$551,219,699	$245,599,423	$581,843,016	$232,673,138	$551,219,699	$253,355,195	$600,217,006
2026	$243,973,942	$603,237,763	$252,106,406	$623,345,688	$243,973,942	$603,237,763	$257,528,049	$636,750,972	$243,973,942	$603,237,763	$265,660,514	$656,858,897
2027	$255,852,367	$660,164,721	$264,380,780	$682,170,211	$255,852,367	$660,164,721	$270,066,388	$696,840,538	$255,852,367	$660,164,721	$278,594,800	$718,846,029
2028	$268,339,445	$722,463,820	$277,284,093	$746,545,947	$268,339,445	$722,463,820	$283,247,192	$762,600,698	$268,339,445	$722,463,820	$292,191,840	$786,682,826
2029	$281,467,947	$790,642,024	$290,850,212	$816,996,758	$281,467,947	$790,642,024	$297,105,055	$834,566,580	$281,467,947	$790,642,024	$306,487,320	$860,921,315
2030	$295,272,488	$865,254,138	$305,114,904	$894,095,943	$295,272,488	$865,254,138	$311,676,515	$913,323,812	$295,272,488	$865,254,138	$321,518,931	$942,165,617
2031	$309,789,633	$946,907,325	$320,115,954	$978,470,902	$309,789,633	$946,907,325	$327,000,168	$999,513,287	$309,789,633	$946,907,325	$337,326,489	$1,031,076,865
2032	$325,058,012	$1,036,266,043	$335,893,279	$1,070,808,244	$325,058,012	$1,036,266,043	$343,116,790	$1,093,836,379	$325,058,012	$1,036,266,043	$353,952,057	$1,128,378,580
2033	$341,118,440	$1,134,057,456	$352,489,055	$1,171,859,371	$341,118,440	$1,134,057,456	$360,069,464	$1,197,060,648	$341,118,440	$1,134,057,456	$371,440,079	$1,234,862,563
2034	$358,014,045	$1,241,077,349	$369,947,846	$1,282,446,594	$358,014,045	$1,241,077,349	$377,903,714	$1,310,026,090	$358,014,045	$1,241,077,349	$389,837,516	$1,351,395,335
2035	**$375,790,403**	**$1,358,196,604**	**$388,316,750**	**$1,403,469,825**	**$375,790,403**	**$1,358,196,604**	**$396,667,647**	**$1,433,651,971**	**$375,790,403**	**$1,358,196,604**	**$409,193,994**	**$1,478,925,192**
2035 FCR ($M)	**$1,734.0**		**$1,791.8**		**$1,734.0**		**$1,830.3**		**$1,734.0**		**$1,888.1**	
Benefit of Adaptation ($M)	**$57.8**				**$96.3**				**$154.1**			

Notes:

1. Farm cash receipts (FCR) for 1993-2013 for B.C. tree fruits and grapes were accessed from Statistics Canada Table 002-0001 http://www5.statcan.gc.ca/cansim/a05?lang=eng&id=0020001.
2. Compound annual growth rates for 2003-2013 were calculated (4% tree fruits and 6% grapes) and used to derive projections for 2014-2035.
3. BC VQA wine sales were accessed from the B.C. Wine Institute http://www.winebc.org/press_room/statistics/.
4. Compound annual growth rates for 1993-2013 (16%) and 2003-2013 (9%) were calculated.
5. From 2015 onwards wine sales are assumed to grow at the 10-year annual growth rate (slower growth as the market matures).
6. During the forecast period, 2014-2035, annual FCR and wine sales were reduced by the percentage noted in the "No Adaptation" and "With Adaptation" columns.
7. The benefit of adaptation was calculated as the difference between FCR with adaptation and with no adaptation.
8. Low, medium, and high cases show a range of adaptation implementation extent and adaptation effectiveness.

Climate Change Adaptation Strategy
B.C. Ministry of Agriculture

DRAFT FOR REVIEW
14 April 2015

Produced for:
Innovation and Adaptation Services Branch
British Columbia Ministry of Agriculture

Adaptive Resource Management Ltd.

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To be completed….

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Executive Summary

Climate Change & B.C. Agriculture
In 2013 B.C. agricultural sales revenues were $2.7 billion, and combined agrifoods revenues (including seafood, and food and beverage sales) were $11.6 billion. The B.C. government has a target to increase annual agrifoods revenues to $14 billion by 2017.

Projections indicate accelerating climate change in British Columbia in the coming decades, leading to changing temperature, precipitation, climate variability and extremes. These changes will increase the risk and operational complexity for B.C. agricultural producers. To maintain profitability and increase the value of agricultural output, the sector will need to effectively adapt.

Adaptation Strategy Purpose
This strategy serves as a guide to integrating the effects of climate change into the Ministry of Agriculture's business planning and program implementation. This strategy is aligned with *British Columbia's Climate Change Adaptation Strategy* (2010) deliverable to "Make adaptation part of Government's business" and with the Ministry's *Service Plan 2015-16 / 2017-18* (Objective 2.2) commitment to support "the efforts of industry to develop innovative products, tools and processes to reduce and mitigate greenhouse gas emissions and adapt to climate change."

Building Linkages
The adaptation strategy builds on the results of an assessment of the adaptability of 14 Ministry of Agriculture programs, undertaken in 2013 using the ADAPTool methodology. The strategy recommends a collaborative learning-oriented approach to increase knowledge and capacity in the area of adaptation. A key focus is to increase linkages between the Ministry's business areas and new studies and practices for climate adaptation in the agriculture sector.

An important adaptation learning opportunity for agriculture sector programs is through the B.C. Agriculture and Food Climate Action Initiative (CAI). The CAI is delivering the industry-led climate change adaptation program funded by the Ministry through Growing Forward 2, a federal-provincial-territorial initiative. As results are reported from the CAI's regional scale and farm-level projects underway, a systematic effort by both the Ministry and CAI to share and interpret the learning is essential to the success of this strategy.

Other organizations whose work provides an opportunity for program learning about climate change adaptation include:

- Fraser Basin Council – Lower Mainland flood management study
- Pacific Climate Impacts Consortium – Plan2Adapt, studies on extreme events
- Ministry of Environment – Water Sustainability Act implementation
- Ministry of Forests, Lands and Natural Resource Operations – climate action plans for regions and business units

The Ministry of Agriculture's preparation for Growing Forward 3 discussions with the federal government also provides an important opportunity to identify mechanisms for better integration of climate change adaptation in programming.

Alignment with Program Areas' Priorities
The purpose of this strategy is not to introduce additional programming responsibilities or mandates, but to ensure that current programs remain effective and responsive to the needs of the agriculture sector as climate risks change and producers respond. Actions for each program

area will be supported by the Ministry's climate action team, but will be driven by program leads and integrated into ongoing programming in a manner and schedule determined largely by the program areas themselves. s.13

Five Key Mechanisms
The strategy provides a platform for engagement and shared learning about climate impacts and potential adaptation measures, and for program area discussions about the integration of climate adaptation into business planning. Five mechanisms are proposed for strengthening learning and communication:

1. Ministry adaptation contact group
2. adaptation dialogues
3. information briefs highlighting recent lessons for programs
4. field visits
5. key role of regional agrologists and industry specialists

Initial Actions
Suggested initial actions for programs have been identified through the ADAPTool assessment, subsequent consultation with program leads, and exploratory dialogue sessions with some program staff. The initial measures proposed here respond to existing opportunities (see Table 1, below) and most can be implemented in the short term with existing resources. These actions are a starting point – climate adaptation is an ongoing process that will evolve with additional information and experience, and as new collaborative opportunities arise. s.13

Monitoring & Implementation
The strategy includes a streamlined monitoring report template that can be used by program leads and the Ministry's climate action team to track the actions of program areas for reporting purposes.

- For each program, the monitoring should be updated every 2 years and form the basis of reports to senior management.
- The climate action team should also assess the adaptability of programming by repeating the ADAPTool assessment in 2018, once Growing Forward 3 is in place.

Outcomes
The results from implementing this strategy will be a suite of Ministry of Agriculture programs that integrate climate adaptation considerations effectively into service delivery, providing better support to producer innovation and competitiveness.

In the long term, indicators of success in climate adaptation include:

- measures of agricultural output and revenue
- recorded insured and uninsured losses from weather events
- level of losses and speed or recovery from climate disasters

Table 1: Summary of recommendations and actions for integrating adaptation

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Core Groups	Recommendations
Ministry of Agriculture Climate Action Team	1. Establish and coordinate adaptation contact group with Ministry programs 2. Facilitate programs' access to CAI products, tools, and knowledge: • Lead 2 - 4 climate adaptation dialogue sessions per year • Prepare up to 4 adaptation briefs / digests per year 3. Monitor how adaptation measures are being implemented in programs 4. Assess adaptability of programming by repeating ADAPTool assessment (2018)
B.C. Agriculture and Food Climate Action Initiative (CAI)	1. Support adaptation dialogue sessions and information sharing opportunities 2. Publicize field events and invite Ministry staff 3. Work with Ministry climate action team to develop information packages targeted at specific program and management audiences
Program Areas	**Proposed Initial Actions**
Regional Agrologists & Industry Specialists	• Continue to support CAI projects • Create more frequent opportunities for agrologists' team learning and interaction • Help identify emerging issues of climate risk and adaptation for other programs • Share knowledge of CAI projects within the Ministry
Agricultural Emergency Management	• Provide more information to producers and local government on risk reduction measures for extreme climate events (flood, wildfire, drought) • Strengthen communication of specific risks with local government and producers • Coordinate farm-level messaging on risk reduction and site planning • Promote emergency planning and risk reduction in local government AAPs • Appoint a representative to Fraser Basin Council Joint Program Committee to monitor Lower Mainland flood management study
Plant Health & Pest Management	• Identify specific emerging pest threats with industry • Continue collaborative monitoring and research projects with industry, focusing on pests relevant to a variety of crops • Review results from CAI collaborative monitoring project in Peace Region and consider how to improve monitoring information for high-value crops
Production Insurance	• Monitor Manitoba task force on BRM programs and evaluate implications for B.C. • Ensure that premium subsidies do not create disincentives for producer adaptation • Implement proposed database enhancements (geospatial / weather data) to provide better information on climate-related losses • Explore emerging producer concerns on climate risk management with CAI
Strengthening Farming	• Recognize and build program knowledge about climate risks related to land use planning • Bring together local governments and producers (e.g. through Agricultural Advisory Committees) to gain agreement on adaptation issues and to develop solutions • Monitor emerging experience with Water Sustainability Plans
Agroforestry	• Identify ecosystem services and climate buffering functions of agroforestry at site and landscape scales • Promote agroforestry where relevant to meet land use objectives • Monitor agroforestry demand and interest related to climate • Foster demonstrations and extension through partnerships with producers and local groups
Environmental Farm Plan & Beneficial Management Practices	• Explore how to incorporate changing climate risks and disaster risk reduction at farm and community level (together with Agricultural Emergency Management) • Consider linkages to the national FireSmart program for assessment of fire risk • Review results of relevant CAI projects to consider how to incorporate drought planning, drainage and flood protection measures
Agriculture Water Management	• Anticipate increasing demand for program • Collaborate to simplify data sharing protocols between different agencies • Update models with new information from climate models and research projects • Expand program availability in new regions
Agrifood Business Development	• Review results from relevant CAI projects • Work with industry to explore opportunities / impacts of changing climate conditions

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List of Acronyms

AAFC	Agriculture and Agri-Foods Canada
AAP	Agriculture Area Plan
ADAPTool	Adaptative Design and Assessment Policy Tool
AEM	Agricultural Emergency Management program
B.C.	British Columbia
BMP	Best Management Practices program
BRM	Business Risk Management programs
CAI	B.C. Agriculture and Food Climate Action Initiative
CAS	Ministry of Environment Climate Action Secretariat
EFP	Environmental Farm Plan program
FBC	Fraser Basin Council
FLNRO	Ministry of Forests, Lands and Natural Resource Operations
IASB	Ministry of Agriculture Innovation and Adaptation Services Branch
IISD	International Institute for Sustainable Development
NRCan	Natural Resources Canada
PCIC	Pacific Climate Impact Consortium
PICS	Pacific Institute for Climate Solutions
WSP	Water Sustainability Plan

1. Introduction

British Columbia has a diverse and important agriculture sector, with over 200 commodities being produced on approximately 2.8 million hectares. The major producing regions are the Fraser Valley (field vegetables, berries, dairy, poultry, greenhouse vegetables, horticulture), Vancouver Island (livestock and horticulture crops), the Okanagan (tree fruits and wine grapes), the Peace Region (grains and oilseeds), and the Central Interior (cattle and forage). In 2013 B.C. agricultural sales revenues were $2.7 billion, and combined agrifoods revenues (including seafood, and food and beverage sales) were $11.6 billion. The B.C. government has a target to increase annual agrifoods revenues to $14 billion by 2017.[1]

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Climate change is already occurring in British Columbia, with mean annual temperatures having warmed by about 1.4 degrees Celsius across the province in the past century. Projections indicate accelerating climate change in the coming decades, requiring the province's agricultural producers to adapt to changing conditions that include:

- **warmer minimum temperatures, particularly at night and in winter**
- **reduced winter snowfall, leading to earlier spring runoff and in some regions declining late summer streamflow**
- **increased, and more intense, spring and fall precipitation**
- **increased variability in weather conditions (figure 1) and seasonal boundaries**
- **warmer and drier summer conditions in the southern Interior**
- **increased uncertainty and instability of local climate**
- **sea level rise on the coast**

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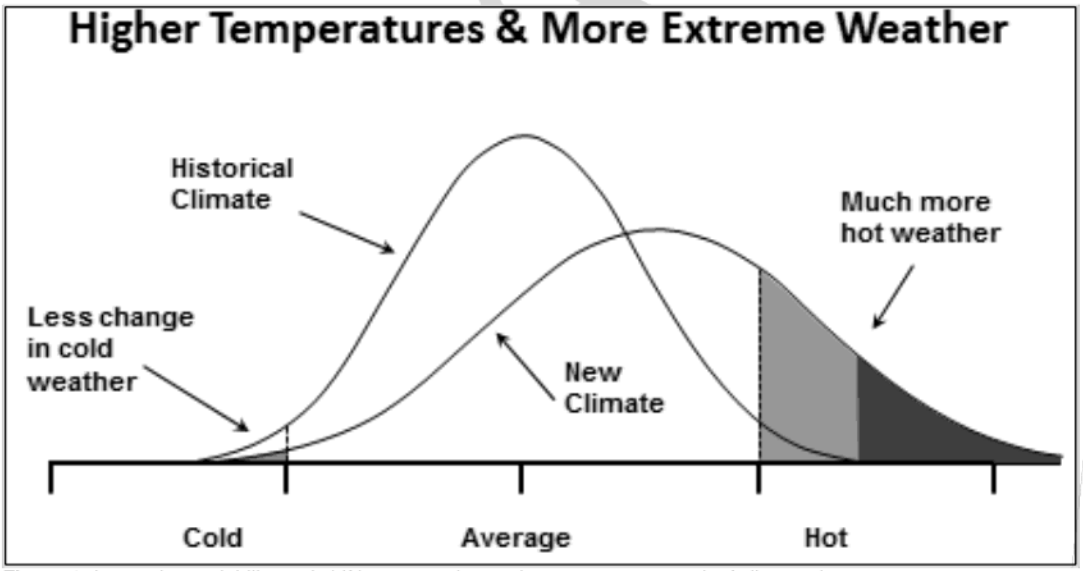


Figure 1: Increasing variability and shifting means in weather events as a result of climate change (Trevor Murdock, 2014).

[1] B.C. Ministry of Agriculture. 2013. *British Columbia Agrifood Industry Year in Review.*

Changing climatic conditions will affect agricultural producers in a variety of ways depending on their location and production systems. Growing seasons will increase, especially in the north, but changing soil moisture conditions will affect production systems. Some regions will experience more frequent drought and increased wildfire hazard, while others may see more frequent spring flooding.[2] ~~A report prepared in 2014 indicated that C~~climate change ~~could~~is expected to present a significant risk to B.C. agriculture revenues; however proactive measures that address changing climate conditions ~~and that adaptation measures~~ would have substantial economic benefit.[3] ~~These changes~~Climate change will mean increased risk and operational complexity for B.C. farmers. To maintain profitability and continue to increase the value of output, the agriculture sector will need to adapt. ~~A report prepared in 2014 indicated that climate change could present a significant risk to B.C. agriculture revenues and that adaptation measures would have substantial economic benefit.~~[4]

Comment [JKP12]: Plan and prepare for a changing climate

The Ministry of Agriculture Service Plan (Objective 2.2) commits to supporting producers to innovate and adapt in a changing climate:

"The Ministry supports the efforts of industry to develop innovative products, tools and processes to reduce and mitigate greenhouse gas emissions and adapt to climate change." [5]

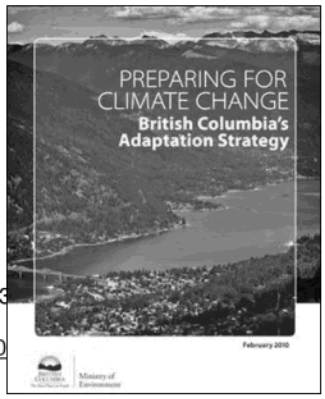
In 2013, the Ministry commissioned a study of 14 of its program areas to assess their adaptability to changing climate conditions in the province. This study was led by the International Institute for Sustainable Development (IISD), with funding from Natural Resources Canada, using the Adaptive Design and Assessment Policy Tool (ADAPTool). The Ministry has committed to developing an action plan to implement priority recommendations from this assessment in order to ~~mainstream~~ integrate adaptation in relevant program actions.[6]

Comment [JKP13]: Do you mean this Strategy?

The Ministry's commitments respond to the Province of British Columbia's 2010 Climate Change Adaptation Strategy. One of the three foundational commitments in that strategy was to "*make adaptation a part of the Government's business, ensuring that climate change impacts are considered in planning and decision-making across government.*"[7] Key deliverables are summarized in Annex ~~6~~7.

Comment [JKP14]: I don't think the Annex adds much. I'd cut it to reduce the length of the document. Including a reference is enough.

Climate adaptation is a component of the innovation focus area under Growing Forward 2 (GF2), the five-year federal-provincial-territorial initiative that provides funding for the agriculture and agri-foods sector to help producers and processors to manage business risks and to become more innovative and competitive.



[2] Pacific Institute for Climate Solutions (E. Crawford and R. Beverige) (2013 *Agriculture Sector in the Face of Climate Change.* http://pics.uvic.ca/sites/default/files/uploads/publications/Strengthening%20 ctor_0.pdf

[3] Ministry of Agriculture climate action team (K. Donahue) (2014) at http://pics.uvic.ca/sites/default/files/Climate%20Stressor%20Scenarios-%20Final%20Report%20pdf.pdf

[4] ~~Ministry of Agriculture climate action team (K. Donahue) (2014) at http://pics.uvic.ca/sites/default/files/Climate%20Stressor%20Scenarios-%20Final%20Report%20pdf.pdf~~

[5] Ministry of Agriculture, *2015-16 / 2017-18 Ministry Service Plan, p. 11* – Objective 2.2 http://bcbudget.gov.bc.ca/2015/sp/pdf/ministry/agri.pdf

[6] Ministry of Agriculture, May 30, 2014. Carbon Neutral Action Report Overview.

[7] Ministry of Environment, Feb 2010. British Columbia's Adaptation Strategy.

Through GF2, an industry-led climate change adaptation program is funded by the Ministry through GF2 and delivered by the B.C. Agriculture and Food Climate Action Initiative (CAI), set up by the B.C. Agriculture Council.

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1.1 Purpose and Structure of this Climate Adaptation Strategy

This strategy provides guidance on implementing the Ministry's commitment to integrate climate change effects into business planning and program implementation. The strategy includes an action plan for implementation of priority measures to follow up from the ADAPTool assessment. The purpose of this strategy is **not** to introduce additional responsibilities or mandates to existing program areas of the Ministry, but to ensure that current programs remain effective and responsive to producer needs as climate risks change and producers respond. Climate adaptation strategies will be supported by the Ministry's climate action team, but will be driven by program leads and integrated into ongoing programming as determined largely by the program areas themselves.

~~The document is structured as follows:~~

- ~~Section 2 summarizes the 2013 ADAPTool report findings and followup interviews with program leads, and consultations with external organizations.~~
- ~~Section 3 presents program specific components of the strategy.~~
- ~~Section 4 discusses implementation and monitoring.~~
- ~~Supporting information is presented in Annexes 1 - 6.~~
    - ~~Annex 1: Recommendations of ADAPTool Assessment (2013)~~
    - ~~Annex 2: Climate Action Initiative and Ministry of Agriculture~~
    - ~~Annex 3: List of CAI projects~~
    - ~~Annex 4: Proposed Structure for Climate Dialogue Sessions~~
    - ~~Annex 5: External Organizations Consulted~~
    - ~~Annex 6: Ministry of Agriculture Program Contacts~~
    - ~~Annex 7: B.C. Climate Change Adaptation Strategy: Core Deliverables~~

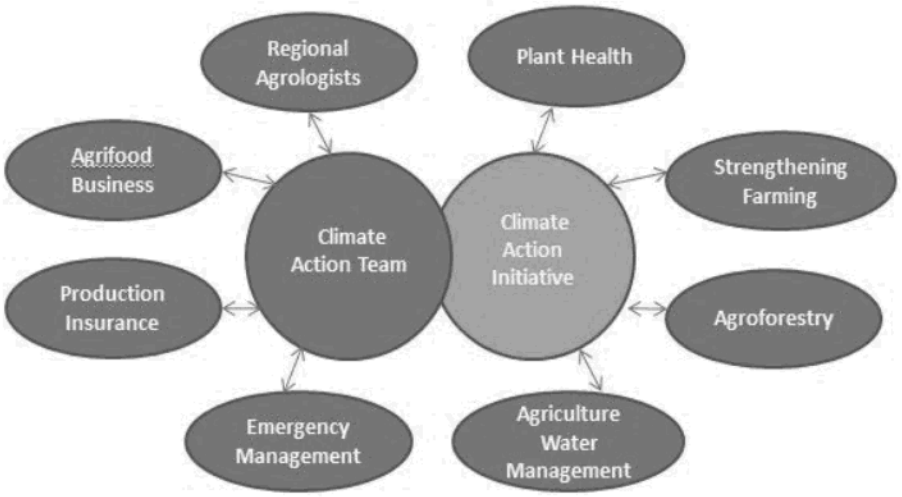

Figure 2: Ministry of Agriculture climate change adaptation network includes program areas, the Ministry's climate action team, and the B.C. Agriculture and Food Climate Action Initiative.

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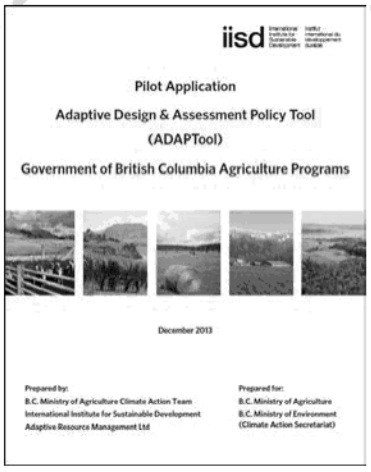
2. Climate Adaptation Opportunities for Ministry Programs

2.1 ADAPTool Assessment

In 2013, the ADAPTool was used to assess the ability of Ministry programs to meet their objectives under conditions where climate change will affect producer behaviour and demands on programs.

- The assessment showed that agricultural producers will already receive broad *indirect* support for adaptation from the Ministry's programs.[8]
- Several of the programs were rated as highly adaptive, providing support to producers to adapt to *anticipated* climate change as well as being sufficiently flexible to be responsive to *unanticipated* climate-related stresses. These programs include: Environmental Farm Plan, Beneficial Management Practices, and Agri-Food Business Development, and the Agriculture Water Management program.


iisd

Pilot Application

Adaptive Design & Assessment Policy Tool

(ADAPTool)

Government of British Columbia Agriculture Programs

December 2013

Prepared by:
B.C. Ministry of Agriculture Climate Action Team
International Institute for Sustainable Development
Adaptive Resource Management Ltd

Prepared for:
B.C. Ministry of Agriculture
B.C. Ministry of Environment
(Climate Action Secretariat)

The ADAPTool assessment found that other programs are likely to be challenged under conditions of increasing climate variability and extreme weather events.

- More frequent and severe extreme climate events will significantly affect the Agricultural Emergency Management program. The program is already paying more attention to

[8] Pilot Application Adaptive Design and Assessment Policy Tool (ADAPTool) Government of British Columbia Agriculture Programs. Dec 2013.

preparedness as well as response, but as climate risks change, producer options for reducing climate related risks may need further consideration.
- The Pest Management and Plant Health program can expect to see increased incidence of both familiar and new types of threats to productive agro-ecosystems. The specific changes and the nature of threats will be difficult to predict, and may require additional resources for surveillance, monitoring and research.

Other programs examined were moderately adaptable, offering some support to adaptation measures by producers, and some responsiveness to changing climate stresses by virtue of program design and management. These programs may benefit from considering specific climate issues within their mandates.

The ADAPTool assessment also found that:
- few programs supported producers to improve their adaptive capacity;
- changing climate risks could impact the effectiveness of business risk management programs; and
- research and extension needs would likely increase as climate change accelerates.[9]

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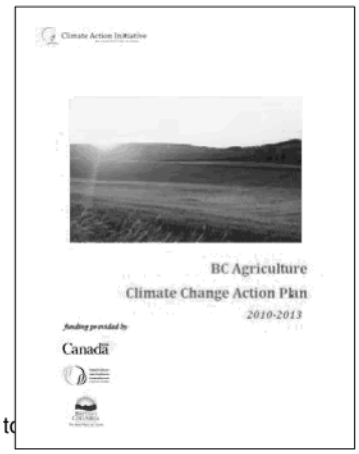
2.2 Opportunities to Integrate Climate Adaptation into Programs

This section provides an overview of emerging opportunities and new insights on climate adaptation that are relevant to Ministry programs. These opportunities include:
1. Studies and pilot projects on climate adaptation measures for the agriculture sector
2. Innovative practices introduced as a result of local, regional or provincial initiatives
3. Climate related studies that may not specifically address agricultural activities but have important implications for agriculture, and
4. Planned changes or regular reviews of Ministry programming.

These opportunities are described here so that they may be followed up using the tools described in the implementation and monitoring section of this document.

2.2.1 B.C. Agriculture and Food Climate Action Initiative

CAI is nationally recognized as a leader in climate change adaptation in the agricultural sector. The CAI was established in 2008 as a joint initiative by the Ministry of Agriculture, the B.C. Agriculture Council, and the Investment Agriculture Foundation. CAI supports producers with a wide range of tools and resources on its website and through social media.[10]



The CAI released the BC Agriculture Climate Change Action Plan in 2010, and then in 2012 produced six regional/commodity sector adaptation risk and opportunity assessment reports.

[9] In the ADAPTool assessment "adaptive capacity" is related to access to information and skills, infrastructure, and to institutions and networks.
[10] Climate Action Initiative. 2010. *BC Agriculture Climate Change Action Plan.* http://www.bcagclimateaction.ca/wp/wp-content/media/BC-Agriculture-Climate-Change-Action-Plan.pdf

Since 2013, CAI has delivered the Ministry's climate adaptation programming funded by the Province and the federal government through the innovation component of the Growing Forward 2 initiative. Focus areas are regional adaptation strategies and farm-level adaptation innovations.

- **Regional Agricultural Adaptation**: Comprehensive regional adaptation strategies have been developed for the Cowichan, Peace, Delta, Cariboo, and Fraser Valley areas. A regional strategy process for the Okanagan is planned for 2015. Once regional adaptation strategies are prepared, funding is available to implement projects aligned with priority actions identified by a local working group and the CAI.
- **Farm Adaptation Innovator Program**: Provides funding for innovative farm-level adaptation, risk reduction practices and new production opportunities. The program also emphasizes communication of results and sharing of knowledge and resources through industry associations, networks and support organizations.

The CAI is the main vehicle through which the Ministry supports agricultural climate change adaptation.

- In addition to the GF2 funding provided, technical staff from Ministry programs and regional offices play key advisory roles in the regional and farm-level projects.
- Key roles are also played by local governments, industry partners and local producer groups. The CAI shares updates on relevant projects with Ministry program leads and seeks their input and feedback on project development.

The CAI has a large number of projects underway, which will generate considerable useful knowledge as they are completed in the next two years. Annex 3 provides a list of CAI projects, and Annex 2 provides background on the partnership between the CAI and the Ministry.

While there are already linkages between the Ministry's programs and CAI, there is a clear need to extend the learnings from CAI projects beyond the current technical contacts to reach other Ministry programs for which they are relevant. Both the Ministry and CAI can take measures to strengthen the knowledge sharing.

2.2.2 Fraser Basin Council Lower Mainland Flood Management Study

~~There is growing recognition of the need for flood management in the lower Fraser River basin.~~

- ~~Local, provincial and federal governments are all likely to be involved in response measures due to the high value of urban land uses, strategic infrastructure such as highways, ports and rail lines, and the high cost and limited effectiveness of protective measures such as dikes.~~
- ~~Flood management interventions in this region will involve trade-offs, and some agricultural areas will not be defensible against future extreme flooding.~~
- ~~Risk reduction strategies, such as improving drainage infrastructure, livestock protection, farm building design and siting, and evacuation routes may need to be incorporated into advisory services in vulnerable areas.~~

The Fraser Basin Council (FBC) is undertaking a comprehensive study of changing flood risks in the Lower Mainland.[11] This is a major project involving all three levels of government that will shape planning and investment measures for flood hazard in the Lower Mainland for the coming decades. Phase 1 of the project, which includes vulnerability assessment and management recommendations based on climate change and flood scenarios, has a target completion of December 2015.

- As the Lower Fraser Valley is the region of B.C. with the highest value agricultural production, the implications of this FBC study should be of interest to the sector and are likely to interact with various Ministry programs.
- Participation on the study's Joint Program Committee would provide the Ministry with greater insight into key issues in vulnerability assessment for the agriculture sector, and highlight potential issues for various industry groups or programs.

To keep current with work on flood management and planning, Ministry staff should monitor planning processes led by other agencies and discuss implications for Ministry programming.

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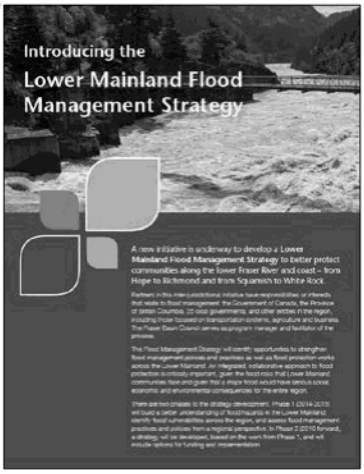
2.2.3 Pacific Climate Impacts Consortium (PCIC)

PCIC is a research group at the University of Victoria that produces regional climate information for British Columbia and the Yukon. Climate scientists at PCIC test and downscale global climate models (GCMs), linking climate and hydrological models for surface water management purposes and interpreting results for a variety of user groups. Recent work on projecting climate extremes is particularly useful for the Ministry because agricultural impacts are likely to be felt first through extreme events such as drought, flooding, and heat stress.[12]

PCIC maintains the user-friendly online Plan2Adapt Tool, which provides climate projections and maps for each region of the province. The PCIC website provides further information and access to its resource library and climate data bases.



PCIC climate projections are summarized and presented by CAI in their regional adaptation strategies, but other studies generated by PCIC are also be directly relevant to Ministry programming and should be monitored, summarized and communicated to staff.

[11] http://www.fraserbasin.bc.ca/_Library/Media/backgrounder_lmfls.pdf

[12] Murdock and Sobie, 2013.

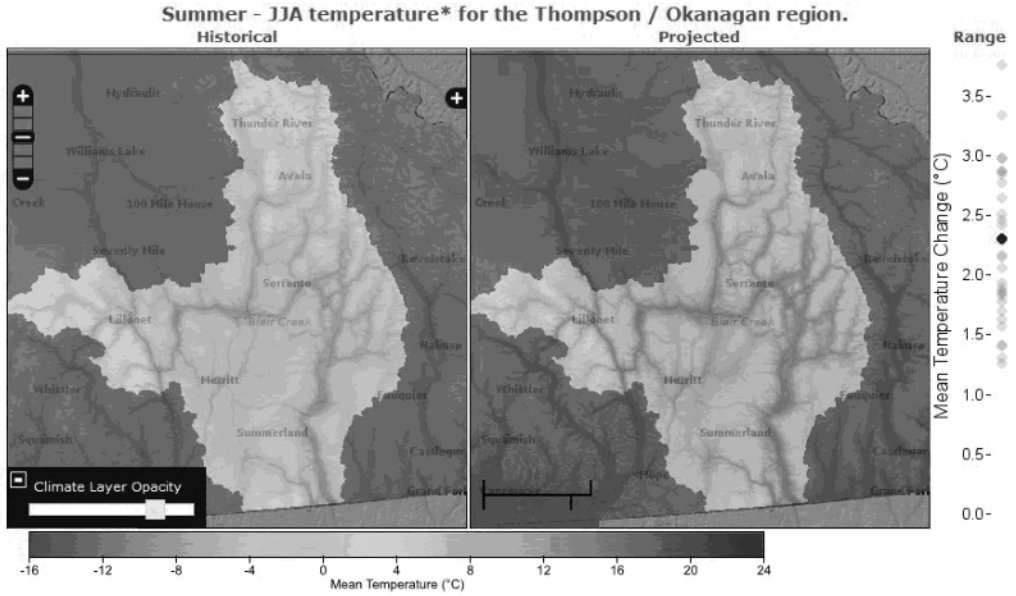


Figure 3: Average summer temperatures for the 2080sin the Thompson / Okanagan region are projected to be 2.4 degrees higher than historical averages, as shown by PCIC's online Plan2Adapt tool.

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2.2.4 Water Sustainability Act Implementation Measures

For agricultural producers to adapt effectively to climate risks, and for the Ministry to coordinate and support the interests of the agricultural sector in multi-agency initiatives, it is important for Ministry staff to be aware of and respond to emerging practices led by other agencies.

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B.C.'s 2014 *Water Sustainability Act* includes new provisions for regulating groundwater use, protecting water flows, and for broad regulatory authority to implement Water Sustainability Plans (WSPs) that could override provisions in other legislation. While the Ministry is well positioned to provide input for modelling water demand, it is not yet clear how agricultural interests and land uses may be affected under new WSPs, which may legally override other legislative provisions.

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As detailed regulations are being developed, and as various local and regional bodies become involved in developing WSPs, the implications for the agriculture sector and for specific Ministry programs should be explored. Monitoring and learning from such processes as they are introduced in agricultural watersheds will provide important opportunities to identify needed program responses.

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2.2.5 Ministry of Forests, Lands and Natural Resource Operations

The Competitiveness and Innovation Branch in FLNRO provides technical and policy advisory services on climate change. Guided by its Climate Change Steering Committee, FLNRO is implementing a climate change strategy that includes three goals:

1. Climate change is integrated in ministry core business.
2. Climate-relevant science, data and knowledge guide and inform the identification of the ministry's environmental, social, and economic risks, opportunities, and priorities for climate change action.
3. Climate change action is undertaken through collaboration, partnerships, communication and outreach with First Nations, communities and the natural resource sector.[13]

With the large operational and regional components of FLNRO services, that ministry has chosen to require major programs and regions to produce their own climate action plans that integrate climate change adaptation into their ongoing operational plans. The program action plans and regional action plans will be integrated into business plans for funding opportunities and priority implementation.[14]

The FLNRO action plans are especially relevant to agricultural producers and Ministry of Agriculture programs in regions with extensive grazing leases and forest / agriculture interfaces.

- The climate action plans produced by the Wildfire Management Branch addresses the anticipated increase in fire severity and size in the Interior.
- Other key points of overlap with the agricultural sector are range management, where the issues are drought and forage supply, and invasive species.

The Ministry of Agriculture Climate Action Team will review FLNRO climate action plans should and communicate them to relevant Ministry of Agriculture staff. s.13

2.2.6 Growing Forward 3

In 2015 federal and provincial preparations will get underway for negotiating the joint funding of agricultural programs for the period 2018 - 2023. The reviews, background studies, reports and discussions linked to this planning process provide a good opportunity for considering the role that changes in climate risk will play in the sector's innovation and competitiveness.

Preparatory studies or specific reviews of relevant factors for these negotiations should be undertaken to ensure that appropriate consideration of climate adaptation measures, as related to sector innovation and competitiveness, can be incorporated in the design of GF3 program elements.

3. Strategy Components

2.3 Approach

The Ministry of Agriculture Climate Adaptation Strategy is guided by the broad policy goal of Growing Forward 2 to help the agriculture sector become more competitive and innovative. Integrating climate change adaptation into Ministry of Agriculture sector programming will s.13

[13] FLNRO 2013. http://www.for.gov.bc.ca/het/climate/strategy/ClimateChangeStrategy_2013-2018.pdf
[14] Hopkins, K., Techical Advisor, Climate Change, FLNRO – pers comm Mar 12, 2015

strengthen competitiveness by ensuring that business operations are better able to adopt innovative practices and identify and manage climate risks.

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Approach:

1. **Integrative (?): Builds on anticipated program changes and updating opportunities that are already planned, or can be reasonably anticipated~~, such as the planned extension of Water Demand Modelling to the Peace region, or future transitions to Growing Forward 3~~.**
2. **Synergistic: complementing or supplementing other programming initiatives.**
3. **?: Focus on maximizing the value of existing activities and opportunities, so resulting learnings can be better integrated into programming.**

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The purpose of this strategy is not to introduce additional responsibilities or mandates for Ministry programs, but to ensure that current programs remain effective and responsive to producer needs as climate risks change and producers respond. Climate adaptation strategies will be supported by the Ministry's climate action team, but will be driven by program leads and integrated into ongoing programming largely as determined by program areas themselves.

2.4 Integrating Climate Change into Ministry Programming

2.4.1 The Need for Integrating Adaptation

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Adaptation planning in agriculture is crucial to address the adverse impacts of climate change on the sector. The Ministry's role in promoting innovative practices and planning will build the capacity of the sector to deal with climate change challenges through more informed strategic and operational decision making resulting in increased business competitiveness.

A key part this climate adaptation strategy is the strengthening of linkages and learning mechanisms so that program staff are able to integrate the new information and experiences about climate risks into program management and implementation.

Linkages between Ministry programs and CAI must be strengthened. CAI offers a unique opportunity to build on strong local collaboration and industry investment in innovation. Efforts should be made by both CAI and the Ministry to systematically integrate relevant learnings from CAI into programming. It should be recognized that adaptation is a slow and on-going process: initial results will require confirmation and replication, and early progress will be slow.

Moving forward, several actions have been identified for CAI and the Ministry's climate action team to ensure more effective communication and knowledge sharing between Ministry staff and CAI. The intention would be to support for broader interaction between Ministry staff and CAI, where CAI can be clearly seen as a resource for Ministry programming (just as the Ministry is a resource for CAI programming). In addition to CAI insights on climate adaptation, CAI engagement practices such as small group planning and structured focus group discussions may be relevant for Ministry programs.

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CAI actions ~~on key elements relating~~relevant to the Ministry strategic direction (?) goals (?):

- identification of emerging adaptation issues
- share publications, reports, and planning tools
- outreach to industry, extension or field schools, as relevant

- presentations and communications materials
- serve as a resource for discussion of implications of CAI work with ministry programs and management

Ministry's Climate Action Team actions:

- develop program-focused summaries of CAI results
- organize and facilitate dialogue sessions with program units
- help to identify funding for relevant staff engagement and learning opportunities, where possible

The Ministry has ~~strong~~ demonstrated a strong capacity to adapt and learn. One example is its experience with avian influenza in the Fraser Valley. The 2008-9 outbreak provided lessons that were applied to better control and manage the 2014 episode, such as through better spatial analysis and premises identification, communications protocols, and clarification of inter-agency roles and responsibilities.

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Some learning can be accomplished through shared documentation, but learning also means shared experience and testing of assumptions through face-to-face interaction and field visits. Learning is best structured as a two-way (or multi-directional) exchange recognizing that different participants hold various kinds of knowledge relevant to decisions to manage climate risks.

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This strategy proposes five mechanisms for strengthening learning and communication about climate impacts and adaptation within the Ministry in order to integrate these into programming:

1. **adaptation contact group**
2. **multi-party adaptation dialogues**
3. **information briefs and digests highlighting recent lessons for programs**
4. **field visits**
5. **key role of the Ministry's regional agrologists and industry specialists**

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2.4.2 Adaptation Contact Group

As the Ministry integrates climate adaptation into its ongoing programming, support from the climate action team will be crucial.

- While adaptation is relevant to many Ministry programs, and some programs are already considering climate change in their work, it would be helpful if contacts were clearly identified for providing support or updates.
- It would also be beneficial if program areas were to see how adaptation has been successfully integrated into operational tasks, and benefit from sharing adaptation experience between different program areas.

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For these purposes, it would be helpful to have an informal adaptation contact group in the Ministry, with representation from each of the relevant programs. The main role of the contact group would be information sharing, serving as an entry point for program or regional colleagues to identify relevant emerging climate opportunities or practical lessons.

- At the regional or program level, the contact person should be somebody with an interest in the topic and with working networks of Ministry colleagues.
- ~~Content should be of direct relevance to Ministry program areas~~

- Membership in the group would be up to each program area to determine, and could include program leads or designated expert staff, as well as staff who have a particular interest in the subject matter and those that were part of the ADAPTool assessment.
- The group would be coordinated by the Ministry's climate action team.
- While regular meetings may not be required, the establishment of designated contacts would make it easier to consult quickly on specific issues or opportunities.

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2.4.3 Adaptation Dialogue Sessions

~~The program areas know their own context best, and would benefit from knowledge about the interacting risks of accelerating climate change.~~ Risks will be dealt with most efficiently and effectively if they are well understood and best allocated to those who have the decision-making authority, technical expertise and are best placed to manage them. Program area experts will need to understand what the risks of a changing climate mean to their business area and service delivery.

- A learning-oriented dialogue session provides a constructive format for introducing new knowledge, identifying opportunities, and discussing appropriate responses and follow-up actions (such as additional monitoring, detailed studies or support mechanisms).
- The learning dialogues ~~should be~~will be facilitated and led by the Ministry's climate action team, in response to program agendas and priorities.
- A key part of each dialogue would be the presentation of new information from a recent study or practice, typically by an expert familiar with the work who can respond to questions.
- The type of information delivered can be best targeted if organizers are clear on who the participants will be and the program's current strategic plans.
- A proposed outline for an adaptation dialogue is shown in Annex 4.
- A target of two to four dialogue sessions per year could be held.

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Preparation for an adaptation dialogue session will involve identification of a candidate program and a relevant topic for which new information has become available as a result of recent studies or practice. A climate change topic may be brought forward by the program or by the climate action team.

~~With the ongoing work of CAI, there will be many opportunities in the next two years to discuss and present results of interest to programs. For example, results from the CAI pilot project in the Peace Region to undertake collaborative monitoring for pests, disease, weeds and invasive species will be of interest to the Pest Management / Plant Health group.~~

2.4.4 Information Briefs

The climate action team already closely tracks activities of CAI and related initiatives. Key results of potential program area interest should be summarized by the Ministry's climate action team in a concise 2 - 3 page format, with Ministry staff as the target audience. The briefs should focus on new information relevant to agricultural management decisions in B.C., and be clearly targeted at specific program issues.

- Each summary would focus on a single issue or CAI project. It is anticipated that 2 - 4 of these could be generated each year.

- The summary should conclude with 2 - 3 questions that would form the basis discussion with interested respondents.
- For example, a discussion brief could be developed based on results from the CAI Delta Flood Preparation and Mitigation Pilot, highlighting potential implications and recommendations for EFP and BMP programming and documentation.
- Another example would be to produce a brief review of the forthcoming Climate Action Plan for FLNRO's Wildfire Management Branch, highlighting practical implications for ranching operations, the Agricultural Emergency Management Program, and for regional agrologists.

The informational briefs would be circulated in the Ministry through the adaptation contact group, and a conference call with those interested would be scheduled. Follow-up discussions would review the content of the brief, provide more detail, respond to questions, and identify potential implications. CAI or other experts may join the call, depending on availability.

2.4.5 Field Visits

Field visits to consider new practices or climate impacts can be very effective learning tools, particularly if they involve producers and producer organizations as well as other stakeholders such as local government. These field visits not only demonstrate practical issues, but allow discussion and interaction among the participants. For example, inspection of new drainage approaches could help illustrate the importance not only of on-site, farm-based measures for producers, but also of improved land use planning and municipal infrastructure management.

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The adaptation contact group would provide a mechanism for informing colleagues of field visit opportunities and outcomes. Field visits will be developed as opportunities arise, but are likely to be infrequent and should be coordinated with events scheduled by CAI or producer organizations.

2.4.6 Key Role of Regional Agrologists and Industry Specialists

All of these mechanisms (Adaptation Contact Group, adaptation dialogues, informational briefs, and field visits) should include an important role for regional agrologists, who are frequently the key Ministry partners for local and regional CAI initiatives, and are on the front lines of interaction with producers. Industry specialists may also play a similar role in relation to particular production systems.

~~The agrologists are the "eyes and ears" of the Ministry.~~ As active participants and advisors in CAI projects, ~~they~~ agrologists are well placed to provide critical insight into programmatic implications of regional and farm-level adaptation projects. These insights should be exchanged with appropriate program leads and technical staff. Key requirements for this communications and learning role are:

- Regional agrologists and industry specialists are supported with time and resources to engage in CAI and other adaptation initiatives and to review experiences with each other and with Ministry colleagues.
- Program staff can create opportunities for interaction (preferably face-to-face) with regional agrologists to discuss relevant issues.

These interaction opportunities are necessary for effective learning and capitalizing on the opportunity for regional agrologists and industry specialists to facilitate adaptation into programming. This role could be supported through leveraging resources for:

- **Regular interaction between regional agrologists, the climate action team, and CAI to update on project results and issues (e.g. conference calls or face-to-face meetings twice a year).**
- **Meetings between agrologists or industry specialists and program leads about specific regional or commodity-based program related issues flagged through these interactions.**
- **Regional agrologist or industry specialist participation in Adaptation Dialogues with program staff and external adaptation resource persons.**

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2.4.7 Program Capacity Building

~~The impacts of climate change on the agriculture sector, and the ability of producers to adapt and respond, will be a recurring theme for the sector in coming decades. Over time, climate adaptation will become, like other aspects of agricultural innovation, a continuing process that demands relevant and updated information, transparent analysis, and ongoing professional development. But for now the field is still novel and unfamiliar.~~

While there is a high level of general awareness of the issue of climate change and its relevance, the recognition of specific implications for programming responsibilities is variable. Gaps in basic knowledge of climate impacts are not widely recognized.

- Reliable general scientific information about climate change is readily available in the on-line Climate Insights 101 course, designed by the Pacific Institute for Climate Solutions (PICS) at the University of Victoria. This course allows the user to review several modules explaining the scientific basis of climate change and its impacts in B.C. This ~~would be~~is a useful resource to provide a common foundation for program staff to engage in further detailed discussions on adaptation measures.
- The climate action team has facilitated previous webinar presentations from CAI for Ministry staff, introducing the program and providing examples of recent work. These webinars should be continued.
- Learning and capacity building mechanisms that focus more specifically on programmatic issues can be initiated by the climate action team, in response to emerging opportunities. Program audiences will have different needs and varying levels of background, so planning for such activities should include an assessment of participants and learning needs related to the particular subject matter.

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The climate action team should be recognized by the rest of the Ministry as a resource for supporting this learning and helping to build program capacities to integrate adaptation.

2.5 Program Specific Strategies and Actions

This section provides initial ~~strategies and opportunities~~actions? to integrate climate adaptation in ~~each of the~~ Ministry programs ~~assessed in the ADAPTool study~~.

- The suggestions presented here have been identified through the ADAPTool assessment, through further consultation with program leads, or through exploratory dialogue sessions with the program staff.
- These actions would be implemented by the respective programs, with support from the climate action team as appropriate.

- The measures proposed here respond to opportunities already identified (see Table 2 below) and should be relatively easy to implement. The action details will be determined by the programs themselves and suitably incorporated into business plans.
- The actions proposed here are just a starting point – climate adaptation is an ongoing process that will evolve with additional information, experience, and new collaborative opportunities.

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2.5.1 Regional Agrologist Network

Regional agrologists have a key role to play in the Ministry's adaptation strategy because they are a vital link between programs and producers. Several regional agrologists are engaged with CAI projects as members of the regional adaptation strategy working groups and project management committees. They are well placed to provide critical and practical reviews of project lessons, and to interpret ways that other Ministry programs enable or constrain local adaptation actions.

This strategy recommends that additional support and resources be provided to enable regional agrologists fulfill this important learning and advisory role.

2.5.2 Agricultural Emergency Management (AEM)

Disasters such as wildfires, flooding and drought are likely to become more frequent and to have increasing impact on agricultural producers. Many flooding events are small scale, but can have a big impact on individual producers.

- The AEM program is working with local governments to promote emergency management and disaster risk reduction measures in Agricultural Area Plans (AAPs).
- The program may wish to encourage agricultural interests to become involved in FLNRO's Landscape Fire Management Plans, which will be undertaking stakeholder consultations after the risk and threat assessment phase of their work in the Cariboo and Central Okanagan Shuswap regions in future.[15]
- There are also potential links to FLNRO's Strategic Wildfire Prevention Initiative, which includes planning, technical support, fuel management training and funding for local governments and First Nations.

The AEM program has had discussions with CAI about several projects: Flooding Preparedness and Mitigation in Delta (DL07), Extreme Weather Events Preparedness in Cowichan (CW04) and Wildfire Preparedness and Mitigation in the Cariboo (CB01) (see list of CAI projects in Annex 3).

- **As CAI's emergency management related projects are completed, they should serve as the basis for a facilitated adaptation dialogue session to share the content of project reports and to reflect on key learnings and transferrable options for both risk reduction and emergency response.**
- **The AEM program should follow the progress of the Fraser Basin Council's Lower Mainland Flood Management project to ensure that agricultural issues are adequately considered.**

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[15] L. Gawalko, Manager – Wildfire Management, FLNRO, pers comm. March 9, 2015.

2.5.3 Pest Management and Plant Health

Climate change is likely to lead to an expanded range for pests and pathogens, as well as the introduction of new pests. Increasing variability will complicate pest management practices and treatment advice. However, pest ecology is complex and difficult to model or predict. This suggests the high value of improved monitoring and surveillance for key agricultural regions and crops.

Results from CAI's collaborative pest monitoring project in the Peace Region should be shared with the Plant Health program.

The Plant Health program pursues opportunities for funding for 1 - 5 year projects on emerging issues in monitoring and management research, often in collaboration with producer associations who maintain their own monitoring networks. These efforts should continue, with climate change and variability issues in mind, and with a focus on pests of relevance to multiple crops.

There is potential for more collaborative monitoring and research, and for networking with other provinces and jurisdictions around pest management issues, but even this level of collaboration would be challenging without additional provincial resources for networking and engagement.

2.5.4 Production Insurance

Although climate change will mean increased likelihood of extreme weather events, the production insurance program is not at financial risk in the near term for several reasons:

- Diversity of crops grown and of regional climates mean that any single extreme weather event or disaster is unlikely to affect a large area of insured crops.
- The program is financially sound and has not seen catastrophe claims in over a decade.
- The program structure ensures that in the event of high claims from an extreme weather event, premiums will go up and coverage will decline. This provides both financial recovery and an incentive for producers to adapt.
- The highest exposure to widespread weather damage for high value crops is for risks of frost and winterfreeze, which are declining in frequency.

While the Production Insurance program appears robust and supportive of climate adaptation, if several severe weather events occurred in different regions in the same or consecutive years, this could strain the program and expose producers to much higher levels of risk due to reduced coverage. Although such a combination of events may become more likely under a changing climate, this likelihood in any given year would still be very low in the near term. In fact, recent trends have been the opposite: claims are steady or declining while participation in the program has stayed relatively constant. Moreover, producers have adopted technologies and practices to reduce typical climate risk exposure (e.g. varietal selection in fruit trees and vines; zero-tillage and more robust seed stock for grains and oilseeds), which also appears to have moderated claims.

The production insurance program is structured to support producer adaptation and innovation. However, there are premium subsidies may deter desirable producer adaptation and lead to problems of adverse selection. Improved information about the effects of changing climate risk on claims and coverage in future would be helpful for producers.

A key issue as climate risks increase is to obtain more information from producers about affordability and the level of uninsured losses, recognizing that premium subsidies and lower incentives for adaptation are also challenges.

Potential actions to support the integration of climate change adaptation in the Production Insurance program include:

- **Support efforts to improve digital claims database with geo-referencing and weather event data, and explore how to share this data more effectively with the industry.**
- **Monitor producer responses to climate risks, particularly if claims increase and coverage declines.**
- **A key issue is the question of continued affordability and uninsured losses. This may include consultation with existing producer advisory groups or with CAI, based on their networks of regional contacts.**
- **For GF3 considerations, monitor the outcomes of the Manitoba provincial task force on BRM programs, and similar assessments being undertaken by other provinces, to evaluate implications for B.C. and ensure that premium subsidies do not create disincentives for producer adaptation.**

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2.5.5 Strengthening Farming

The program supports resolution of land-use conflicts and community planning for a sustainable agriculture industry in B.C. Both components of the program will be affected by climate change. Water management is likely to be an early issue. For example, iIncreased runoff and frequency of extreme events will lead to diverging interests between urban communities and nearby agricultural areas. Issues of drainage and flood discharge, dike protection and flood retention areas, and risk reduction or planning all involve interaction between adjacent urban and rural areas. Many of the Strengthening Farming program's current tools and procedures will be directly relevant in these situations.

- **The Strengthening Farming program can assist in bringing together local government bodies and producers to gain agreement on what the issues are in order to develop solution strategies that may involve senior levels of government. The Agriculture Advisory Committees serve as an important source of intelligence on emerging issues.**
- **The program produces valuable tools such as land use inventory and GIS, and should add applications that deal specifically with flood retention and runoff management in land use planning applications.**
- **Potential issues for consideration include: emerging subdivision guidelines and stormwater runoff guidelines that rely more heavily on "green infrastructure"; wildfire protection planning; and emerging Water Sustainability Plans under the new *Water Act*.**

2.5.6 Agroforestry

The Agroforestry program is small but already oriented to climate adaptation.

- There is a recognition that agroforestry can contribute to landscape and ecosystem management to improve climate buffers, reduce erosion, manage runoff and modify extreme temperatures at a site level.
- The program is structured to foster engagement, learning and support to regional colleagues and producer organizations, and in this respect serves as a model. However, the program's potential influence is limited due to its small size.

Extreme heat and cold, wind and winter storms, flooding and drainage projects, and changing water management planning may all have implications for agroforestry.

- **Program actions should include assessing CAI regional adaptation strategies to identify opportunities for agroforestry measures, and monitoring agroforestry demand and interest related to climate.**
- **Agroforestry should be promoted where relevant to meet land use objectives and ecosystem services at site and landscape scales to help meet climate buffering demands under increased threat of extreme climate conditions (e.g. flood and erosion control; water management; shade management).**
- **Regional demonstrations and extension materials related to adaptation applications should be expanded as possible and new partnerships with producers explored in response to demand.**
- **New watershed management and local integrated water sustainability planning processes may provide further opportunities for agroforestry promotion.**

2.5.7 Environmental Farm Plan and Beneficial Management Practices Programs

These programs emphasize planning and practices for managing environmental risk to improve sustainability of agricultural practices. They already consider climate risks but need to be sensitive to how these risks are changing. Examples include flood risks, runoff and soil erosion, heat waves and drought protection measures. In all cases, the emphasis should be on risk reduction, both on individual farms and in agricultural communities where risks are affected by action on adjacent lands.

- **In light of growing wildfire risk, the program should consider linkages to the national FireSmart program and its on-line tools for assessment of fire risk to buildings and yards in forest interface areas.[16]**
- **Consideration should also be given to extending financial support to investments that reduce climate risks under this program in environmentally sustainable ways, e.g. funding for farm level reservoir construction and inspection; funding for erosion management and levelling; agroforestry for slope stabilization, riparian integrity, and wetland protection and retention.**
- **The EFP and BMP programs already interact with CAI and could maximize their benefits from relevant CAI projects through the proposed Adaptation Dialogues and other interactive learning tools. The programs should monitor the CAI's Integrated Farm Water Planning Project (CW06); Delta Flood Preparedness and Mitigation (DL07); and Cariboo Livestock Surface Water Assessment (CB04).**

2.5.8 Agriculture Water Management Program

The Agriculture Water Management Program provides analytical support for water management in agriculture, so it is already oriented to climate issues and adaptation. The program's services are likely to be increasingly valuable as the B.C. climate changes.

The program has implemented ADAPTool recommendations by expanding its services into new regions. It provides modelling support to agricultural water demand estimates, which are likely to become more widespread as local governments and water management organizations introduce Water Sustainability Plans under the new *Water Act*.

- **The program should keep informed on CAI projects that relate to water use, such as weather monitoring and support tools (PC05) and potential for irrigation in the Peace Region (PC06).**
- **Drainage and flooding issues are also relevant to water demand modelling, and the program is already aware of the CAI work in Delta on drainage issues.**

[16] http://bcwildfire.com/Prevention/FireSmart.htm

- **As new planning processes are implemented for water management, the program should be attentive to how issues of data sharing can be addressed to build confidence and trust between agencies while safeguarding privacy.**
- **Another issue for future consideration is that as water use efficiency increases, there is less scope for reductions in use under severe drought conditions. This has implications for provincial drought management responses in the agricultural sector.**

2.5.9 Agrifood Business Development

This program is already responsive to local producer and business priorities, so is well placed to identify emerging priorities as climate risks become more important to producers. But the program does not explicitly identify changing climate factors and how these would be likely to influence risk management or market opportunities.

- Increasing precipitation in spring and fall seasons in various regions could create challenges for harvesting, storage and processing of produce.
- Warmer, drier summers in southern regions may create new market opportunities in B.C. at the same time as production declines in other areas (e.g. California).

The CAI project investigating enhanced local processing and storage in the Cowichan Valley, now complete, may be a helpful starting point. Competitive opportunities for the industry will change as production shifts in other regions of North America, and globally. These issues may be relevant for the Agrifood Business Development program in the longer term.

Table 2: Review of opportunities ~~and proposed initial actions for integrating adaptation into program areas~~and actions

Program Areas	Current Opportunities	Potential for Integrating Adaptation	Proposed Initial Actions
Ministry of Agriculture Climate Action Team	- mandate to support climate mitigation and adaptation responses within the Ministry	- role is to support integration in other programs	- Establish and coordinate Adaptation Contact Group - Lead 2 - 4 climate adaptation dialogue sessions per year - Prepare up to 4 adaptation briefs / digests per year
B.C. Agriculture and Food Climate Action Initiative (CAI)	- delivers Regional Adaptation Enhancement Program and Farm Adaptation Innovator Program - collaboratively develops Regional Adaptation Strategies, implements priority projects - supports farm-level adaptation through competitive grant applications - documents and shares project results	- adaptation is the key focus of the program already	- Support adaptation dialogue sessions and information sharing opportunities. - Invite ministry staff to field events. - Support climate action team to develop information packages targeted at specific program and management audiences.
Regional Agrologists & Industry Specialists	- agrologists are often involved in project management for CAI projects and identify local connections to many other programs. - contacts for local issues arising from Water Sustainability Plans; FireSmart planning; regional drought management	- familiar with local and regional issues / innovations and are key to effective implementation of many other programs - front lines for regional interaction with other agencies (wildfire, water, drought management)	- Continue to support CAI pilot projects. - Create more frequent opportunities for team learning and interaction. - Help identify emerging issues of climate risk and adaptation for other programs. - Share knowledge of CAI projects.
Agricultural Emergency Management	- links/lessons from CAI projects including Delta Flooding Preparedness and Mitigation, Extreme Weather Event Preparedness and Mitigation in the Cowichan and Widlfire Preparedness and Mitigation in the Cariboo - FBC Lower Mainland flood management project - FireSmart program: FLNRO	- CAI studies can point to regional hazards that are likely to be exacerbated by climate change, to focus information strategies with producer groups - growing need for consideration of risk reduction measures at farm and community scale - potential to coordinate with EFP / BMP to harmonize messaging - collaborate with FLNRO and local	- Provide more information to producers and local government on risk reduction measures for extreme climate events (flood, wildfire, drought). - Strengthen communication of specific risks with local government and producers (e.g. drought situation on VI). - Coordinate farm-level messaging on risk reduction, site planning, EM with EFP. - Promote emergency planning and risk

Program Areas	Current Opportunities	Potential for Integrating Adaptation	Proposed Initial Actions
	connection - drought management a growing issue in the interior (forage, livestock watering)	governments on planning for wildfire risk reduction	reduction in local government AAPs. - Develop a system for better tracking local government coordination of agricultural EM. - Appoint a representative to FBC Joint Program Committee to monitor Lower Mainland flood management study.
Plant Health & Pest Management	- CAI Collaborative monitoring project in the Peace (underway) - opportunities to commission new studies around specific questions, perhaps in collaboration with industry	- how to maintain and build on knowledge gains of 2 yr CAI project to strengthen surveillance - identify emerging research or monitoring issues in collaboration with producers, AAFC	- Identify specific emerging pest threats with industry. - Continue collaborative monitoring and research projects with industry, focusing on pests relevant to a variety of crops. - Review lessons from CAI collaborative monitoring project in Peace Region and consider how to improve monitoring information for high-value crops.
Production Insurance	- Manitoba BRM Task Force: reviewing changing climate risks and program performance (some interest in other provinces as well)	- efforts to improve data base to ensure geospatial and weather event data are tied to claims - consult with producers around issue of premium subsidies as disincentive for adaptation	- Monitor outcomes of MB Task Force. - Implement proposed database enhancements (geospatial / weather data) to provide better information on climate-related losses. - Explore emerging producer concerns on climate risk management with CAI. - Monitor farmer advisory committees to assess whether coverage meets risk management needs while providing incentives for adaptation as climate risks increase.
Strengthening Farming	- CAI study defining a new approach to Agricultural Land Use Inventory in the BC Peace (PC04) - CAI regional adaptation strategies - *Water Act* implementation - FBC Lower Mainland Flood Management study: implications for land use and local planning	- monitor emerging issues in local planning (particularly dealing with subdivision, drainage, flood retention, etc) - potential FireSmart connections to agricultural producers for wildfire planning	- Recognize and build program knowledge about climate risks related to land use planning: e.g. flood management, drainage, water consumption. - Monitor emerging experience with Water Sustainability Plans.

Program Areas	Current Opportunities	Potential for Integrating Adaptation	Proposed Initial Actions
Agroforestry	- FBC Lower Mainland Flood Management study - PCIC extreme events studies - CAI assessment of Shelterbelts.	- links to EMP / BMP for flood management, streambank erosion control, runoff management, etc	- Identify ecosystem services and climate buffering functions of agroforestry at site and landscape scales. - Foster demonstrations and extension through partnerships with producers and local groups.
Environmental Farm Plan & Beneficial Management Practices	- relevant CAI projects: Delta Flood Preparedness and Mitigation pilot (DL07); Cariboo Livestock Suface Water Assessment (CB04); Integrated Farm Water planning Project (CW06); … - FBC Lower Mainland Flood Management study	- emerging concerns with runoff, erosion control, water management, flood risk reduction - monitor relevant information from related activities - collaborate with AEM, other programs	- Explore how to incorporate changing climate risks and disaster risk reduction at farm and community level (with AEM). - Review results of relevant CAI projects to consider how to incorporate drought planning, drainage and flood protection measures.
Agriculture Water Management	- relevant CAI projects: PC02 Increasing availability of agriculturally relevant weather data, Possibly connect wt Delta drainage and sub-irrigation project (DL09) - FBC Lower Mainland Flood Management study	- more effort to simplifying data sharing protocols between different agencies - update models with new information from climate models and other research projects	- Anticipate increasing demand for program. - Collaborate to simplify data sharing protocols between different agencies. - Update models with new information from climate models and other research projects. - Expand program availability in new regions.
Agrifood Business Development	- CAI projects: Enhancing Local Processing and Storage in Cowichan (complete March 2014)	- support to explore business and market risks (and opportunities) associated with increasing climate variability and climate change	- Review results from relevant CAI projects. - Work with industry to explore new opportunities and impacts of changing local climate conditions.

3. Implementation and Monitoring

Implementation
Integration of climate adaptation into Ministry programming is primarily the responsibility of program leads and should be undertaken as part of ongoing business processes. The main goal of these efforts should be to support broader learning by program staff and management.

- Adaptation actions should be seen as part of continuous improvement and corporate learning processes.
- The Ministry's climate action team will support this process by facilitating adaptation dialogues, sharing new information in the form of information notes, and coordinating information exchange.
- The Climate Action Initiative will serve as a resource to these efforts, and will undertake outreach to Ministry programs by supporting the information sharing efforts of the climate action team and by collaborating directly with relevant program staff in the field.

Monitoring
Strategy implementation can be monitored using the template shown below, which can be maintained by the climate action team in collaboration with program leads.

- **For each program, the monitoring should be updated every 2 years. This can form the basis of periodic reports by the climate action team to senior management.**
- **In addition to regular monitoring of how adaptation measures are being implemented in programs, the climate action team should reassess the adaptability of programming by repeating ~~the~~ a ~~ADAPTool~~ program assessment in 2018, once Growing Forward 3 is in place.**
- **The next ~~ADAPTool~~ assessment should include both the Agricultural Land Reserve and the Climate Action Initiative. ~~The CAI program in particular should be able to demonstrate substantial contributions to producer adaptive capacity.~~**
- **~~In the next iteration of ADAPTool,~~ producer adaptation measures and vulnerability assessments should be updated based on the latest information from CAI.**

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Summary information from the monitoring template (below) can be used to describe specific changes that have been incorporated into programs since the ADAPTool assessment. These changes can be incorporated in the analysis for the next iteration of the ADAPTool assessment, to ensure that programs are credited with the adaptation efforts they have undertaken.

- Learning mechanisms, such as those recommended in this strategy, that have been adopted and implemented at the program level should be explicitly taken into consideration in the assessment.
- The ADAPTool may also be used in the early stages of policy and program design for new program initiatives, to test their adaptability to climate change stresses.

The Ministry can anticipate that new adaptation issues will arise from several sources over time from:~~.~~

- Increasing producer experience with climate variability in different regions of B.C.
- New information from CAI programming: regional strategies, specific studies, pilots
- Industry initiatives to advise and support producers
- Initiatives promoted by other provinces and territories under FPT agreements

These issues will affect different programs and services offered by the Ministry.

- Because adaptation will be an ongoing process, is central to producer behaviour, and affects many different program areas, it will be important for the Ministry to assess new and existing activities to ensure that they foster producer adaptation and innovation.
- The shared learning tools recommended in this strategy can provide mechanisms for collaborative assessment of emerging opportunities. ADAPTool can also be applied to planned or existing programs to assess their adaptability as conditions change.

The Ministry's success in fostering innovation and adaptive responses to climate change by producers will be reflected in the performance of the agriculture sector. This is not just a matter of Ministry programs, but also about producer associations and services in the industry that support innovation and competitiveness.

The climate action team should identify and track actionable issues that arise from CAI's regional strategies and farm pilot projects, share these with program staff using the learning mechanisms recommended above, and then jointly assess the need for followup measures.

In the long term, indicators of success in climate adaptation will include:
- measures of agricultural output and revenue (farm cash receipts)
- recorded insured and uninsured losses from weather events (BRM data)
- level of losses and speed or recovery from climate disasters (BRM data)

These measures will fluctuate in the short term, but significant variations should be examined critically. If there were high future levels of climate losses and significant losses from natural disasters, the Ministry should re-appraise adaptation measures, producer risk reduction behaviour, and related information resources provided by the Ministry's programs.

Table 3: Monitoring Template for Integrating Adaptation into Programs

Date:	**Program Name:**
1. Climate implications for program are identified	- list most important issues from CAI regional adaptation strategies, or other studies, relevant to the program - producer concerns raised in recent consultations or through CAI - areas of potential weakness or vulnerability relative to these climate impacts / demands
2. Program has explored recent innovations or lessons	- summary of documented output from adaptation dialogue, field visit, study, publication review or other knowledge sharing mechanism - potential opportunities for collaboration or innovation with external organizations
3. Actions identified to address priority adaptation issues	- 3 to 5 feasible actions over short to medium term - Program areas should identify metrics to assess the implementation of their actions - may be conditional on resources
4. Actions implemented	- document actions implemented
5. Explanatory notes / plans for upcoming period	- actions planned for next 2 years

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Annex 1: Recommendations of ADAPTool Assessment (2013)

ADAPTool Assessment – Actions for 5 Key Programs

AgriStability

1. Monitor the program to assess whether increasing climate variability and extremes are affecting the AgriStability program's ability to meet its policy objectives, as a means of preparing for future program design discussions.
2. Employ greater use of multistakeholder deliberation in implementation and decentralize decision making to aid in responding to regional diversity and increasing climate variability.

Production Insurance

1. In regular actuarial certifications, consider whether the effects of climate change are affecting recent loss experience to an extent that shifts in coverage and/or premium rates are required. The certifications should also consider if self-sustainability mechanisms remain adequate.
2. Evaluate production insurance to determine if the program and the premium structure adequately support the introduction of new and potentially better-adapted crops and cultivars and encourage other innovative adaptation measures that farmers adopt due to climate change.
3. Evaluate production insurance governance models in other jurisdictions to determine options for increased decentralization of decision making.

Agricultural Emergency Management

1. Conduct a review of provincial agricultural vulnerabilities to extreme events, including identification of significant gaps in preparedness and risk mitigation at the broad scale (e.g., infrastructure issues).
2. Collaborate with the B.C. Agriculture and Food Climate Action Initiative on projects to pilot risk reduction measures with producers.
3. Expand engagement with local authorities and agriculture sectors to increase their emergency preparedness and recovery for events that affect agriculture, and continue to conduct after-action event reviews.

Invasive Alien Plant Program and Pest Management/Plant Health (for both programs)

1. Conduct further study of program needs and available resourcing within the next 12 months to ensure that emerging priorities are addressed.
2. Consider whether current monitoring of invasive plants and emerging pests is sufficient to ensure that highest priorities and risks are being tackled as new threats emerge.
3. Identify priority areas for research.

Additional action:

1. Create a climate adaptation contact group with a designated representative from each program area, coordinated by the ministry's climate action team, to support the government's strategic direction to mainstream adaptation across ministry programs.

Annex 2: Climate Action Initiative and Ministry of Agriculture

CAI was initiated by the B.C. Agriculture Council in 2008, with funding from Investment Agriculture Foundation and the Ministry. Over the past five years CAI has been very productive, undertaking regional climate change risk and opportunity assessments, and regional adaptation strategies, implementing pilot projects based on producer-identified priorities, and initiating the Farm Adaptation Innovator program, all undertaken in close collaboration with producer and industry groups, and with the support of Ministry staff. In 2013 the CAI was engaged by the Ministry to deliver its industry-led climate change adaptation program, funded by the innovation component of Growing Forward 2, a federal-provincial-territorial initiative.

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CAI has been very effective at engaging Ministry staff on regional strategies and projects. As a result, these staff are familiar with CAI work. However, neither the Ministry nor CAI have devoted much effort yet to determining how lessons from CAI projects will be systematically integrated into regular Ministry programming. This is understandable as there has been a tremendous effort involved in setting up the program, undertaking regional studies, establishing relations with stakeholder groups, defining priorities for pilots, initiating the Farm Adaptation Innovator funding, defining projects, managing competitions, awarding contracts and assuring deliverables. However, it would be timely to consider how best to make use of program results now that a large number of projects are underway and delivering valuable results.

Annex 3: List of CAI projects

Regional Adaptation Projects			
Region	***Proj #***	***Title and Description***	***Timeline***
Delta	1	**Potential economic and agricultural production impacts of climate change related flooding in the Fraser Delta** *Evaluation of economic and food security implications of climate change related flooding in Delta, Richmond and Surrey.*	Oct 2013 - Mar 2014
Delta	3	**Flooding preparedness and mitigation pilot project (Phase 1)** *Identify risks and develop materials and process for on-farm flooding preparedness and mitigation.*	Nov 2013 - Mar 2014
Delta	5	**Collaborative Climate Change and Agriculture Communications Strategy** *Strategy to increase public knowledge and understanding of local agriculture and climate change adaptation.*	Jan 2014- Mar 2014
Delta	DL06	**Forum: Agricultural vulnerabilities to coastal flooding** *A forum to bring together the agriculture sector and partners to share findings of project #1 and discuss plans and options for addressing climate change related flood risk.*	Nov 2014- Feb 2015
Delta	DL07	**Flooding preparedness and mitigation pilot project (Phase 2)** *Pilot individualized on-farm flood preparedness and mitigation. Evaluate pilot and develop transferable tools.*	Aug 2014 - April 2015
Delta	DL08	**Agriculture and Climate Change Outreach and Education Pilot Project** *Implement priority outreach and education activities from strategy developed in project Delta 5.*	Nov 2014 - Nov 2015
Delta	DL09	**Delta drainage and sub-irrigation project** *Analyze existing knowledge of in-field management to increase drainage and improve irrigation.*	Aug 2014 - Apr 2015
Cowichan	1	**Integrated Farm Water Planning Pilot (Phase 1)** *Develop integrated water management and planning process and toolkit*	Nov 2013- Mar 2014
Cowichan	3	**Business case for regional agriculture extension services** *Scan and evaluate extension delivery options across jurisdictions, develop and evaluate various models for extension and recommend a sustainable business model.*	Nov 2013 - Mar 2014
Cowichan	4	**Extreme Weather Events preparedness (Phase 1)** *Identify areas of vulnerability to extreme events across the region. Develop agriculture specific informational materials and strategies to prepare for an mitigate impacts of events.*	Nov 2013 - Mar 2014
Cowichan	5	**Enhancing Local Processing and Storage** *Strategy for the region to improve local processing, storage and value-added capacity through an assets inventory and options analysis.*	Nov 2013 - Mar 2014
Cowichan	CW03	**Business case for regional agriculture extension services** *Scan and evaluate extension delivery options across jurisdictions, develop and evaluate various models for extension and recommend a sustainable business model.*	Mar 2014- July 2014
Cowichan	CW04	**Extreme Weather Events preparedness and mitigation pilot project (Phase 2)***Pilot a group approach to planning, preparedness and mitigation for extreme events.*	May 2014 - Mar 2015
Cowichan	CW06	**Integrated Farm Water Planning Pilot (Phase 2)** *Undertake integrated farm water planning process and plan development with 5-10 farms.*	Sep 2014 - Apr 2015
Peace	2	**Increasing availability of agriculturally relevant weather data (Phase 1)** *Determine gaps in weather monitoring network and provide recommendations for filling gaps and developing decision support tools*	Jan 2014- Mar 2014

Peace	PC02	**Increasing availability of agriculturally relevant weather data (Phase 1)** *Determine gaps in weather monitoring network and recommendations for filling gaps and developing decision support tools*	Mar 2014-June 2014
Peace	3	**Collaborative monitoring pilot project in the BC Peace** *Implement collaborative monitoring strategy for pests, disease, weeds and invasive species.*	Jan 2014-Mar 2014
Peace	PC03	**Collaborative monitoring pilot project in the BC Peace** *Implement collaborative monitoring strategy for pests, disease, weeds and invasive species.*	Apr 2014 - Apr 2016
Peace	PC04	**Feasibility study: Defining a new approach to Agricultural Land use Inventory in the BC Peace** *Evaluate feasibility of an alternative form of Land Use Inventory process in the Peace.*	Aug 2014 - Sept 2015
Peace	PC05	**Evaluation of irrigation potential in the BC Peace region** *A study will be conducted (including four distinct areas of analysis) to support improved understanding of the irrigation potential in the Peace Region.*	Nov 2014-July 2015
Peace	PC06	**Peace agriculture weather monitoring and decision support tools** *This project will implement actions to address significant monitoring and data gaps identified in project 2 and PC02, and will develop a collaborative approach to maintaining a network over time.*	Nov 2014-Nov 2016
Cariboo	CB01	**Wildfire preparedness and mitigation planning and resources** *Complete 8-10 individual plans and 2-3 group plans for wildfire preparedness/mitigation and development of agriculture-specific resources.*	Feb 2015 - June 2016
Cariboo	CB02	**Cooperative maintenance and enhancement of agriculturally significant dams** *Complete agricultural dams inventory, identifiy priority dams, and document issues and secondary benefits. Provide recommendations for cooperative approaches to dam maintenance and enhancement.*	Nov 2014-May 2015
Cariboo	CB04	**Livestock surface water assessment and options** *Assessment of surface water available for livestock and options for access.*	Feb 2015 - Nov 2015

Farm Adaptation Projects

	Proj #	*Title and Description*	*Timeline*
FAIF	FI01	**Using Management-intensive Grazing for Adapting to and Mitigating Climate Change** *Test MiG for its potential as a tool for adaptation and mitigaiton of climate change through carbon sequestration, soil moisture retention and enhanced plant diversity.*	May 2014 - April 2017
FAIF	FI02	**Vented orchard covers to protect cherries from rain and hail** *Piloting a net to protect orchards from rain and hail and transferring knowledge to growers.*	Jul 2014 - Nov 2017
FAIF	FI03	**Innovative Forage Practices** *Demonstrating innovative forage production practices to increase climate change adaptation including user manual/guide.*	Oct 2014 - May 2017
FAIF	FI04	**Evaluation of thrips damage to potatoes in a changing climate** *Evaluating yield loss due to thrips damage in relation to growing season conditions.*	Jan 2015 - June 2017
FAIF	FI05	**Economic, social & environmental benefits of riparian rehabilitation as a climate change adaptation strategy** *Project will assess efficacy of group Environmental Farm Plan process in Alderson Creek drainage.*	March 2015 - Feb 2018

Annex 4: Proposed Structure for Climate Dialogue Sessions

As part of its commitment to integrating climate change adaptation into all Ministry programs, the Ministry of Agriculture will plan a series of informal, program-focused dialogues in close cooperation with The B.C. Agriculture and Food Climate Action Initiative (CAI). Timing of these events could be approximately semi-annually, but should be flexible to complement other meeting opportunities and respond to program priorities.

Preparation
Experience with conducting 2 pilot sessions in February 2015 suggests the value of early discussion with managers and program leads in planning the workshops, particularly about:

- **Who should be invited**?
  Which regional agrologists or industry specialists do you work most closely with already? The idea is to get the core people who know the program and are already active in framing / responding to program issues. The intent is to focus on issues of program strategies and planning.
- **What are the areas of program activity most closely related to climate?**
  Who is already engaged with CAI? Who is not? How is info from CAI fed back to the program now?
- **Agenda**
  Test some potential focal areas for program implications from climate change, based on agenda materials
- **How can the session be structured to provide useful feedback to the program's own strategic planning efforts?**
  What is the program planning to do,and how can the Adaptation Dialogue support that?
- **Subject matter experts**
  Make sure the resource persons can speak to program-specific interests.

Introduction for Program Area Staff
Climate change is beginning to affect agricultural producers in B.C. and these effects are expected to accelerate. Do these changes affect your program? What issues do you see from the program side? What concerns are emerging among producers or producer groups?

We propose a 2 – 3 hour dialogue that allows program staff to explore issues of concern to them and to agricultural producers, based on their own experience, and evidence from CAI regional profiles and projects.

The expected result will be improved understanding of the program risks posed by climate change and the implications (if any) for program planning and management. Where there are significant implications for programming, this will allow program managers to plan for any adjustments necessary to ensure program effectiveness. Where there are no significant implications for programming, this exercise will provide confidence and evidence of how the Ministry has assessed the issues.

The discussion will be structured around 6 general principles and 3 guiding questions.

General Principles

1. Sessions are scheduled based on program area interest and Ministry priorities
2. Program staff bring their questions and concerns
3. External resource persons bring new knowledge about recent studies or producer practices in the sector
4. Both managers and regional staff should be involved. Regional agrologists should be invited wherever possible.
5. Content specific to program or theme
6. Process is light and low-cost

Guiding question 1: What are the implications of climate change for this program?

1. Changing climate risks – what do we see already in relation to this topic? (~30 min). External resource persons set the stage, with open discussion about interactions between climate risk and other agricultural business risks in relation to the specific topic and program focus. Particular attention paid to the producer perspective.
2. What are the Ministry's responsibilities in relation to existing programming; and / or public profile or perceived responsibility that could expose it to liability (~10 min)

Guiding question 2: What recent innovations or lessons can provide insights for the program?

3. Presentation of new knowledge or practices related to climate adaptation in agriculture sector (~30 min) e.g. CAI
4. How might these issues affect Ministry functions and programming? (~20 min)

Guiding question 3: What follow-up actions should be undertaken?

5. What strategies would be appropriate to ensure that programs continue to meet producer needs under a changing risk profile? This could include program actions, further consultation, monitoring, or detailed studies, if any action required. (~30 min)
    a. What aspects of your current programming and practices could be adjusted in light of the information discussed at this session?
    b. What questions need to be resolved before action can be taken?
6. Follow-up measures or next steps (if any required)

Potential Participants (depends on theme / location)

- Innovation and Adaptation Services Branch management
- Manager and staff of climate action team
- Program lead(s)
- Regional staff
- Regional agrologist(s) and industry specialists – relevant to theme
- CAI
- External resource person(s) (depending on topic)

Total: about 10 – 12 people

Annex 5: External Organizations Consulted

B.C. Agriculture and Food Climate Action Initiative

Emily MacNair – Manager, Adaptation Programming
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Manitoba Agriculture, Food and Rural Development

Matt Wiens – Landscape Stewardship Specialist; Agri-Environment Knowledge Centre
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Annex 6: Ministry of Agriculture Program Contacts

Name	Title	Program
Grant Halm	Program Specialist Business Risk Management Branch	Production Insurance
Leslie MacDonald	Assistant Director Sector Development Branch	Agriculture Emergency Management
Brent Barclay	Resource Stewardship Agrologist Sector Development Branch	Agriculture Emergency Management
Orlando Schmidt	Regional Manager, Coast Sector Development Branch	Regional Agrologist Network
Greg Tegart	Regional Manager, Interior Sector Development Branch	Regional Agrologist Network
Greg Bartle	Land Use Planner Innovation and Adaptation Services Branch	Strengthening Farming
Dave Trotter	Agroforestry Specialist Sector Development Branch	Agroforestry
Tracy Hueppelsheuser	Entomologist Plant Health Unit Plant and Animal Health Branch	Pest Management (Plant Health)
Gayle Jesperson	Plant Pathologist and Acting Manager, Plant Health Plant and Animal Health Branch	Pest Management (Plant Health)
Geoff Hughes-Games	Manager, Resource Management Innovation and Adaptation Services Branch	Environmental Farm Plan Program Beneficial Management Practices Program
Stephanie Tam	Water Management Engineer Innovation and Adaptation Services Branch	Agriculture Water Management
Carly Haycroft	Agri-Innovation Officer – Climate Action Innovation and Adaptation Services Branch	Climate Action Team
Anna Stemberger	Climate Change Researcher Innovation and Adaptation Services Branch	Climate Action Team
Ian McLachlan	Manager – Climate Action Innovation and Adaptation Services Branch	Climate Action Team

Annex 7: B.C. Climate Change Adaptation Strategy: Core Deliverables

http://www.livesmartbc.ca/attachments/Adaptation_Strategy.pdf

Strategy 1: Build a strong foundation of knowledge

Engage climate science:

- Continue engaging with the research institutions Pacific Institute for Climate Solutions (PICS), Pacific Climate Impacts Consortium (PCIC) and other research centres to ensure they produce high quality applied science information that decision-makers need.

Continue building robust observation networks:

- The Ministries of Environment, Forests and Range, and Transportation and Infrastructure will jointly develop a long-term climate related monitoring program to optimize the value of existing data and networks in partnership with PCIC.
- Explore opportunities to gather climate change observations in other vulnerable sectors, such as health, agriculture and ecosystems.

Develop adaptation planning tools for decision-makers:

- Promote and support the development of tools that can be used by a broad range of decision-makers taking adaptation actions. Such tools could include: guides for local government, and climate change assessment methods for identifying and evaluating adaptation options.

Continue knowledge transfer and outreach activities:

- Continue supporting existing organizations that work with decision-makers to help them prepare for climate change.
- Work with PICS to develop a continuing education program on climate change impacts and adaptation for professionals (e.g. engineers) and decision-makers (e.g. local government).
- Incorporate, where appropriate, adaptation concepts and actions into provincial climate change outreach programs.

Strategy 2: Make adaptation part of Government's business

Consider adaptation in planning:

- Ministries will consider climate change impacts by incorporating adaptation in Ministry Service Plans and business planning, where relevant.
- Integrate adaptation into B.C. Government policies, legislation and regulations:
    - Ministries will consider climate change impacts and adaptation when drafting new or amending existing legislation and regulations.
- Identify approvals that are sensitive to climate by determining whether climate change impacts will be significant over the life of a decision and, where possible, incorporate consideration of climate change impacts into the approvals process.

Implement through a coordinated approach:

- Strengthen cross-government coordination to ensure that ministries share experiences, have access to the same information and work towards common goals.
- Engage and work with partners in other levels of government, the private and non-profit sectors and other jurisdictions.
- Integrate adaptation into the strategies for building B.C.'s Green Economy.

Strategy 3: Assess risks and implement priority adaptation actions in sectors

Assess risks and implement actions:

- Conduct climate change assessments for sectors known to be sensitive to climate change.
- Establish Sector Working Groups with government and stakeholder co-chairs to lead the process. The assessment will be supported by appropriate social and natural science experts from the Pacific Institute for Climate Solutions.
- Review and update, through the assessment process, existing B.C. Government policies, strategies and operational activities to ensure that they will deliver the desired objectives for their sectors in a changing climate.
- Implementation of sector assessments will be a staged process, beginning with one or two key sectors.

Partners:

The B.C. Government will work with local and federal governments, First Nations and other stakeholders, including research institutions, non-governmental organizations, and professional associations, to implement specific core deliverables.

– END OF DOCUMENT –

Economic Analysis of Climate Change Adaption in B.C. Agriculture

Literature Review

B.C. Ministry of Agriculture

Innovation and Adaptation Services Branch

Climate Action Team

By Kayleigh Donahue

November 2014

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1) Introduction

Despite agricultural producers' propensity to adapt to changing conditions, the climate change currently underway is anticipated to impact agriculture on a much larger scale than ever before. The 2012 Risk and Opportunity Assessments of B.C. agriculture, by the B.C. Agriculture and Food Climate Action Initiative (CAI), discuss climate change projections for five regions of the province and explore the sector's adaptive capacity. Climate impacts such as increases in the number of hot days, changes to precipitation patterns, and more frequent and intense extreme weather events such as wind-storms, hail and droughts with associated effects such as increases in wild fires and pest outbreaks are anticipated to affect B.C. agriculture. Climate change will results in more uncertainty and farm management complexity. These changes will also impact government programs such as production insurance and agricultural emergency management.

The B.C. agriculture sector will have to adapt successfully to climate change to maintain growth and profitability. The Ministry of Agriculture, through the Growing Forward 2 (GF2) program, is funding programming to direct and support agriculture sector adaptation at the regional and farm levels. This programming is delivered by the B.C. Agriculture and Foods Climate Action Initiative (CAI). The CAI has completed four regional adaptation strategies and evaluations of six on-farm management practices. Regional adaptation projects are implemented through joint funding by regional partners and GF2, and farmers can access fund to pilot innovative farm practices through the Farm Adaptation Innovator Fund (see Appendix 1 for more details on the CAI).

Adaptation actions have begun in B.C., yet there have been few attempts to assess the economic costs associated with climate change or the benefits of adaptation in the province. This literature review is the first of five project[1] components outlined by the B.C. Ministry of Agriculture ("the Ministry")and the Pacific Institute for Climate Solutions (PICS) to consider these questions. The subsequent stages of the project are: analysis of Ministry production insurance and AgriStability records to gauge the lost farm revenues and fiscal implications of increased climate extremes, and development of planning scenarios which include region specific climate risks as well as a range of adaptation options. These project goals may require separate analytical techniques because specific climate stressors and adaptations are better suited to certain modelling techniques. This literature review is intended to inform and guide the larger analysis by clarifying the advantages and disadvantages of each methodology.

[1] The project is funded by the Pacific Institute for Climate Solutions and the Ministry of Agriculture (through Growing Forward 2)

2) Methodology

Section Overview

- This is a broad literature review and jurisdictional scan
- Overview papers from international research institutes guided the search
- The economics literature focused on hedonic or Ricardian pricing or Integrated Modeling Systems (IMS)
- Analysis of insurance programs may require further research, although some analysis techniques are reviewed
- A draft report by Golder Associates formed the foundation of this literature review

This literature review is a broad scan of the intersection of four topic areas: economic analysis, climate change, adaptation and agriculture. Key word searches focus on these four terms. The literature in Canada and other jurisdictions with similar political and economic systems and facing similar climate risks, such as the US and Australia, is reviewed to find the state of research in this topic area. Government agricultural research units across the provinces as well as the federal government were contacted to gauge progress on this topic.

After starting with overview papers[2], the research focused down to individual papers and methodologies best suited to answer the research question: What is the economic impact of climate change adaptation in the agriculture sector? While assessing the impact of climate change is more common in the literature, a more limited body of work incorporates adaptation into the analysis.

The economics literature related to climate change focused on hedonic (Ricardian) pricing through regression analysis of land values or integrated modelling systems (IMS) which combine crop simulation models, hydrology models and economic models, both of which were highlighted in the overview papers. Extreme weather events, incentives and insurance could be found in the economics literature[3], but with very loose connections, if any, to the broader questions of climate change and adaptation. Some of these analysis techniques are reviewed in this document, but due to the lack of direct overlap, may require further research with a separate central question.

The draft report *Development of Climate Change Adaptation Case Analysis Literature Review* by Golder Associates is an excellent overview of current work in the area of economic analysis and climate change (with a focus the mining sector) and served as the template for this literature review.

[2] OECD (2008), World Bank (2010), German Society for International Cooperation (GIZ), and Smit (2002)
[3] Kimura (2010). Kimura (2012), Cheng C.S. (2012)

3) Definitions

Section Overview
- Hard and soft adaptation
- Equilibrium
- Autonomous adaptation
- Planned adaptation

a) Hard and Soft Adaptation

A challenge associated with economic analysis of climate change impacts and adaptation (particularly with cost benefit analysis), is the tendency to focus on "hard" adaptation measures (physical infrastructure and changes to natural capital such as irrigation systems, land terracing, and earthen dams), as they are relatively easy to quantify.[4] Costs and benefits of "soft" adaptation measures (modified institutions, planning processes and incentives which aim to alter the circumstances under which private or autonomous adaptation investments are made) such as knowledge and skill development, networks and institutions are comparatively more difficult to quantify[5]. The focus of most studies on the assessment of hard adaptation may lead to the neglect of potentially critical adaptation measures. A historical example of a critical soft adaptation measure is the development in the 1930s of the Prairie Farm Rehabilitation Administration in Saskatchewan and the Special Areas Board in Alberta, which have generally been viewed as successful institutional adaptations to the severe extended drought conditions of the time.[6]

Most of the climate adaptation actions in B.C. have been preliminary soft adaptations: researching impacts and solutions, disseminating information, strengthening information networks and encouraging producer collaboration on climate change. Regional agricultural adaptations strategies have been completed for the Cowichan Valley, Delta, Peace and Cariboo regions. These documents include specific adaptation actions and identify the stakeholders and networks that could be leveraged to implement each strategy. The Farm Innovator Fund provides funding or innovative adaptation pilots to enable farmers to take risks and share the knowledge gained with other producers.

b) Equilibrium

In general, equilibrium can be characterized as a state in which various opposing forces or influences are balanced. Equilibrium in an economic context implies that forces of supply and demand are balanced in the absence of external forces. When an external force (or shock) is applied to a "steady-state" equilibrium the system returns to the original equilibrium. Conversely, an "unstable" equilibrium will diverge from the original point of balance or move to a new equilibrium when an external force is applied.

[4] OECD (2008)
[5] World Bank (2010)
[6] Marchildon (2008)

c) Autonomous adaptations

As mentioned earlier, the agriculture sector is familiar with adaptation in response to external forces such as price volatility, regulatory changes and climate. It is reasonable to assume that producers will respond to incentives and climate pressures to improve their outcomes without any direct government involvement. Autonomous adaptations refer to adjustments private individuals would take in response to climate change in the absence of government intervention. Many autonomous adaptations will take place at the farm level through changes in crop mixes, planting dates and fertilizer use.[7] However they will be influenced by the economic environment and public policies. Although autonomous adaptations are important, they can be difficult to separate from total adaptation in the sector. Moreover, autonomous adaptations alone may only partly drive the full degree of adaptation required by the sector.

d) Planned adaptations

Hard and soft adaptations both fall under the classification of planned public sector adaptations.[8] These adaptations involve actions by governments to provide public goods or incentives to motivate action by the private sector. Governments may choose to participate in planned adaptation because certain adaptation actions have benefits that cannot be captured by private individuals, resulting in under investment. For example, a farmer may not choose to experiment with a new technology because his success will be copied by others (free rider problem). Development of new irrigation infrastructure, land-use arrangements and property rights, water pricing and training for the private and public sector (capacity building) are some examples of planned adaptations.[9]

[7] OECD (2008)
[8] World Bank (2010)
[9] Rosenzweig and Tubiello (2007)

4) Economic Analysis Techniques: Climate Change Adaptation

Section Overview

- Decomposing the price of land into various components to assess the economic impact of climate change on agriculture is Ricardian or hedonic Pricing
- Partial and general equilibrium models are a diverse family of tools and have been used alone or in combination with other models to ascertain the economic impact of climate change
- Integrated Modeling Systems are combinations of models that work together and several examples and potential configurations are discussed
- Adaptation Gap Analysis is a basic tool to determine the cost of adaptation on infrastructure projects

This section discusses specific modelling and estimation approaches that could be used to estimate the economic impact of climate change adaptation in B.C. Each subsection highlight the usefulness of the approach, its drawbacks and data requirements.

a) Ricardian (Hedonic) Pricing

Ricardian models or hedonic pricing models are used to answer the question: What is the economic impact of climate change, and in some cases, How is this reduced by adaptation? Hedonic pricing models are used to isolate the price effects of various characteristics, for example, the amount by which a nearby green space increases the value of a home. For this project, Ricardian analysis would be used to quantify the costs of climate change through lower land values. Farm land values are used to estimate the long-term economic impacts of different climate conditions than those observed in the past.

This technique is derived from the writing of David Ricardo (1817), who stated that "net land value is equal to net productivity".[10] The hedonic pricing technique assumes that land owners will maximize the productivity of their land and that price paid for a piece of land is equal to its productive capacity. The value of land is decomposed into its various components by regressing the price of land on historical climate data, land characteristics and agriculturally significant historical events. For example, the price of land without irrigation may be lower than land with irrigation. The hedonic pricing technique isolates the effect of irrigation on land price, holding all other characteristics fixed. Alternative regression approaches use farmer profits or net revenue in lieu of land values.[11] Land values are then calculated from profits: they are assumed to be equal to the present discounted stream of rental rates. In other words, land values are the discounted sum of future profits from the use of the land.

This technique assumes that farmers are actively adapting to climate change and findings are therefore net of autonomous adaptations. As a result, Ricardian models can be used to assess what would happen in the absence of a government intervention. Adaptations can be difficult to include in these models because they rely on historical information. If there was a major infrastructure project in the past, a parameter could be estimated to model the impact of a similar hard adaption in the future.

[10] Moeller (2010)
[11] Deschenes (2007)

Similarly, if there was a past change in incentives through the introduction of a government program, a soft adaptation could be modelled in the future. In the absence of either of those past events, impacts of future adaptations cannot be estimated.

Because time series data can be difficult to compile and requires more stringent data analysis techniques, most Ricardian models use cross-sectional data (multiple locations). Using climate, water flow, soil and economic variables Kurukulasuriya and Mendelsohn (2008) estimate the impact of climate change in 11 African countries under two different climate scenarios.[12] This analysis does not incorporate adaptation. In order to isolate the effects of past adaptations in a given region of B.C., time series data of land values and regional climate and historical infrastructure projects would be required.

Advanced Ricardian regression techniques have used multinomial probability distributions to determine the probability that an Agro-Ecological Zone (a proxy for productivity developed by the Food and Agriculture Organization) will be present in a given district.[13] Different Agro-Ecological Zones have different net revenues and crop suitability. As these zones shift across the continent due to climate change, net revenue and crop choice will change in a given district. This method allows for one type of adaptation (changing crop mix in response to climate change) but requires advanced econometrics. The results of this study found that there would be fewer high-value Agro-Ecological Zones in Africa, resulting in a negative impact of climate change on the African economy.

b) Partial Equilibirium (PE) and General Equilibrium (GE) Analysis

Many methods for modelling the economic impact of climate change adaptation require modules to link predicted physical and biological changes to the choices of individual economic agents such as farmers and municipalities. Ultimately these predicted changes flow through to the economy through market (and government) mechanisms.

Typically economists posit that economic systems under a given set of inputs, production and consumption conditions will move towards a particular equilibrium and that if the system is changed (shocked) it will move towards a different equilibrium. Economists aim to measure the impact of the system change by measuring the difference in the two predicted equilibriums. Changes or shocks will typically have market (and government) impacts which are largest for the economic systems and actors directly affected. These impacts will diminish in size and speed of effect for those indirectly affected. For example, a flood in the Peace Region would have the largest effect on the businesses and residents in the inundated areas, a somewhat smaller effect on the businesses and communities in the immediate area and even less in other regions of the province.

The terms “partial equilibrium” and “general equilibrium” refer to a more limited or extensive analysis of these ripple effects through the economy. In PE analysis, the effect of a change or shock is considered in one sector of the economy, while in GE analysis the model incorporates the effects on all interrelated sectors of the economy. Agriculture and Agri-Food Canada’s Agri-Environmental Policy

[12] Kurukulasuriya and Mendelsohn (2008)
[13] Kurukulasuriya and Mendelsohn (2008)

Analysis group uses a PE model of the Canadian agriculture sector to evaluate policy.[14] In relation to climate change, both PE and GE models provide a framework through which a user may look at potential interactions between climate change impacts, adaptation options and the economic system. They achieve this by forecasting future market changes based on driving forces observed in the past and assumptions of market mechanisms[15]. These PE and GE models are often incorporated within an integrated modelling system (see Figure 1). Furthermore, PE and GE models rely heavily on historical estimates of market behaviour, which adds considerable uncertainty to models in which adaptation efforts induce behavioural changes over time. [16] In other words, the PE and GE models reflect the historical structure of the economy and may not reflect the structure of the economy in the future.

PE and GE models are a very diverse family and are created to answer a range of different economic questions. Within these broad categories there are also static models, which stay the same over time, and dynamic models which allow changes over time. They can focus on a range of geographic areas, from regional or national to international trade and can focus on different combinations of commodities. Each economic model is based on a series of assumptions to answer a specific question. One good example is the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) model, developed by the International Food Policy Research Institute, which is a GE model. The model determines global food supply, demand and agricultural food prices at the country or sub-regional level then aggregates these values to the global scale. The model has been combined with a water simulation model in an integrated modelling system to incorporate water availability concerns. However, weather variability due to climate change has not been included in the analysis and is not reflected in the results.[17]

c) Integrated Modelling Systems (IMS)

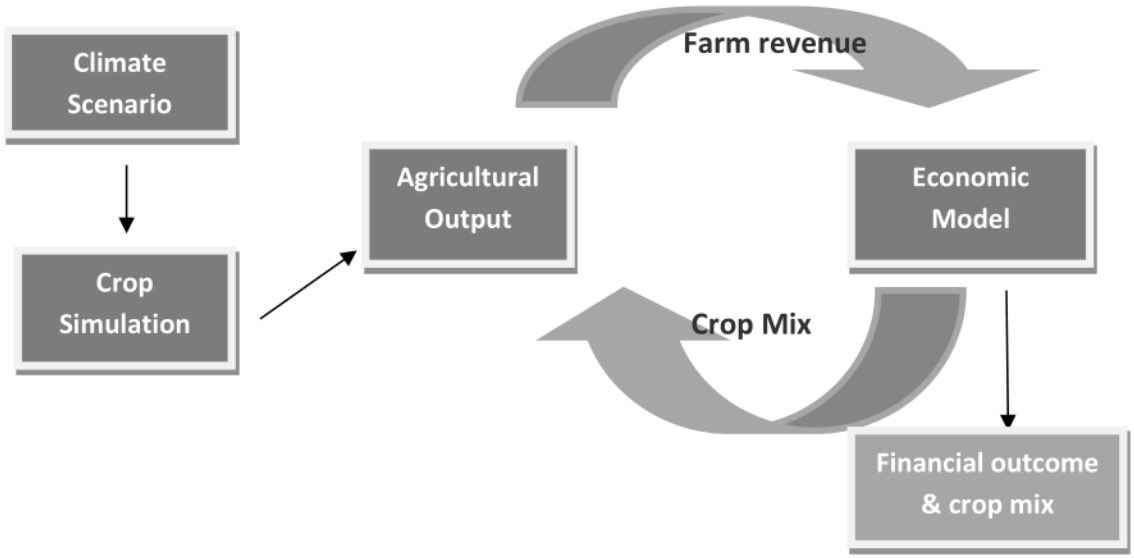

Figure 1. Integrated modelling system (Adapted from the World Bank 2010)

[14] Canadian Regional Agricultural Model (CRAM)
[15] Noleppa, (2013)
[16] Noleppa, (2013)
[17] Rosengrant (2008)

Integrated modelling systems in which several models work together to generate economic impacts of climate change on agriculture are the new standard in this area of analysis. The IMS approach is common at the global scale[18], and has also been used in region specific climate adaptation studies.[19] Climate scenarios, crop simulations, and representative agent (economic) models are common components of IMS used to measure impacts of climate change adaptation (Figure 1). In the figure above, the baseline scenario would model the outcome of climate change on the agriculture sector without adaptation. A representative farmer economic model would show which adaptations would be selected by allowing farmers to choose different crop types or management techniques (such as higher efficiency irrigation). A PE economic model would demonstrate the aggregate impact on the agriculture sector; however the adaptations chosen by producers would need to be assumed in the alternate scenario. The IMS can be tailored to suit the research question through the choice of economic model.

The system is created by linking several distinct models together by matching outputs of one model to inputs of another. Climate change scenarios produce future projections of daily, monthly or annual temperature and precipitation. This information is an input into hydrology models and crop simulations, which produce estimates of water availability and crop growth respectively. Based on projected crop yields and water availability, economic outcomes are estimated with farm level decision making or sector level PE models. In Figure 1, each blue box represents an individual model, arrows represent outputs from one model and inputs into the next, and the final outcome is in the green box. Along with Ricardian analysis, the IMS technique is at the forefront of economic research on the topic of climate change, adaptation and agriculture.

IMS are flexible tools tailored by the modeller to fit the specific climate change projections and adaptation options of interest. For regional analysis, downscaled climate change scenarios are required. Crop simulation can be done with physical models or econometric estimates (see below). Adaptation options must be incorporated into the crop simulation or economic model components. Developing the expertise to work with models from several different disciplines and finding or creating linkages between these models is the most difficult aspect of the analysis.

The Agri-Environmental Policy Analysis group at Agriculture and Agri-Food Canada (AAFC) is currently developing an IMS (see Figure 2) using downscaled regional climate scenarios, the DSSAT crop simulation model, and their in-house PE model, the Canadian Regional Agricultural Model (CRAM).

Figure 2. Integrated Modelling System (AAFC)

[18] Tan 2003, Rosegrant (2008)
[19] World Bank (2008), Rosegrant (2012)

i) Physical Models

Physical models use plants science or commonly known relationships between soil type, climate, hydrology, and crop type to determine total production. These models use climate scenarios to predict future agricultural production. The climate scenarios are those developed by international climate models, most often the IPCC. These global climate models (GCM) are built based on physical science as well as socioeconomic factors that influence global emissions of greenhouse gases. GCMs can be downscaled to represent climate projections for smaller regions. There have been many advances in downscaling techniques and the most recent iteration of climate scenarios for B.C. provided by the Pacific Climate Impacts Consortium (PCIC)[20] provide daily temperature and precipitation levels for 1951-2100 at a 10 km spatial resolution.[21] This data is crucial for modelling hydrology and plant growth, key components of IMS.

(1) Decision Support System for Agrotechnology Transfer (DSSAT)

Developed by several universities and research institutes, the Decision Support System for Agrotechnology Transfer (DSSAT) is software that, for over 28 crops, simulates growth, development and yield as a function of the soil-plant-atmosphere dynamics. [22] This model was used at the global scale to model the effects of climate change on food production[23], but can be used for on-farm precision management and regional assessments of climate change adaptation.[24] The yield output under various climate change scenarios could be used as part of an integrated model to determine the economic impact on agriculture. The latest work-in-progress version of this model has been acquired from DSSAT for use on this project.

(2) Environmental Policy Integrated Climate (EPIC) Model

EPIC is a cropping systems model developed to estimate soil productivity and erosion. It was created as part of the analysis for the 1980 *Soil and Water Resources Ac*t in the US and is housed at the Texas A&M University. It has been used to examine climate change and drought impacts on crop yields and soil erosion[25]. Although both DSSAT and EPIC model crop yields, EPIC is better at modeling erosion and other environmental impacts[26]. The EPIC model can be extended to evaluate agricultural policy by incorporating Agricultural Policy/ Environmental eXtender Model (APEX) to consider the impact of management practices on a variety of agricultural and environmental indicators.

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[20] PCIC is a regional climate technical service centre at the University of Victoria that provides information on the physical impacts of climate variability and change, including support for long-term planning with climate projections for regions of B.C. based on downscaled global climate change models. www.pacificclimate.org
[21] PCIC poster #GC43C-1069 (2013)
[22] University of Florida, the University of Georgia, University of Guelph, University of Hawaii, the International Center for Soil Fertility and Agricultural Development, USDA-Agricultural Research Service, Universidad Politecnica de Madrid, Washington State University, and other scientists associated with ICASA
[23] Rosegrant (2012)
[24] http://dssat.net/about
[25] http://epicapex.tamu.edu/epic/
[26] Discussion with Tom Goddard at Alberta Agriculture and Rural Development

(3) Agriculture Water Demand Model (AWD)

The Agriculture Water Demand (AWD) model was developed by the B.C. Ministry of Agriculture to support planning to address water shortages across the province. Water demand models have been created for 10 watersheds across B.C., mostly in the south of the province. The models use a cadastre provided by regional districts to inform detailed land use surveys to determine which crops are being grown and if there is irrigation present on a given piece of land. [27] This information is combined with soil and historical climate data to determine water demand at various levels of regional aggregation. The AWD uses climate projections provided by PCIC to model future water demand.

The AWD model developers have run several scenarios similar to climate change adaptation by altering the number of irrigated farms and the type of irrigation or increasing the number of active farms. The model can generate an intermediate output of the number of irrigated acres of a given crop in the watershed, which can be used to determine the share of irrigated farms. These two numbers can be combined with a measure of the average value of a particular crop in that particular region to estimate the total value of production. This approach is especially useful for running scenarios based on water use and crop mix adaptations and already incorporates the climate scenarios developed by PCIC. It may also be possible to use AWD models with estimates of the increased value from irrigation to measure the economic impact of increased irrigation or water storage for irrigation as adaptations to climate change. [28]

AWD models have not been completed for all regions of B.C., so the analysis would be restricted to specific regions, some of which are smaller than the regions for which the CAI has completed climate change risk and opportunity assessments. The AWD model requires intensive surveying of agricultural land use, which is the major delay in completing all regions of B.C. and also results in data that is somewhat dated for regions completed earlier (e.g. the Okanagan). This model is useful for running scenarios in which adaptations are (or are not) implemented; however climate stressor scenarios such as droughts or increased precipitation would require new climate projections to be developed by PCIC. The feasibility of developing these climate stressor scenarios has not yet been explored. Finally, although this approach generates dollar figures for the cost of climate change and the benefits of adaptation, it neglects the economic incentives by excluding an economic model. It is an integrated model (see Figure 3), but it does not model producer profitability and the forces that might induce an investment in adaptation nor does it model how water availability would affect the structure of the agricultural sector.

[27] A cadastre includes details of ownership, tenure, location, dimensions (and area), crop cultivations, and the value of individual parcels of land.
[28] Samarawickrema (2008), Faux (1999)

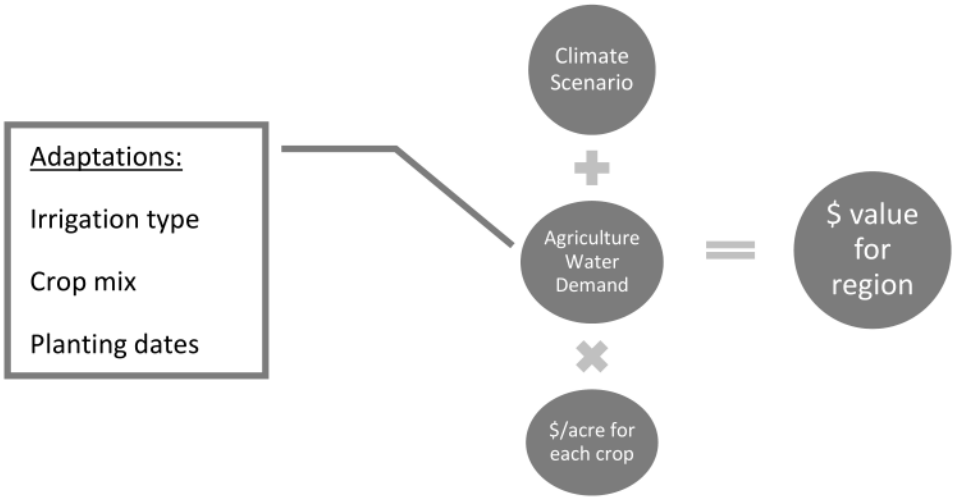

Figure 3. Integrated Modelling System (AWD and B.C. production insurance data)

b) Econometric Crop Simulation

Econometric crop simulation models are calibrated using historical data on climate, soil profile, management practices and other explanatory variables to estimate the relationships between these independent variables and production output. In practice, crop yields are regressed as a function of historical climate, soil profile, economic and region specific variables to determine parameter values. These parameters are used to estimate future crop yields using climate projections. As with the Ricardian technique, similar hard adaptations must have occurred in the past in order to estimate their impacts in the future. Soft adaptations, cannot be incorporated because they are specifically designed to alter the relationships (change parameters) between inputs and outputs, which must remain fixed in the simulation. It is also common to estimate of the rate of technology or adaptation adoption by farmers, which must be based on survey results.[29]

Econometric analysis of crop yields has so far only been used to look at past relationships between yield and climate variables, but Sun (2013) suggests that it could be used for climate change modelling. This technique inherently overstates longer-term potential impacts of adaptation projects because "without adaptation project" costs or damages are overestimated due to the exclusion of autonomous adaptations. The econometric regression can incorporate spatial climate data; however the scale of the climate scenario has a significant impact on the economic impacts measured. Smaller scale climate data consistently results in less favourable economic implications for agriculture, in that the parameter values for unfavourable weather have larger impacts on production.[30] In other words, when the climate projections are focused on a smaller region, more hot days or different precipitation patterns have a larger negative effect on agricultural production.

[29] World Bank (2010)
[30] Adams (2003)

c) Adaptation Gap Analysis: Cost of Adaptation

Adaptation gap analysis calculates the increase in costs for an existing project if it were redesigned to consider climate change adaptations.[31] The adaptation gap is the additional amount that an existing project would cost in order to be upgraded to include climate adaptation measures. This method is used for existing capital projects being evaluated for their climate change suitability. It is useful to derive a cost of adaptation but gives no insight into the benefits of adaptation or the costs of climate change.

[31] World Bank (2010)

5) Climate Stressor Scenarios

Section Overview

- As part of an integrated and forward looking analysis, scenario development can help determine the impacts of climate change through a series of "what if" stories
- Three examples of scenarios are given to show how these can be useful for climate change adaptation as both qualitative and quantitative exercises

In contrast to climate change scenarios with and without adaptation, which quantify the costs of climate change and isolate the impact of adaptation on the agriculture economy of the future, climate stressor scenarios model a specific impact of climate change. Climate stressors such as sea level rise, more frequent floods, and droughts are often cited as consequences of climate change. However a great deal of uncertainty surrounds the extent, timing, and location of these climate stressors. In order to plan for these hazards without exact data on frequency or magnitude, climate stressor scenarios are built using reasonable assumptions.

a) Coastal Flooding in Australia

The CSIRO estimated the impacts of coastal flooding in Australia using current dollars and assumptions about future population and number of buildings at risk. [32] Three scenarios are defined based on changes to planning and building regulations and the defence of existing homes and buildings. The first scenario holds regulations fixed so that the *proportion* of people and buildings at risk is the same but applied to a larger population, while the second scenario allows for no further risky developments. The third scenario holds the *number* of people and buildings at risk fixed (a smaller proportion of the future population).[33] This type of approximation may be useful for very rough estimates of the impact of climate change in agriculture: estimates of the proportion of producers at risk from climate change in a given region could be used along with an assumption of how this proportion would change with various adaptation measures.

b) Flooding in the Fraser Valley, B.C.

A similar analysis has been applied to flooding scenarios in the Fraser Delta region of British Columbia. [34] Sea-level rise due to climate change exacerbates the flooding risks faced by this major agricultural production region. The report quantifies the economic costs of a major flooding event in Delta, Surrey and Richmond, B.C. The authors defined the perimeters and weather events that would cause major flooding in the region using "vulnerable areas" identified from previous flooding studies and municipal plans and the corresponding types of floods (dike breach, seepage, freshet melt) that would inundate these areas. Ministry of Agriculture land use inventories informed the type of agricultural activity and the proportion of total provincial production that occupy each vulnerable area.

[32] Wang (2010)
[33] Wang (2010)
[34] Robbins, M and Tatebe, K (2014)

The purpose of this assessment is to highlight the general economic risk of failing to adapt to climate change because all of the vulnerable areas could not be flooded with a single flooding event.

Case studies based on past flooding events were the primary evaluation technique to determine the economics losses associated with major flooding induced by climate change. Farm-gate receipts are pro-rated to the vulnerable areas to estimate lost revenues. Agricultural impacts depended on: the amount of agricultural activity in the vulnerable area, the timing of the flooding event, the salinity of the flood waters and the rate at which it could be removed from the land. Economic costs associated with each scenario are calculated based on total economic impact, additional farmer costs and total farmer costs. The total economic impact is lost farm gate receipts plus secondary impacts (estimated as exactly the amount of lost farm receipts) which makes total economic loss two times the lost farm gate receipts. Additional farmer costs, which seeks to quantify lost capital investments, is equal to damage to buildings and equipment plus lost livestock feed and replanting costs. Total farmer costs are additional farmer costs plus lost farm gate receipts.

This approach can estimate the costs of climate change on agriculture, but the inclusion of adaptation is somewhat limited. Some adaptation measures are assumed, such as raising the dikes above the current height standard of 3.56 metres. Other adaptations, such as on farm drainage, are discussed as ways to mitigate agricultural losses without quantifying the impact this would have on economic losses. Other drawbacks include the fact that the study does not specify a time frame, other than the length of the flooding events, and uses fixed dollar assumptions of building and replanting costs. As a result, the study illustrates the costs of flooding due to climate change at some unspecified point in the near future.

c) Climate Change in Alberta

The consulting group Scenarios to Strategy used a seven step planning process to build planning scenarios for natural disasters in Alberta:[35]

1) Clarifying the focus of the scenarios (choosing the focal question)
2) Examining past changes to identify ongoing trends and forces
3) Identifying future changes and underlying forces
4) Identifying the key uncertainties which could lead to distinctly different futures
5) Creating a logical framework based on the uncertainties
6) Fleshing out the major characteristics and developing coherent stories for each scenario
7) Identifying implications for the organization from the scenarios

This framework was used in a workshop setting to develop a scenario related to climate change and to identify priority actions that could have prevented the adverse outcomes illustrated. The activity was qualitative in nature, and used to spark collaborative discussion. However, the scenario planning process and resulting products draw upon past experiences and present conditions. This allows for the development of more quantitative scenarios where data exists.

[35] Brummell and MacGillivray (2007)

6) Insurance Analysis

Section Overview

- Several forces influence the impact of climate change on agriculture insurance programs
- Critical threshold analysis is a means to determine the future cost of insurance programs in light of climate change
- Probabilistic methods can help measure how risks for agriculture will change due to climate change and help programs adapt to new climate change risks
- More detailed research should be pursued in this topic area

Crop insurance, or production insurance, is both an adaptation and a program at risk under climate change.[36] The availability and type of crop insurance can have significant impacts on land use allocations by agricultural producers, which could both support adapting to new crops or incentivize producers to grow crops that are no longer viable by shielding producers from climate change impacts.[37] In other words, easy access to insurance can make agriculture more vulnerable to climate change by reducing the incentives for adaptation. Agriculture income stabilization programs could undermine climate change adaptation[38] by reducing the incentives to diversify crop types or locations through program disqualification. On the other hand, access to insurance can allow farmers to quickly adapt to new climate realities by providing liquidity.

The production risks of new and potentially better adapted crops will need to be evaluated and incorporated into the existing insurance programs. Several studies have examined the impact of different insurance schemes on producer crop choices. [39] Although insurance may decrease climate change vulnerability by increasing a producer's ability to adapt, it may inadvertently create a moral hazard whereby the producer increases his or her exposure to physical hazards[40]. The substitution between self-insurance (adaptation) and buying insurance could also reduce the base for loss sharing and increase actuarial risk through adverse selection: producers who are better able to take adaptive actions might disproportionately opt out of buying insurance.[41]

The increased prevalence of extreme weather events, such as drought and floods, anticipated under climate change projections, places new pressure on the provincial Production Insurance and AgriStability programs. This section explores methods best suited to analyze the effects of crop insurance on agricultural adaptation and the effects of extreme weather on agricultural insurance programs.

[36] Adaptive Design and Assessment Policy Tool (ADAPTool): Government of British Columbia Agriculture
[37] Adaptive Design and Assessment Policy Tool (ADAPTool): Government of British Columbia Agriculture
[38] Bourque et al (2007)
[39] Boere & Van Kooten (2014 in Print), Turvey (2012)
[40] Mcleman &Smit (2006)
[41] Adaptive Design and Assessment Policy Tool (ADAPTool): Government of British Columbia Agriculture

a) Critical Threshold Analysis

In order to determine if there will be a greater number of insurance claims in the future, this method seeks to determine what critical weather event thresholds have previously triggered large numbers of insurance claims.[42] The relationship between weather (measured by indexes or monthly totals) and insurance claims is used to determine when weather thresholds trigger high average numbers of insurance claims. This information is then combined with regional climate scenarios to determine how much more often weather will surpass these thresholds. The frequency of increased claims is then combined with the associated payouts to determine the higher cost to the insurer under the climate scenario. This method is still subject to the uncertainties associated with downscaled climate data and requires data on monthly insurance payouts by region.

b) Probabilistic Methods and Extreme Weather Events

Most climate change models predict not only changes in the means of climate variables but also that the frequency of extreme weather events will increase. Coupled with this, we know that uncertainties surrounding possible events are a key determinant of people's behaviour. We should therefore expect that climate change uncertainties will also be a key determinant of their adaptation behaviour.

Choosing the key weather hazards of concern and then modelling the future probability of these hazards is a difficult process. In probabilistic models, the relationship between the defined hazard (i.e. intensity or rainfall, river height, number of floods exceeding a certain height) and the probability of a hazard occurring are captured in a probability density function (pdf) with the hazard intensity measured on the x axis and the probability of occurrence measured on the y axis.

In the science of modelling natural catastrophe probabilities the relationship between probability of a hazard and the intensity are measured with an *exceedance curve*.[43] The estimation of the exceedance curve allows for the probabilistic estimation of monetary loses due to natural disasters. Sometimes these curves are presented with frequency on the vertical axis and intensity on the horizontal axis (see Figure 4).[44] To determine the exeedence curve, a researcher requires information about the frequency, the intensity and the resulting economic impacts of extreme weather events. Estimating probability distributions can be difficult for high-intensity, low frequency events. Although it is very difficult to determine how exactly future climate scenario will alter the distribution, appropriate assumptions can be made.

[42] Cheng C.S. (2012)
[43] World Bank (2010)
[44] http://understandinguncertainty.org/node/622

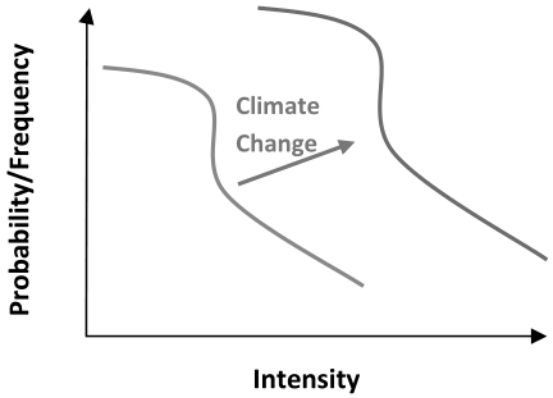

Figure 4. Effect of climate change on the intensity-probability function (Adapted from World Bank 2010)

Previous applications of probabilistic methods have been in weather simulators which use Monte-Carlo simulations to generate daily weather variables.[45] Downscaled climate models now include daily temperature and precipitation data which could allow for new applications of probability distribution. Although it has yet to be attempted, an econometric crop simulation which uses distributions of daily temperatures could be used to estimate production outcomes for a representative farmer. This could be useful for insurance analysis because it would allow different coverage options to be tested against these simulated outcomes to determine expected insurance liabilities under climate change.

The insurance choices of three representative farmer types in Saskatchewan were modelled by Kimura et al (2012). The authors simulated future yields using four climate change and adaptation scenarios as well as the farmer's endogenous choice among four risk reduction strategies (individual yield insurance, area yield insurance, weather indexed insurance and ex-post government payments). High risk farmer's increased their purchases of weather indexed insurance but yield area insurance had the largest increase in demand with marginal climate change. Area yield insurance also enhanced diversification strategies. The paper goes on to quantify the budgetary costs of the various insurance options and the uncertainty surrounding future climate scenarios and farmer's adaptation choices. The paper uses advanced modelling techniques and regional yield data from Saskatchewan from 2003-2008 for wheat, barley and canola[46]. Some results are difficult to interpret for the purpose being investigated here. For example, welfare gains are measured in dollars per acre and are not aggregate to show total gains for various policies. Although very thorough and precise, the paper requires lots of data and modelling expertise and does not report the results of interest to this project.

[45] World Bank (2008)
[46] Kimura et al (2012)

7) Traditional Project Evaluation Techniques

Section Overview

- This section summarizes well known and commonly used economic analysis techniques: Cost Benefit Analysis, Cost Effectiveness Analysis, Multi-criteria Analysis, and Multiple Accounts Analysis
- The usefulness of each technique and its drawbacks for this particular research question are highlighted

a) Cost Benefit Analysis (CBA)

CBA is best suited to hard adaptation projects where investment amounts and resulting benefit streams are easily monetized. Investment amounts are measured and discounted according to when the cost is incurred. Similarly, income or benefit flows are estimated and discounted. This method requires a tangible investment in climate adaptation, such as a dike or a seawall, and is best suited for specific infrastructure projects. In the case of soft adaptations, such as access to information or research into new crop varieties, a CBA would require assumptions to be made about the timing of these adaptations.

The nine steps for a CBA are: [47]

1. **Define the relevant group**: for example: region, commodity, representative farmer or aggregate farm revenue
2. **Select the portfolio of project options and define project timelines (implementation dates, time horizon)**; for example, adaptation measures such as
    a. Water management (regional or on farm)
    b. Crop insurance or weather derivatives
    c. Adopting/developing new crop varieties
3. **Catalogue potential impacts and select management indicators**:
    a. Increased water availability on crop yields
    b. Effect of insurance on total farm income
    c. Effect of new varieties on crop yields
4. **Predict quantitative impacts over project life**: economic model of relationship between impacts and indicators, based on historical relationship and reasonable assumptions
5. **Monetize all impacts**: convert crop yields into revenue, aggregate farm income to regional or provincial level
6. **Calculate Net Present Value, Internal Rate of Return, Payout Time, Benefit Cost Ratio**: choose a social discount rate that is appropriate for climate change and adaptation analysis
7. **Indentify distribution of costs and benefits**: Who bears adaptation costs? Who receives benefits? Are there externalities?
8. **Perform sensitivity analysis**: make changes to reasonable assumptions to determine how sensitive the results are to small changes. This is particularly important for all parameters whose future values are uncertain.
9. **Make a recommendation**

[47] Adapted from Peter Kennedy's (University of Victoria) Cost Benefit Analysis course notes

b) Cost Effectiveness Analysis (CEA)

A CEA determines how an objective can be achieved in the most cost-efficient way.[48] It is often used when it is difficult (or impossible) to assign monetary value to benefits (for example: the value of human life).[49]Benefits are still quantified although not as monetary values. The output of a CEA is the ratio of discounted costs to benefits (Cost-Benefit Ratio, or CBR). The lowest CBR indicates the lowest cost per unit of benefit. If there are multiple types of benefits from an adaptation project, a CEA requires that all benefits must be measured in the same units.[47]

c) Multi-Criteria Analysis (MCA)

Unlike a strictly economic CBA, MCA includes an economic analysis component but also evaluates projects based on qualitative assessment of cost-effectiveness, co-benefits, required resources and ease of implementation. This allows projects to be ranked and prioritized based on a broader set of factors. MCAs are most commonly used when benefits cannot be measured quantitatively or when multiple benefits cannot be aggregated.[50]

MCA has been used by CAI to assess the climate adaptation potential of several on-farm practices.[51] Instead of ranking the various practices, the MCA is used to improve understanding of how each practice relates to climate change adaptation. Selected based on producer surveys, the evaluation criteria are: effectiveness, economic efficiency, flexibility, adaptability and institutional compatibility.

d) Multiple Accounts Analysis (MAA)

MAA is a system to document the important implications of a project or program. In complex situations, it is not possible to "add everything up to one number". As an alternative, implications of different options or scenarios are organized in specified "accounts" such as financial performance, environmental implications, and economic development impacts. The process involves three main steps: 1) identification of evaluation accounts, 2) documentation and assessment of implications in each account, and 3) presentation and documentation of results.[52]

Clear guidelines have been developed for the use of MAA in Socio-Economic and Environmental Assessments (SEEA) done for the Government of B.C. Economic development goals are quantified through input/output models or other techniques which show direct, indirect and induced impacts on employment and GDP but are limited by time specific economic multipliers. Net economic value is measured with a CBA to derive the change in economic activity net of project externalities. Fiscal

[48] Noleppa (2013), UNFCCC (2011)
[49] Golder Associates (2014)
[50] Golder Associates (2014)
[51] CAI B.C. Farm Practices and Climate Change Adaptation Series (2013)
[52] Craig et al (1993)

impacts are also quantified through changes in government revenue and expenditures, and assessments of social implications, aboriginal implications and environmental impacts are blended with these economic dimensions to generate a comprehensive MAA.[53] The MAA presents the various implications for decision makers, who apply their own weighting to the importance of the different accounts.

e) Existing Resources for Project Analysis

The German Society for International Co-operation (GIZ) developed a CBA Template which is an Excel document designed to sum and discount streams of costs and benefits for three separate adaptation projects. This may be useful if combined with an integrated modelling system using baseline (without adaptation) economic outcomes as costs and with adaptation scenarios as associated benefits. Initially designed for adaptation projects with explicit costs and measurable benefits overtime, it may be challenging to apply the template to soft adaptations.

[53] SEEA Guidelines (2007)

8) Conclusions and Recommendations

The analysis techniques presented in this document are evaluated in Table 1 (below). Modelling techniques that have not been previously published or attempted (such as an insurance analysis using an econometric crop simulation) have been excluded from this evaluation when they could not be discussed in adequate detail. The project proponents are seeking to quantify the economic impact of climate change adaptation, so all models presented below are quantitative. Economic decision making components, such as PE or GE models, allow individuals or markets to respond to incentives and can allow for autonomous adaptation responses. The literature is quite new on how to quantify the impacts of adaptation, so not all economic analysis techniques can easily incorporate this addition. Hydrology was chosen as an evaluation criterion because water stress was identified as a concern in all of the CAI regional risk and opportunity assessments. If a modelling technique uses downscaled climate data as a direct input, it is easier to quantify the uncertainty because the climate scenarios include measures of uncertainty, and it provides better estimates of the impacts of climate change. Finally, although agricultural insurance program analysis is intended to be included in this project, this was not a common research question in the literature and most techniques have not attempted to incorporate this addition. However, it is possible to incorporate insurance impacts in the very flexible IMS analysis technique.

Table 1. Summary of Methodological Characteristics

	Characteristics						
Methodology	**Quantitative**	**Economic Decision-Making**	**Climate Change Impacts**	**Adaptation Impacts**	**Hydrology**	**Climate Models**	**Insurance Payouts**
Ricardian Analysis	yes	yes	yes	difficult	possible	yes	no
Econometric Crop simulation	yes	no	yes	difficult	possible	yes	possible
IMS: physical crop simulation & economic model	yes	yes	yes	yes	possible	yes	possible
Climate Stressor Scenario	yes	no	yes	possible	no	no	possible
Critical Threshold Analysis	yes	no	yes	no	possible	yes	yes

Ricardian or hedonic price analysis captures autonomous adaptations. It does not provide a good framework to evaluate planned adaptation or the impact of knowledge generating programs designed to encourage autonomous adaptation. Further research could be done by developing the necessary data which pairs detailed land use with land values. Preliminary attempts have been made using B.C. assessment data and Land Use Inventories compiled by the Ministry of Agriculture. Several issues emerge when combining these complex data sets, so a focused research project would be necessary.

Econometric crop simulation requires detailed yield data for regions in which historical and projected climate data can be paired. This technique cannot be applied in the current project because annual yield data for sub-regions of the province has not been found.

An integrated modelling system in which climate, water, agricultural and economic models are linked allows for the greatest amount of flexibility and specificity in modelling climate change adaptation economics. Most major modelling exercises using downscaled climate data use the integrated modelling approach. However, these models have only just begun to incorporate adaptation in the analysis[54].

Scenario analysis is the easiest to implement and has other benefits when undertaken as a group exercise. The integrated and forward looking nature of scenario analysis opens up discussions about key assumptions and uncertainties and allows decision-makers to consider the impacts of several different visions of the future. Given the time and capacity constraints during the delivery of this project, scenario analysis with a workshop of agricultural, climate and adaptation experts has been chosen to illustrate the impacts of climate change on the B.C. agriculture economy.

The insurance programs are more sensitive to extreme weather events, and as such cannot be modelled with basic mean and variance forecasts. A probabilistic approach may better illustrate the financial impacts of weather variability on producer choices and government programs. The critical threshold analysis uses available downscaled climate data and historical regional averages. However, a long enough time series of total claims and values for specific regions of B.C. is not available from the agricultural insurance programs to match with monthly climate data. Data on the month in which a claim was activated would also improve the feasibility of this technique.

Finally, many of the adaptation projects currently supported by the B.C. Ministry of Agriculture, through GF2 and the CAI, strengthen the productive capacity of farmers through innovation and stronger communication networks. These productivity improvements have benefits beyond their impacts in promoting climate change adaptation. Productivity growth increases long run economic growth and standards of living. The causalities between information, networks and productivity growth are complex and have their own separate literature. The benefits of these types of adaptation projects may be better demonstrated through a qualitative discussion of the research surrounding productivity and innovation as key drivers of long run growth in B.C.

[54] Gordon et al (2014) , and work underway at AAFC Agri-Environmental Policy Research

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Appendix 1: B.C. Agriculture and Food Climate Action Initiative

In 2008, the B.C. Agriculture Council and the Investment Agriculture Foundation set up the B.C. Agriculture and Food Climate Action Initiative. The Initiative has been led by an advisory committee of agricultural producers, food processors and representatives from various government agencies. The Initiative assists the agriculture sector with addressing the challenges, and acting on the opportunities associated with climate change.

In the spring of 2012, the Initiative completed a climate change risk and opportunity assessment series for the B.C. agriculture sector (*Adaptation Risk & Opportunity Assessment* report series). Based on the findings of the assessments, the Initiative developed regional agricultural adaptation strategies with local partners in the Peace, the Cowichan Valley, Delta and Cariboo. The Initiative also completed a series of reports on six farm-level adaptation practices.

Approximately $5.7 million in adaptation programming funded through Growing Forward 2 from 2014 to 2018 is planned to be delivered by CAI, B.C. Agriculture Council and the Investment Agriculture Foundation. Three more regional adaptation strategies will be developed and implemented, and farm-level adaptation will be advanced through pilot and demonstration projects.

Home: http://www.bcagclimateaction.ca/

Risk and Opportunity Assessments (2012)
The assessments gathered perspectives from agricultural producers about their ability to adapt to current and projected challenges and opportunities, and to identify approaches, tools and resources required to better support adaptation. http://www.bcagclimateaction.ca/regional/overview/risks-opportunities/

Regional Adaptation Strategies (2013)
The risk and opportunity assessments made clear that the ability of agricultural producers to adapt to changes in climate is linked to physical resources and decision-making processes that are beyond the individual farm (e.g. water management, emergency planning, land use practices, economic development, and regional infrastructure). The regional adaptation strategies identify actions and projects that will help to strengthen the agriculture sector's capacity to adapt and integrate agriculture's climate change issues into local processes, planning and decisions.
http://www.bcagclimateaction.ca/regional/overview/adaptation-strategies/

Farm Adaptation Practices (2013)
This project involved research and engagement with producers across the province about current and innovative farm practices with the intent of evaluating how these practices may support adaptation for climate change. A multi-criteria analysis was used to evaluate the farm practices, to help identify factors involved in farm management decision-making. Reports were done for on water storage, drainage, shelterbelts, nutrient management, management intensive grazing, and conservation tillage.
http://www.bcagclimateaction.ca/farm-level/farm-practices/

Literature Review

Economic Analysis of Climate Change Adaption in B.C. Agriculture

November 2014

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Growing Forward 2

Pacific Institute for Climate Solutions
Knowledge. Insight. Action.

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1. Introduction

Despite agricultural producers' propensity to adapt to changing conditions, the climate change currently underway is anticipated to impact agriculture on a much larger scale than ever before. The 2012 Risk and Opportunity Assessments of B.C. agriculture, by the B.C. Agriculture and Food Climate Action Initiative (CAI), discuss climate change projections for five regions of the province and explore the sector's adaptive capacity. Climate impacts such as increases in the number of hot days, changes to precipitation patterns, and more frequent and intense extreme weather events (e.g. wind-storms, hail and droughts) are anticipated to affect B.C. agriculture. These climate impacts would also be associated with effects such as increases in as flooding, erosion, excess moisture, wild fires and pest outbreaks. Climate change will result in more uncertainty and farm management complexity. These changes will also impact Ministry of Agriculture programs such as Production Insurance and Agricultural Emergency Management.

The B.C. agriculture sector will have to adapt successfully to climate change to maintain growth and profitability. The Ministry of Agriculture, through the *Growing Forward 2* (GF2) initiative, is funding programming to direct and support agriculture sector adaptation at the regional and farm levels. This programming is delivered by the CAI. The CAI has completed four regional adaptation strategies and evaluations of six on-farm management practices. Regional adaptation projects are implemented through joint funding by regional partners and GF2, and farmers can access funds to pilot innovative farm practices through the Farm Adaptation Innovator Fund (see Appendix 1 for more details on the CAI).

Adaptation actions have begun in B.C., yet there have been few attempts to assess the economic costs associated with climate change or the benefits of adaptation in the province. The purpose of this literature review is to identify and assesses methodologies that could be used to estimate the economic benefits of adaptation.

2. Methodology

Section Overview

- This is a broad literature review and jurisdictional scan
- Overview papers from international research institutes guided the search
- The economics literature focused on hedonic (Ricardian) pricing or Integrated Modelling Systems (IMS)
- Analysis of insurance programs may require further research, although some analysis techniques are reviewed
- A draft report by Golder Associates formed the foundation of this literature review

This literature review is a broad scan of the intersection of four topic areas: economic analysis, climate change, adaptation and agriculture. Key word searches focus on these four terms. The state of research in this topic area was assessed through the review of literature in Canada and other jurisdictions with similar climate risks, political, and economic systems (e.g. US and Australia). Government agricultural agencies in Alberta, Ontario and the federal government were also contacted to gauge progress on this topic.

After starting with overview papers[1], the research focused on individual papers and methodologies best suited to answer the research question: What is the economic impact of climate change adaptation in the agriculture sector? While assessing the impact of climate change is more common in the literature, a more limited body of work incorporates adaptation into the analysis.

The economics literature related to climate change focused on hedonic (or Ricardian) pricing through regression analysis of land values or integrated modelling systems (IMS). IMS combine crop simulation models, hydrology models and economic models, both of which were highlighted in the overview papers. Extreme weather events, incentives and insurance could be found in the economics literature;[2] however connections, to the broader questions of climate change and adaptation were limited or non-existent. Some of these analysis techniques are reviewed in this document, but due to the lack of direct overlap, may require further research with a separate central question.

The draft report *Development of Climate Change Adaptation Case Analysis Literature Review* by Golder Associates served as a template for this literature review. It is an excellent overview of current work in the area of economic analysis and climate change (with a focus on the mining sector).

[1] OECD (2008), World Bank (2010), German Society for International Cooperation (GIZ), and Smit (2002)
[2] Kimura (2010). Kimura (2012), Cheng C.S. (2012)

3. Definitions

Section Overview

- Hard and soft adaptation
- Equilibrium
- Autonomous adaptation
- Planned adaptation

a) Hard and Soft Adaptation

A challenge associated with economic analysis of climate change impacts and adaptation (particularly with cost benefit analysis), is the tendency to focus on "hard" adaptation measures as they are relatively easy to quantify.[3] Hard adaptation measures include physical infrastructure, changes to natural capital such as irrigation systems, land terracing and earthen dams. "Soft" adaptation measures include modified institutions, planning processes and incentives which aim to alter the circumstances under which private or autonomous adaptation investments are made. Cost and benefits of soft adaptation such as knowledge, skill development, networks and institutions are comparatively more difficult to quantify[4]. The focus of most studies on the assessment of hard adaptation may lead to the neglect of potentially critical adaptation measures. A historical example of a critical soft adaptation measure is the development in the 1930s of the Prairie Farm Rehabilitation Administration in Saskatchewan and the Special Areas Board in Alberta. These have generally been viewed as successful institutional adaptations to the severe extended drought conditions of the time.[5]

Most of the climate adaptation actions in B.C. have been preliminary soft adaptations, including: researching impacts and solutions, disseminating information, strengthening information networks and encouraging producer collaboration on climate change. Regional agricultural adaptation strategies have been completed for the Cowichan Valley, Delta, Peace and Cariboo regions. These documents include specific adaptation actions and identify the stakeholders and networks that could be leveraged to implement each strategy. The Farm Innovator Fund provides funding for innovative adaptation pilots to enable farmers to take risks and share the knowledge gained with other producers.

b) Equilibrium

In general, equilibrium can be characterized as a state in which various opposing forces or influences are balanced. Equilibrium in an economic context implies that forces of supply and demand are balanced in the absence of external forces. When an external force (or shock) is applied to a "steady-state" equilibrium the system returns to the original equilibrium. Conversely, an "unstable" equilibrium will diverge from the original point of balance or move to a new equilibrium when an external force is applied.

[3] OECD (2008)
[4] World Bank (2010)
[5] Marchildon (2008)

c) Autonomous adaptations

The agriculture sector is familiar with adaptation in response to external forces such as price volatility, regulatory changes and climate. It is reasonable to assume that producers will respond to incentives and climate pressures to improve their outcomes without any direct government involvement. Autonomous adaptations refer to adjustments private individuals would take in response to climate change in the absence of government intervention. Many autonomous adaptations will take place at the farm level through changes in crop mixes, planting dates and fertilizer use.[6] However, they will be influenced by the economic environment and public policies. Although autonomous adaptations are important, they can be difficult to separate from total adaptation in the sector. Moreover, autonomous adaptations alone may only partly drive the full degree of adaptation required by the sector.

d) Planned adaptations

Hard and soft adaptations both fall under the classification of planned public sector adaptations.[7] These adaptations involve actions by governments to provide public goods or incentives to motivate action by the private sector. Governments may choose to participate in planned adaptation because certain adaptation actions have benefits that cannot be captured by private individuals, resulting in under investment. For example, a farmer may choose not to experiment with a new technology because his success will be copied by others (free rider problem). Development of new irrigation infrastructure, land-use arrangements and property rights, water pricing and training for the private and public sector (capacity building) are some examples of planned adaptations.[8]

[6] OECD (2008)
[7] World Bank (2010)
[8] Rosenzweig and Tubiello (2007)

4. Economic Analysis Techniques: Climate Change Adaptation

Section Overview

- Decomposition of the price of land into various components to assess the economic impact of climate change on agriculture is Ricardian (or hedonic) pricing
- Partial and general equilibrium models are a diverse family of tools and have been used alone or in combination with other models to ascertain the economic impact of climate change
- Integrated Modelling Systems are combinations of models that work together; several examples and potential configurations are discussed
- Adaptation Gap Analysis is a basic tool to determine the cost of adaptation on infrastructure projects

This section discusses specific modelling and estimation approaches that could be used to estimate the economic impact of climate change adaptation in B.C. Each subsection highlights the usefulness of the approach, its drawbacks and data requirements.

a) Ricardian (or Hedonic) Pricing

Ricardian models or hedonic pricing models are used to answer the questions: What is the economic impact of climate change, and in some cases, How is this reduced by adaptation? Hedonic pricing models are used to isolate the price effects of various characteristics, for example, the amount a nearby green space increases the value of a home. For this project, Ricardian analysis would be used to quantify the costs of climate change through lower land values. Farm land values are used to estimate the long-term economic impacts of different climate conditions than those observed in the past.

This technique is derived from the writing of David Ricardo (1817), who stated that "net land value is equal to net productivity".[9] The hedonic pricing technique assumes that land owners will maximize the productivity of their land and the price paid for a piece of land is equal to its productive capacity. The value of land is decomposed into its various components by regressing the price of land on historical climate data, land characteristics and agriculturally significant historical events. For example, the price of land without irrigation may be lower than land with irrigation. The hedonic pricing technique isolates the effect of irrigation on land price, holding all other characteristics fixed. Alternative regression approaches use farmer profits or net revenue in lieu of land values.[10] Land values are then calculated from profits: they are assumed to be equal to the present discounted stream of rental rates. In other words, land values are the discounted sum of future profits from the use of the land.

This technique assumes that farmers are actively adapting to climate change and findings are therefore net of autonomous adaptations. As a result, Ricardian models can be used to assess what would happen in the absence of a government intervention. Adaptations can be difficult to include in these models because they rely on historical information. If there was a major infrastructure project in

[9] Moeller (2010)
[10] Deschenes (2007)

the past, a parameter could be estimated to model the impact of a similar hard adaption in the future. Similarly, if there was a past change in incentives through the introduction of a government program, a soft adaptation could be modelled in the future. In the absence of either of those past events, impacts of future adaptations cannot be estimated.

Time series data can be difficult to compile and require more stringent data analysis techniques. Due to this, most Ricardian models use cross-sectional data (multiple locations). Using climate, water flow, soil and economic variables Kurukulasuriya and Mendelsohn (2008) estimate the impact of climate change in 11 African countries under two different climate scenarios.[11] This analysis does not incorporate adaptation. In order to isolate the effects of past adaptations in a given region of B.C., time series data of land values and regional climate and historical infrastructure projects would be required.

Advanced Ricardian regression techniques have used multinomial probability distributions to determine the probability that an Agro-Ecological Zone (a proxy for productivity developed by the Food and Agriculture Organization) will be present in a given district.[12] Different Agro-Ecological Zones have different net revenues and crop suitability. As these zones shift across the continent due to climate change, net revenue and crop choice will change in a given district. This method allows for one type of adaptation (changing crop mix in response to climate change) but requires advanced econometrics. The results of this study found that there would be fewer high-value Agro-Ecological Zones in Africa, resulting in a negative impact of climate change on the African economy.

b) Partial Equilibirium (PE) and General Equilibrium (GE) Analysis

Many methods for modelling the economic impact of climate change adaptation require modules to link predicted physical and biological changes to the choices of individual economic agents such as farmers and municipalities. Ultimately these predicted changes flow through to the economy through market (and government) mechanisms.

Typically economists posit that economic systems under a given set of inputs, production and consumption conditions will move towards a particular equilibrium and that if the system is changed (shocked) it will move towards a different equilibrium. Economists aim to measure the impact of the system change by measuring the difference in the two predicted equilibriums. Changes or shocks will typically have market (and government) impacts that are largest for the economic systems and factors directly affected. These impacts will diminish in size and speed of effect for those indirectly affected. For example, a flood in the Peace Region would have the largest effect on the businesses and residents in the inundated areas, a somewhat smaller effect on the businesses and communities in the immediate area and even less in other regions of the province.

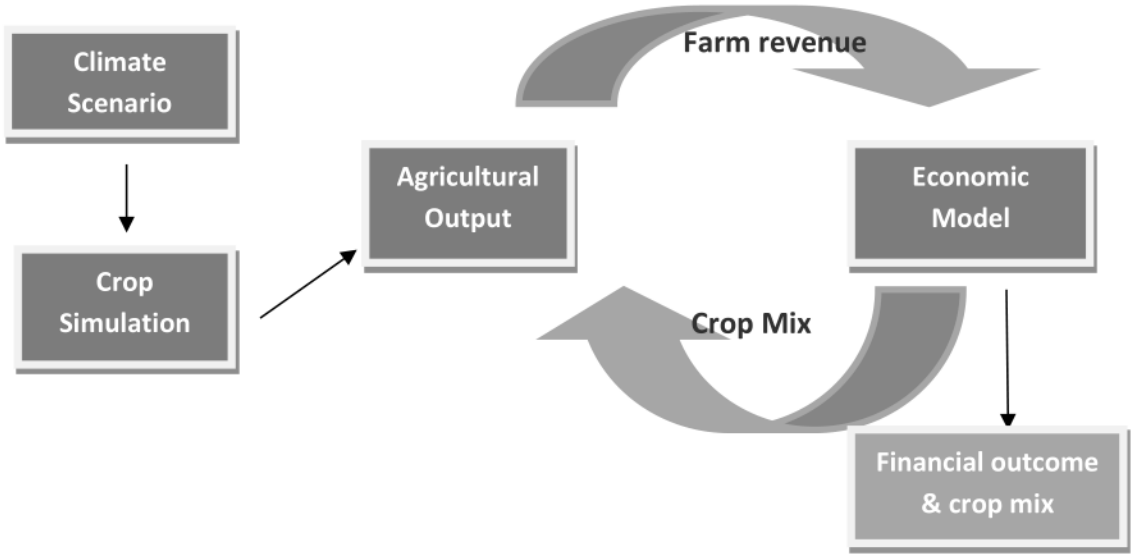
The terms “partial equilibrium” and “general equilibrium” refer to a more limited or extensive analysis of these ripple effects through the economy. In PE analysis, the effect of a change or shock is considered in one sector of the economy, while in GE analysis the model incorporates the effects on all

[11] Kurukulasuriya and Mendelsohn (2008)
[12] Kurukulasuriya and Mendelsohn (2008)

interrelated sectors of the economy. The Agri-Environmental Policy Analysis group at Agriculture and Agri-Food Canada (AAFC) uses a PE model of the Canadian agriculture sector to evaluate policy.[13] In relation to climate change, both PE and GE models provide a framework that allows a user to look at potential interactions between climate change impacts, adaptation options and the economic system. This is achieved by forecasting future market changes based on driving forces observed in the past and assumptions of market mechanisms[14]. These PE and GE models are often incorporated within an integrated modelling system (see Figure 1). Furthermore, PE and GE models rely heavily on historical estimates of market behaviour, which adds considerable uncertainty to models in which adaptation efforts induce behavioural changes over time. [15] In other words, the PE and GE models reflect the historical structure of the economy and may not reflect the structure of the economy in the future.

PE and GE models are very diverse, and are created to answer a range of different economic questions. Within these broad categories there are also static models, which stay the same over time, and dynamic models which allow changes over time. They can focus on a range of geographic areas, from regional or national to international trade and can focus on different combinations of commodities. Each economic model is based on a series of assumptions to answer a specific question. One good example is the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) model, developed by the International Food Policy Research Institute., This is a GE model that determines global food supply, demand and agricultural food prices at the country or sub-regional level, then aggregates these values to the global scale. The model has been combined with a water simulation model in an integrated modelling system to incorporate water availability concerns. However, weather variability due to climate change has not been included in the analysis and is not reflected in the results.[16]

c) Integrated Modelling Systems (IMS)



[13] Canadian Regional Agricultural Model (CRAM)
[14] Noleppa, (2013)
[15] Noleppa, (2013)
[16] Rosengrant (2008)

Figure 1. Integrated modelling system (adapted from the World Bank 2010)

Integrated modelling systems in which several models work together to generate economic impacts of climate change on agriculture are the new standard in this area of analysis. The IMS approach is common at the global scale[17], and has also been used in region specific climate adaptation studies.[18] Climate scenarios, crop simulations, and representative agent (economic) models are common components of IMS used to measure impacts of climate change adaptation (Figure 1). In the figure above, the baseline scenario would model the outcome of climate change on the agriculture sector without adaptation. A representative farmer economic model would show which adaptations would be selected by allowing farmers to choose different crop types or management techniques (such as higher efficiency irrigation). A PE economic model would demonstrate the aggregate impact on the agriculture sector; however the adaptations chosen by producers would need to be assumed in the alternate scenario. The IMS can be tailored to suit the research question through the choice of economic model.

The system is created by linking several distinct models together by matching outputs of one model to inputs of another. Climate change scenarios produce future projections of daily, monthly or annual temperature and precipitation. This information is an input into hydrology models and crop simulations, which produce estimates of water availability and crop growth respectively. Based on projected crop yields and water availability, economic outcomes are estimated with farm level decision making or sector level PE models. In Figure 1, each blue box represents an individual model, arrows represent outputs from one model and inputs into the next, and the final outcome is in the green box. Along with Ricardian analysis, the IMS technique is at the forefront of economic research on the topic of climate change, adaptation and agriculture.

IMS are flexible tools tailored by the modeller to fit the specific climate change projections and adaptation options of interest. For regional analysis, downscaled climate change scenarios are required. Crop simulation can be done with physical models or econometric estimates (see below). Adaptation options must be incorporated into the crop simulation or economic model components. Developing the expertise to work with models from several different disciplines and finding or creating linkages between these models is the most difficult aspect of the analysis.

The Agri-Environmental Policy Analysis group at AAFC is currently developing an IMS (see Figure 2) using downscaled regional climate scenarios, the DSSAT crop simulation model (see below), and their in-house PE model, the Canadian Regional Agricultural Model (CRAM).

[17] Tan 2003, Rosegrant (2008)
[18] World Bank (2008), Rosegrant (2012)

Figure 2. Integrated Modelling System (AAFC)

i) Physical Models

Physical models use plant science or commonly known relationships between soil type, climate, hydrology, and crop type to determine total production. These models use climate scenarios to predict future agricultural production. The climate scenarios are those developed by international climate models, most often the Intergovernmental Panel on Climate Change (IPCC). These global climate models (GCM) are built based on physical science as well as socioeconomic factors that influence global emissions of greenhouse gases. GCMs can be downscaled to represent climate projections for smaller regions. There have been many advances in downscaling techniques and the most recent iteration of climate scenarios for B.C. provided by the Pacific Climate Impacts Consortium (PCIC)[19] provide daily temperature and precipitation levels for 1951-2100 at a 10 km spatial resolution.[20] This data is crucial for modelling hydrology and plant growth, key components of IMS.

(1) Decision Support System for Agrotechnology Transfer (DSSAT)

Developed by several universities and research institutes, the Decision Support System for Agrotechnology Transfer (DSSAT) is software that, for over 28 crops, simulates growth, development and yield as a function of the soil-plant-atmosphere dynamics. [21] This model was used at the global scale to model the effects of climate change on food production[22], but can be used for on-farm precision management and regional assessments of climate change adaptation.[23] The yield output under various climate change scenarios could be used as part of an integrated model to determine the economic impact on agriculture. The latest work-in-progress version of this model has been acquired from DSSAT for use on this project.

(2) Environmental Policy Integrated Climate (EPIC) Model

EPIC is a cropping systems model developed to estimate soil productivity and erosion. It was created as part of the analysis for the 1980 *Soil and Water Resources Ac*t in the US and is housed at the

[19] PCIC is a regional climate technical service centre at the University of Victoria that provides information on the physical impacts of climate variability and change, including support for long-term planning with climate projections for regions of B.C. based on downscaled global climate change models. www.pacificclimate.org
[20] PCIC poster #GC43C-1069 (2013)
[21] University of Florida, the University of Georgia, University of Guelph, University of Hawaii, the International Center for Soil Fertility and Agricultural Development, USDA-Agricultural Research Service, Universidad Politecnica de Madrid, Washington State University, and other scientists associated with ICASA
[22] Rosegrant (2012)
[23] http://dssat.net/about

Texas A&M University. It has been used to examine climate change and drought impacts on crop yields and soil erosion[24]. Although both DSSAT and EPIC model crop yields, EPIC is better at modelling erosion and other environmental impacts[25]. The EPIC model can be extended to evaluate agricultural policy by incorporating Agricultural Policy/ Environmental eXtender Model (APEX) to consider the impact of management practices on a variety of agricultural and environmental indicators.

(3) Agriculture Water Demand Model (AWD)

The Agriculture Water Demand (AWD) model was developed by the B.C. Ministry of Agriculture to support planning to address water shortages across the province. Water demand models have been created for 10 watersheds across B.C., mostly in the south of the province. The models use a cadastre provided by regional districts to inform detailed land use surveys to determine which crops are being grown and if there is irrigation present on a given piece of land. [26] This information is combined with soil and historical climate data to determine water demand at various levels of regional aggregation. The AWD uses climate projections provided by PCIC to model future water demand.

The AWD model developers have run several scenarios similar to climate change adaptation by altering the number of irrigated farms and the type of irrigation or increasing the number of active farms. The model can generate an intermediate output of the number of irrigated acres of a given crop in the watershed, which can be used to determine the share of irrigated farms. These two numbers can be combined with a measure of the average value of a particular crop in that particular region to estimate the total value of production. This approach is especially useful for running scenarios based on water use and crop mix adaptations and already incorporates the climate scenarios developed by PCIC. It may also be possible to use AWD models with estimates of the increased value from irrigation to measure the economic impact of increased irrigation or water storage for irrigation as adaptations to climate change. [27]

AWD models have not been completed for all regions of B.C., so the analysis would be restricted to specific regions, some of which are smaller than the regions for which the CAI has completed climate change risk and opportunity assessments. The AWD model requires intensive surveying of agricultural land use, which is the major delay in completing all regions of B.C. and also results in data that is somewhat dated for regions completed earlier (e.g. the Okanagan). This model is useful for running scenarios in which adaptations are (or are not) implemented; however climate stressor scenarios such as droughts or increased precipitation would require new climate projections to be developed by PCIC. The feasibility of developing these climate stressor scenarios has not yet been explored. Finally, although this approach generates dollar figures for the cost of climate change and the benefits of adaptation, it neglects the economic incentives by excluding an economic model. It is an integrated model (see Figure 3), but it does not model producer profitability and the forces that might induce an

[24] http://epicapex.tamu.edu/epic/
[25] Discussion with Tom Goddard at Alberta Agriculture and Rural Development
[26] A cadastre includes details of ownership, tenure, location, dimensions (and area), crop cultivations, and the value of individual parcels of land.
[27] Samarawickrema (2008), Faux (1999)

investment in adaptation; nor does it model how water availability would affect the structure of the agricultural sector.

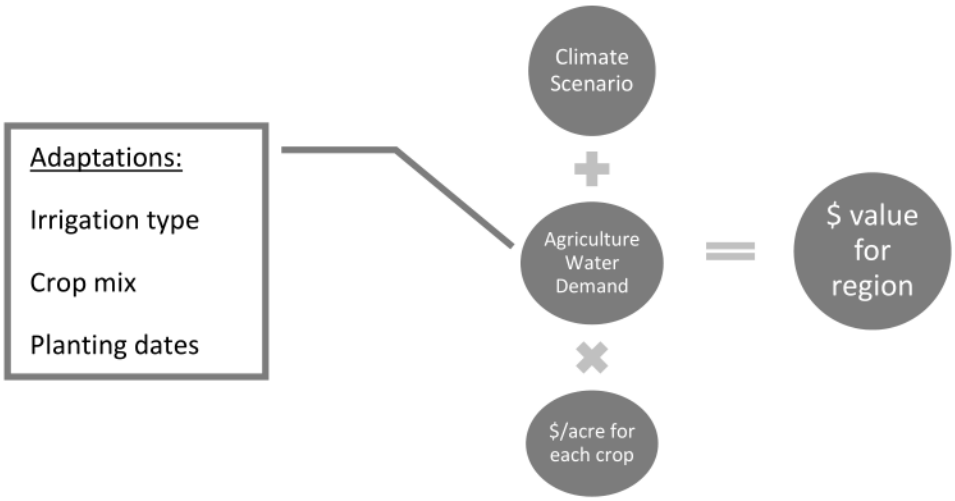


Figure 3. Integrated Modelling System (AWD and B.C. production insurance data)

d) Econometric Crop Simulation

Econometric crop simulation models are calibrated using historical data on climate, soil profile, management practices and other explanatory variables to estimate the relationships between these independent variables and production output. In practice, crop yields are regressed as a function of historical climate, soil profile, economic and region specific variables to determine parameter values. These parameters are used to estimate future crop yields using climate projections. As with the Ricardian technique, similar hard adaptations must have occurred in the past in order to estimate their impacts in the future. Soft adaptations, cannot be incorporated because they are specifically designed to alter the relationships (change parameters) between inputs and outputs, which must remain fixed in the simulation. It is also common to estimate the rate of technology or adaptation adoption by farmers, which must be based on survey results.[28]

Econometric analysis of crop yields has so far only been used to look at past relationships between yield and climate variables; however, Sun (2013) suggests that it could be used for climate change modelling. This technique inherently overstates longer-term potential impacts of adaptation projects because costs or damages in the case "without adaptation project" are overestimated due to the exclusion of autonomous adaptations. The econometric regression can incorporate spatial climate data; however, the scale of the climate scenario has a significant impact on the economic impacts measured. Smaller scale climate data consistently results in less favourable economic implications for agriculture, in that the parameter values for unfavourable weather have larger impacts on production.[29] In other words, when the climate projections are focused on a smaller region, more hot days or different precipitation patterns have a larger negative effect on agricultural production.

[28] World Bank (2010)
[29] Adams (2003)

e) Adaptation Gap Analysis: Cost of Adaptation

Adaptation gap analysis calculates the increase in costs for an existing project if it were redesigned to consider climate change adaptations.[30] The adaptation gap is the additional amount that an existing project would cost in order to be upgraded to include climate adaptation measures. This method is used for existing capital projects being evaluated for their climate change suitability. It is useful to derive a cost of adaptation but gives no insight into the benefits of adaptation or the costs of climate change.

[30] World Bank (2010)

5. Climate Stressor Scenarios

Section Overview

- As part of an integrated and forward looking analysis, scenario development can help determine the impacts of climate change through a series of "what if" stories
- Three examples of scenarios are given to show how these can be useful for climate change adaptation as both qualitative and quantitative exercises

In contrast to climate change scenarios with and without adaptation, which quantify the costs of climate change and isolate the impact of adaptation on the agriculture economy of the future, climate stressor scenarios model a specific impact of climate change. Climate stressors such as sea level rise, more frequent floods, and droughts are often cited as consequences of climate change. However a great deal of uncertainty surrounds the extent, timing, and location of these climate stressors. In order to plan for these hazards without exact data on frequency or magnitude, climate stressor scenarios are built using reasonable assumptions.

a) Coastal Flooding in Australia

The CSIRO estimated the impacts of coastal flooding in Australia using current dollars and assumptions about future population and number of buildings at risk. [31] Three scenarios are defined based on changes to planning and building regulations and the defence of existing homes and buildings. The first scenario holds regulations fixed so that the *proportion* of people and buildings at risk is the same but applied to a larger population, while the second scenario allows for no further risky developments. The third scenario holds the *number* of people and buildings at risk fixed (a smaller proportion of the future population).[32] This type of approximation may be useful for very rough estimates of the impact of climate change in agriculture: estimates of the proportion of producers at risk from climate change in a given region could be used along with an assumption of how this proportion would change with various adaptation measures.

b) Flooding in the Fraser Valley, B.C.

A similar analysis has been applied to flooding scenarios in the Fraser Delta region of British Columbia. [33] Sea-level rise due to climate change exacerbates the flooding risks faced by this major agricultural production region. The report quantifies the economic costs of a major flooding event in Delta, Surrey and Richmond, B.C. The authors defined the perimeters and weather events that would cause major flooding in the region using "vulnerable areas" identified from previous flooding studies and municipal plans and the corresponding types of floods (dike breach, seepage, freshet melt) that would inundate these areas. Ministry of Agriculture land use inventories informed the type of agricultural activity and the proportion of total provincial production that occupy each vulnerable area.

[31] Wang (2010)
[32] Wang (2010)
[33] Robbins, M and Tatebe, K (2014)

The purpose of this assessment is to highlight the general economic risk of failing to adapt to climate change because all of the vulnerable areas could not be flooded with a single flooding event.

Case studies based on past flooding events were the primary evaluation technique to determine the economics losses associated with major flooding induced by climate change. Farm-gate receipts are pro-rated to the vulnerable areas to estimate lost revenues. Agricultural impacts depended on: the amount of agricultural activity in the vulnerable area, the timing of the flooding event, the salinity of the flood waters and the rate at which it could be removed from the land. Economic costs associated with each scenario are calculated based on total economic impact, additional farmer costs and total farmer costs. The total economic impact is lost farm gate receipts plus secondary impacts (estimated as exactly the amount of lost farm receipts) which makes total economic loss two times the lost farm gate receipts. Additional farmer costs, which seeks to quantify lost capital investments, is equal to damage to buildings and equipment plus lost livestock feed and replanting costs. Total farmer costs are additional farmer costs plus lost farm gate receipts.

This approach can estimate the costs of climate change on agriculture, but the inclusion of adaptation is somewhat limited. Some adaptation measures are assumed, such as raising the dikes above the current height standard of 3.56 metres. Other adaptations, such as on farm drainage, are discussed as ways to mitigate agricultural losses without quantifying the impact this would have on economic losses. Other drawbacks include the fact that the study does not specify a time frame, other than the length of the flooding events, and uses fixed dollar assumptions of building and replanting costs. As a result, the study illustrates the costs of flooding due to climate change at some unspecified point in the near future.

c) Climate Change in Alberta

The consulting group Scenarios to Strategy used a seven step planning process to build planning scenarios for natural disasters in Alberta:[34]

1) Clarifying the focus of the scenarios (choosing the focal question)
2) Examining past changes to identify ongoing trends and forces
3) Identifying future changes and underlying forces
4) Identifying the key uncertainties which could lead to distinctly different futures
5) Creating a logical framework based on the uncertainties
6) Fleshing out the major characteristics and developing coherent stories for each scenario
7) Identifying implications for the organization from the scenarios

This framework was used in a workshop setting to develop a scenario related to climate change and to identify priority actions that could have prevented the adverse outcomes illustrated. The activity was qualitative in nature, and used to spark collaborative discussion. However, the scenario planning process and resulting products draw upon past experiences and present conditions. This allows for the development of more quantitative scenarios where data exists.

[34] Brummell and MacGillivray (2007)

6. Insurance Analysis

Section Overview

- Several forces influence the impact of climate change on agriculture insurance programs
- Critical threshold analysis is a means to determine the future cost of insurance programs in light of climate change
- Probabilistic methods can help measure how risks for agriculture will change due to climate change and help programs adapt to new climate change risks
- More detailed research should be pursued in this topic area

Crop insurance, or production insurance, is both an adaptation and a program at risk under climate change.[35] The availability and type of crop insurance can have significant impacts on land use allocations by agricultural producers, which could both support adapting to new crops or incentivize producers to grow crops that are no longer viable by shielding producers from climate change impacts.[36] In other words, easy access to insurance can make agriculture more vulnerable to climate change by reducing the incentives for adaptation. Agriculture income stabilization programs could undermine climate change adaptation[37] by reducing the incentives to diversify crop types or locations through program disqualification. On the other hand, access to insurance can allow farmers to quickly adapt to new climate realities by providing liquidity.

The production risks of new and potentially better adapted crops will need to be evaluated and incorporated into the existing insurance programs. Several studies have examined the impact of different insurance schemes on producer crop choices. [38] Although insurance may decrease climate change vulnerability by increasing a producer's ability to adapt, it may inadvertently create a moral hazard whereby the producer increases his or her exposure to physical hazards[39]. The substitution between self-insurance (adaptation) and buying insurance could also reduce the base for loss sharing and increase actuarial risk through adverse selection: producers who are better able to take adaptive actions might disproportionately opt out of buying insurance.[40]

The increased prevalence of extreme weather events, such as drought and floods, anticipated under climate change projections, places new pressure on the provincial Production Insurance and AgriStability programs. This section explores methods best suited to analyze the effects of crop insurance on agricultural adaptation and the effects of extreme weather on agricultural insurance programs.

[35] Adaptive Design and Assessment Policy Tool (ADAPTool): Government of British Columbia Agriculture
[36] Adaptive Design and Assessment Policy Tool (ADAPTool): Government of British Columbia Agriculture
[37] Bourque et al (2007)
[38] Boere & Van Kooten (2014 in Print), Turvey (2012)
[39] Mcleman &Smit (2006)
[40] Adaptive Design and Assessment Policy Tool (ADAPTool): Government of British Columbia Agriculture

a) Critical Threshold Analysis

In order to determine if there will be a greater number of insurance claims in the future, this method seeks to determine what critical weather event thresholds have previously triggered large numbers of insurance claims.[41] The relationship between weather (measured by indexes or monthly totals) and insurance claims is used to determine when weather thresholds trigger high average numbers of insurance claims. This information is then combined with regional climate scenarios to determine how much more often weather will surpass these thresholds. The frequency of increased claims is then combined with the associated payouts to determine the higher cost to the insurer under the climate scenario. This method is still subject to the uncertainties associated with downscaled climate data and requires data on monthly insurance payouts by region.

b) Probabilistic Methods and Extreme Weather Events

Most climate change models predict not only changes in the means of climate variables but also that the frequency of extreme weather events will increase. Coupled with this, we know that uncertainties surrounding possible events are a key determinant of people's behaviour. We should therefore expect that climate change uncertainties will also be a key determinant of their adaptation behaviour.

Choosing the key weather hazards of concern and then modelling the future probability of these hazards is a difficult process. In probabilistic models, the relationship between the defined hazard (i.e. intensity or rainfall, river height, number of floods exceeding a certain height) and the probability of a hazard occurring are captured in a probability density function (pdf) with the hazard intensity measured on the x axis and the probability of occurrence measured on the y axis.

In the science of modelling natural catastrophe probabilities the relationship between probability of a hazard and the intensity are measured with an *exceedance curve*.[42] The estimation of the exceedance curve allows for the probabilistic estimation of monetary loses due to natural disasters. Sometimes these curves are presented with frequency on the vertical axis and intensity on the horizontal axis (see Figure 4).[43] To determine the exeedence curve, a researcher requires information about the frequency, the intensity and the resulting economic impacts of extreme weather events. Estimating probability distributions can be difficult for high-intensity, low frequency events. Although it is very difficult to determine how exactly future climate scenario will alter the distribution, appropriate assumptions can be made.

[41] Cheng C.S. (2012)
[42] World Bank (2010)
[43] http://understandinguncertainty.org/node/622

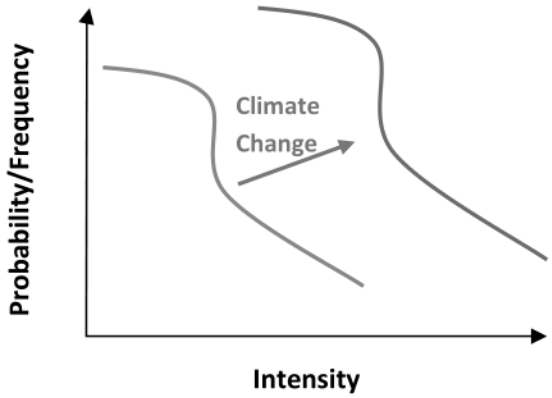


Figure 4. Effect of climate change on the intensity-probability function (Adapted from World Bank 2010)

Previous applications of probabilistic methods have been in weather simulators which use Monte-Carlo simulations to generate daily weather variables.[44] Downscaled climate models now include daily temperature and precipitation data which could allow for new applications of probability distribution. Although it has yet to be attempted, an econometric crop simulation which uses distributions of daily temperatures could be used to estimate production outcomes for a representative farmer. This could be useful for insurance analysis because it would allow different coverage options to be tested against these simulated outcomes to determine expected insurance liabilities under climate change.

The insurance choices of three representative farmer types in Saskatchewan were modelled by Kimura et al (2012). The authors simulated future yields using four climate change and adaptation scenarios as well as the farmer's endogenous choice among four risk reduction strategies (individual yield insurance, area yield insurance, weather indexed insurance and ex-post government payments). High risk farmer's increased their purchases of weather indexed insurance but yield area insurance had the largest increase in demand with marginal climate change. Area yield insurance also enhanced diversification strategies. The paper goes on to quantify the budgetary costs of the various insurance options and the uncertainty surrounding future climate scenarios and farmer's adaptation choices. The paper uses advanced modelling techniques and regional yield data from Saskatchewan from 2003-2008 for wheat, barley and canola[45]. Some results are difficult to interpret for the purpose being investigated here. For example, welfare gains are measured in dollars per acre and are not aggregate to show total gains for various policies. Although very thorough and precise, the paper requires lots of data and modelling expertise and does not report the results of interest to this project.

[44] World Bank (2008)
[45] Kimura et al (2012)

7. Traditional Project Evaluation Techniques

Section Overview

- This section summarizes well known and commonly used economic analysis techniques: Cost Benefit Analysis, Cost Effectiveness Analysis, Multi-Criteria Analysis, and Multiple Accounts Analysis
- The usefulness of each technique and its drawbacks for this particular research question are highlighted

c) Cost Benefit Analysis (CBA)

CBA is best suited to hard adaptation projects where investment amounts and resulting benefit streams are easily monetized. Investment amounts are measured and discounted according to when the cost is incurred. Similarly, income or benefit flows are estimated and discounted. This method requires a tangible investment in climate adaptation, such as a dike or a seawall, and is best suited for specific infrastructure projects. In the case of soft adaptations, such as access to information or research into new crop varieties, a CBA would require assumptions to be made about the timing of these adaptations.

The nine steps for a CBA are:[46]

1. **Define the relevant group**: for example: region, commodity, representative farmer or aggregate farm revenue
2. **Select the portfolio of project options and define project timelines (implementation dates, time horizon)**; for example, adaptation measures such as
    a. Water management (regional or on farm)
    b. Crop insurance or weather derivatives
    c. Adopting/developing new crop varieties
3. **Catalogue potential impacts and select management indicators**:
    a. Increased water availability on crop yields
    b. Effect of insurance on total farm income
    c. Effect of new varieties on crop yields
4. **Predict quantitative impacts over project life**: economic model of relationship between impacts and indicators, based on historical relationship and reasonable assumptions
5. **Monetize all impacts**: convert crop yields into revenue, aggregate farm income to regional or provincial level
6. **Calculate Net Present Value, Internal Rate of Return, Payout Time, Benefit Cost Ratio**: choose a social discount rate that is appropriate for climate change and adaptation analysis
7. **Indentify distribution of costs and benefits**: Who bears adaptation costs? Who receives benefits? Are there externalities?

[46] Adapted from Peter Kennedy's (University of Victoria) Cost Benefit Analysis course notes

8. **Perform sensitivity analysis**: make changes to reasonable assumptions to determine how sensitive the results are to small changes. This is particularly important for all parameters whose future values are uncertain.
9. **Make a recommendation**

d) Cost Effectiveness Analysis (CEA)

A CEA determines how an objective can be achieved in the most cost-efficient way.[47] It is often used when it is difficult (or impossible) to assign monetary value to benefits (for example: the value of human life).[48]Benefits are still quantified although not as monetary values. The output of a CEA is the ratio of discounted costs to benefits (Cost-Benefit Ratio, or CBR). The lowest CBR indicates the lowest cost per unit of benefit. If there are multiple types of benefits from an adaptation project, a CEA requires that all benefits must be measured in the same units.[47]

e) Multi-Criteria Analysis (MCA)

Unlike a strictly economic CBA, MCA includes an economic analysis component but also evaluates projects based on qualitative assessment of cost-effectiveness, co-benefits, required resources and ease of implementation. This allows projects to be ranked and prioritized based on a broader set of factors. MCAs are most commonly used when benefits cannot be measured quantitatively or when multiple benefits cannot be aggregated.[49]

MCA has been used by CAI to assess the climate adaptation potential of several on-farm practices.[50] Instead of ranking the various practices, the MCA is used to improve understanding of how each practice relates to climate change adaptation. Selected based on producer surveys, the evaluation criteria are: effectiveness, economic efficiency, flexibility, adaptability and institutional compatibility.

f) Multiple Accounts Analysis (MAA)

MAA is a system to document the important implications of a project or program. In complex situations, it is not possible to "add everything up to one number". As an alternative, implications of different options or scenarios are organized in specified "accounts" such as financial performance, environmental implications, and economic development impacts. The process involves three main steps: 1) identification of evaluation accounts, 2) documentation and assessment of implications in each account, and 3) presentation and documentation of results.[51]

[47] Noleppa (2013), UNFCCC (2011)
[48] Golder Associates (2014)
[49] Golder Associates (2014)
[50] CAI B.C. Farm Practices and Climate Change Adaptation Series (2013)
[51] Craig et al (1993)

Clear guidelines have been developed for the use of MAA in Socio-Economic and Environmental Assessments (SEEA) done for the Government of B.C. Economic development goals are quantified through input/output models or other techniques which show direct, indirect and induced impacts on employment and GDP but are limited by time specific economic multipliers. Net economic value is measured with a CBA to derive the change in economic activity net of project externalities. Fiscal impacts are also quantified through changes in government revenue and expenditures, and assessments of social implications, aboriginal implications and environmental impacts are blended with these economic dimensions to generate a comprehensive MAA.[52] The MAA presents the various implications for decision makers, who apply their own weighting to the importance of the different accounts.

g) Existing Resources for Project Analysis

The German Society for International Co-operation (GIZ) developed a CBA Template which is an Excel document designed to sum and discount streams of costs and benefits for three separate adaptation projects. This may be useful if combined with an integrated modelling system using baseline (without adaptation) economic outcomes as costs and with adaptation scenarios as associated benefits. Initially designed for adaptation projects with explicit costs and measurable benefits overtime, it may be challenging to apply the template to soft adaptations.

[52] SEEA Guidelines (2007)

8. Conclusions and Recommendations

The analysis techniques presented in this document are evaluated in Table 1 (below). Modelling techniques that have not been previously published or attempted (such as an insurance analysis using an econometric crop simulation) have been excluded from this evaluation when they could not be discussed in adequate detail. The project proponents are seeking to quantify the economic impact of climate change adaptation, so all models presented below are quantitative. Economic decision making components, such as PE or GE models, allow individuals or markets to respond to incentives and can allow for autonomous adaptation responses. The literature is quite new on how to quantify the impacts of adaptation, so not all economic analysis techniques can easily incorporate this addition. Hydrology was chosen as an evaluation criterion because water stress was identified as a concern in all of the CAI regional risk and opportunity assessments. If a modelling technique uses downscaled climate data as a direct input, it is easier to quantify the uncertainty because the climate scenarios include measures of uncertainty, and it provides better estimates of the impacts of climate change. Finally, although agricultural insurance program analysis is intended to be included in this project, this was not a common research question in the literature and most techniques have not attempted to incorporate this addition. However, it is possible to incorporate insurance impacts in the very flexible IMS analysis technique.

Table 1. Summary of Methodological Characteristics

	Characteristics						
Methodology	**Quantitative**	**Economic Decision-Making**	**Climate Change Impacts**	**Adaptation Impacts**	**Hydrology**	**Climate Models**	**Insurance Payouts**
Ricardian Analysis	yes	yes	yes	difficult	possible	yes	no
Econometric Crop simulation	yes	no	yes	difficult	possible	yes	possible
IMS: physical crop simulation & economic model	yes	yes	yes	yes	possible	yes	possible
Climate Stressor Scenario	yes	no	yes	possible	no	no	possible
Critical Threshold Analysis	yes	no	yes	no	possible	yes	yes

Ricardian or hedonic price analysis captures autonomous adaptations. It does not provide a good framework to evaluate planned adaptation or the impact of knowledge generating programs designed to encourage autonomous adaptation. Further research could be done by developing the necessary data which pairs detailed land use with land values. Preliminary attempts have been made using B.C. assessment data and Land Use Inventories compiled by the Ministry of Agriculture. Several issues emerge when combining these complex data sets, so a focused research project would be necessary.

Econometric crop simulation requires detailed yield data for regions in which historical and projected climate data can be paired. This technique cannot be applied in the current project because annual yield data for sub-regions of the province has not been found.

An integrated modelling system in which climate, water, agricultural and economic models are linked allows for the greatest amount of flexibility and specificity in modelling climate change adaptation economics. Most major modelling exercises using downscaled climate data use the integrated modelling approach. However, these models have only just begun to incorporate adaptation in the analysis[53].

Scenario analysis is the easiest to implement and has other benefits when undertaken as a group exercise. The integrated and forward looking nature of scenario analysis opens up discussions about key assumptions and uncertainties and allows decision-makers to consider the impacts of several different visions of the future. Given the time and capacity constraints during the delivery of this project, scenario analysis with a workshop of agricultural, climate and adaptation experts has been chosen to illustrate the impacts of climate change on the B.C. agriculture economy.

The insurance programs are more sensitive to extreme weather events, and as such cannot be modelled with basic mean and variance forecasts. A probabilistic approach may better illustrate the financial impacts of weather variability on producer choices and government programs. The critical threshold analysis uses available downscaled climate data and historical regional averages. However, a long enough time series of total claims and values for specific regions of B.C. is not available from the agricultural insurance programs to match with monthly climate data. Data on the month in which a claim was activated would also improve the feasibility of this technique.

Finally, many of the adaptation projects currently supported by the B.C. Ministry of Agriculture, through GF2 and the CAI, strengthen the productive capacity of farmers through innovation and stronger communication networks. These productivity improvements have benefits beyond their impacts in promoting climate change adaptation. Productivity growth increases long run economic growth and standards of living. The causalities between information, networks and productivity growth are complex and have their own separate literature. The benefits of these types of adaptation projects may be better demonstrated through a qualitative discussion of the research surrounding productivity and innovation as key drivers of long run growth in B.C.

[53] Gordon et al (2014) , and work underway at AAFC Agri-Environmental Policy Research

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Appendix 1: B.C. Agriculture and Food Climate Action Initiative

In 2008, the B.C. Agriculture Council and the Investment Agriculture Foundation set up the B.C. Agriculture and Food Climate Action Initiative. The Initiative has been led by an advisory committee of agricultural producers, food processors and representatives from various government agencies. The Initiative assists the agriculture sector with addressing the challenges, and acting on the opportunities associated with climate change.

In the spring of 2012, the Initiative completed a climate change risk and opportunity assessment series for the B.C. agriculture sector (*Adaptation Risk & Opportunity Assessment* report series). Based on the findings of the assessments, the Initiative developed regional agricultural adaptation strategies with local partners in the Peace, the Cowichan Valley, Delta and Cariboo. The Initiative also completed a series of reports on six farm-level adaptation practices.

Approximately $5.7 million in adaptation programming funded through Growing Forward 2 from 2014 to 2018 is planned to be delivered by CAI, B.C. Agriculture Council and the Investment Agriculture Foundation. Three more regional adaptation strategies will be developed and implemented, and farm-level adaptation will be advanced through pilot and demonstration projects.

Home: http://www.bcagclimateaction.ca

Risk and Opportunity Assessments (2012)
The assessments gathered perspectives from agricultural producers about their ability to adapt to current and projected challenges and opportunities, and to identify approaches, tools and resources required to better support adaptation.
http://www.bcagclimateaction.ca/regional/overview/risks-opportunities

Regional Adaptation Strategies (2013)
The risk and opportunity assessments made clear that the ability of agricultural producers to adapt to changes in climate is linked to physical resources and decision-making processes that are beyond the individual farm (e.g. water management, emergency planning, land use practices, economic development, and regional infrastructure). The regional adaptation strategies identify actions and projects that will help to strengthen the agriculture sector's capacity to adapt and integrate agriculture's climate change issues into local processes, planning and decisions.
http://www.bcagclimateaction.ca/regional/overview/adaptation-strategies

Farm Adaptation Practices (2013)
This project involved research and engagement with producers across the province about current and innovative farm practices with the intent of evaluating how these practices may support adaptation for climate change. A multi-criteria analysis was used to evaluate the farm practices, to help identify factors involved in farm management decision-making. Reports were done for on water storage, drainage, shelterbelts, nutrient management, management intensive grazing, and conservation tillage.
http://www.bcagclimateaction.ca/farm-level/farm-practices

Annex 1: Opportunities for integrating adaptation into key program areas

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Program Areas	Key Opportunities	Potential for Integrating Adaptation
Regional Agrologists	- agrologists are often involved in project management committees for CAI projects and identify local connections to many other programs. - key contacts for in-depth regional studies such as FBC Lower Mainland Flood Management . - local issues arising from Water Sustainability Plans; FireSmart planning; regional drought management	- regional agrologists are a strategic priority across programs; familiar with local and regional issues / innovations and are key to effective implementation of many other programs - front lines for regional interaction with other agencies (wildfire, water, drought management) - support more frequent opportunities for team learning and development - use agrologists to help identify emerging issues of climate risk and adaptation
AgriStability	- GF3 negotiations in coming months will consider terms and criteria	- useful to monitor program data by region to help determine whether climate variability is contributing to program demand
Production Insurance		
Agricultural Emergency Management	- links/lessons from CAI projects including Delta Flooding Preparedness, Extreme Weather Preparedness in the Cowichan and Widlfire Preparedness and Mitigation in the Cariboo - FBC Lower Mainland flood management project - PCIC extreme event analyses - FireSmart program	- studies can point to regional hazards that are likely to be exacerbated to climate change, to focus information strategies with producer groups - growing need for consideration of risk reduction measures at farm or community scale - potential to coordinate with EMP / BMP to harmonize messaging
Plant Health / Invasive species / Pest Management	CAI Collaborative monitoring project in the Peace (underway) - opportunities to commission new studies around specific questions	- how to maintain and build on knowledge gains of 2 yr CAI project to strengthen surveillance - identify emerging research or monitoring issues in collaboration with AAFC
Strengthening Farming	- CAI sStudy defining a new approach to Agricultural Land Use Inventory in the BC Peace (PC04) - *Water Act* implementation - FBC Lower Mainland Flood Management study: implications for land use and local planning	- monitor emerging issues in local planning (particularly dealing with subdivision, drainage, flood retention, etc) - potential FireSmart connections to agricultural producers for wildfire planning

Program Areas	Key Opportunities	Potential for Integrating Adaptation
Agroforestry	- FBC Lower Mainland Flood Management study - PCIC extreme events studies	- links to EMP / BMP for flood management, streambank erosion control, runoff management, etc
Environmental Farm Plan & Beneficial Management Practices	- relevant CAI projects: Business case for regional agriculture extension services in Cowichan (CW03), Integrated Farm Water planning Project (CW06) - FBC Lower Mainland Flood Management study	- emerging concerns with runoff, erosion control, water management, flood risk reduction - monitor relevant information from related activities - collaborate with AEM, other programs
Agriculture Water Management	- relevant CAI projects: PC02 Increasing availability of agriculturally relevant weather data, Possibly connect wt Delta drainage and sub-irrigation project (DL09) - FBC Lower Mainland Flood Management study	- anticipate increasing demand for program - more effort to simplifying data sharing protocols between different agencies - update models with new information from climate models and other research projects
Agrifood Business Development	- CAI projects: Enhancing Local Processing and Storage in Cowichan (5- complete March 2014) & Farm adaptation innovator fund	- support to explore business and market risks (and opportunities) associated with increasing climate variability and climate change

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Annex 2 Min of Agriculture – Climate Adaptation Strategy
Adaptation Dialogue sessions

As part of its commitment to integrating climate change adaptation into all ministry programs, the Ministry of Agriculture will plan a series of informal, program-focused dialogues on the subject. We can foresee one of these events approximately each quarter, but the timing will be flexible to take advantage of other meeting opportunities and respond to program priorities.

Climate change is beginning to affect agricultural producers in B.C. and these effects are expected to accelerate. Do these changes affect your program? What issues do you see from the program side? What are producers or producer groups noticing or getting concerned about?

We propose a 2 – 3 hour dialogue that allows program staff to explore issues of concern to them and to agricultural producers, based on their own experience, and evidence from CAI regional profiles and pilot projects. The expected result will be improved understanding of the program risks posed by climate change and the implications (if any) for program planning and management. Where there are significant implications for programming, this will allow program managers to plan for any adjustments necessary to ensure program effectiveness. Where there are no significant implications for programming, this exercise will provide confidence and evidence of how the ministry has assessed the issues.

Guiding principles:

1. Sessions are scheduled based on program interest and Ministry priorities
2. Program staff bring their questions and concerns
3. External resource persons bring new knowledge about recent studies or producer practices in the sector
4. Both managers and regional staff to be involved. Regional agrologists should be invited wherever possible.
5. Content specific to program or theme
6. Process is light and low-cost
7. Application of "process improvement techniques" will demonstrate due diligence and program responsiveness to climate change

Session structure (in relation to specific programs to be determined e.g. Emergency Management; Pest Management; Strengthening Farming~~, etc~~):

1. Changing climate risks – what do we see already in relation to this topic? (~30 min). External resource persons set the stage, with open discussion about interactions between climate risk and other agricultural business risks in relation to the specific topic and program focus. Particular attention paid to the producer perspective.

2. What are the Ministry's legal or regulatory responsibilities in relation to existing programming; and / or public profile or perceived responsibility that could expose it to ~~political~~ liability (~10 min)

3. Presentation of new knowledge or practices related to climate adaptation in agriculture sector (~30 min) e.g. CAI projects

4. How might these issues affect Ministry functions and programming? (~20 min)

5. What strategies would be appropriate to ensure that programs continue to meet producer needs under a changing risk profile? This could include program actions, further consultation, monitoring, or detailed studies, if any action required. (~30 min)

6. Follow-up measures (if any required)

Potential session participants (depends on theme / location):

- Innovation and Adaptation Branch management
- Ian M~~a~~cL~~l~~achlan
- Program Lead(s)
- Regional staff
- Regional Agrologist(s) – relevant to theme
- CAI
- External resource person (depending on topic)
- Facilitator
- Total of a~~A~~bout 10 – 12 people

The first two of these events will be scheduled before March 12, 2015 to take advantage of the resources available through the current strategic planning consultancy. It is proposed that these sessions be organized for the Agriculture Emergency Management Program and Plant Health Unit and take place in Abbotsford.

Ministry of Agriculture
Climate Adaptation Strategy
DRAFT report (incomplete)
Jan 16, 2015

Comment [MIPA1]: Turn this into a title page

Comment [MIPA2]: And add executive summary that includes action list and highlights the ones for the coming year

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Have some context upfront about 1) climate stressors, 2) agricultural effects, and 3) the need for producer adaptive action. e.g. changes in temperatures and precipitation, as well as variability and extremes. see below:

(and see climate stressors described in ADAPTool – drought, excess moisture, heat, flooding, seal level rise.

- Climate change will result in increased management complexity, business costs, and uncertainty. BC farmers will have to deal with impacts such as rising water tables, soil salinity, limited water supplies, lower productivity and quality of crops and livestock, drought, excess moisture, flood risk, and increases in pests and diseases.
- There will also be an increase in growing days and opportunities for new crops.

Adaptation to climate change is a priority for the ministry and the industry.

- Successful adaptation to climate change will be necessary for the agriculture industry to continue to grow and be an important contributor to the BC economy.

Ministry role to help that adaptation.

1. Introduction and background

Comment [MIPA4]:

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1.1. Provincial policy

The Province of British Columbia adopted and published a Climate Change Adaptation Strategy in 2010. One of the three foundational commitments in this strategy was to "make adaptation a part of the Government's business, ensuring that climate change impacts are considered in planning and decision-making across government." This includes:

- Incorporating adaptation into Ministry Service Plans and business planning, where relevant;
- Integrating adaptation into policies, legislation and regulations;
- Considering climate change impacts and adaptation when drafting new or amending existing legislation.[1]

1.2. Ministry of Agriculture actions and commitments

In 2013, the Ministry commissioned a study of 14 ~~of~~ program areas to assess their adaptability to changing climate conditions in the province. This study was led by the

[1] Ministry of Environment, Feb 2010. British Columbia's Adaptation Strategy.

International Institute for Sustainable Development, with funding support from Natural Resources Canada, using the innovative Adaptive Design and Assessment Policy Tool (ADAPTool). The study included consultations with all the subject program areas, and results were discussed and shared with them. The ministry has committed to developing a strategic plan to implement recommendations from this assessment in order to mainstream adaptation in relevant program actions.[2]

s.13

1.3. Growing Forward 2

The five-year GF2 agreement for British Columbia coordinates federal and provincial funding to the agriculture and agri-foods sector to help producers and processors to become more competitive and innovative. GF2 provides funding for the Climate Action Initiative coordinated by the BC Agriculture Council, which undertakes regional scale assessments of climate change risks and opportunities. This initiative also supports farm-level adaptation pilot projects together with other stakeholder organizations, through the Farm Adaptation Innovator Fund.

1.4. Purpose of this Climate Adaptation Sstrategy

The purpose of this strategy is to provide guidance to the Innovation and Adaptation Services Branch in coordinating the ministry's implementation of the B.C. ~~provincial~~ climate change adaptation strategy~~Climate Change Adaptation Strategy and~~ ensuring that ministry programs consider the effects of climate change, using available resources and emerging information. The strategy also contains and action plan for implementation of the recommendations of the ADAPTool assessment.

Comment [MIPA7]: This should not be abbreviated as CAS, as this already refers to Climate Action Secretariat.

1.5. Approach to strategy and content of this report

Comment [MIPA8]: General comment throughout: use more bullets in the format, rather than paragraphs

The starting point for this study was the 2013 ADAPTool Assessment, and its conclusions about program adaptability. These are summarized below, and presented in Annex 1. With these considerations in mind, the consultants interviewed program leads to determine whether there had been any significant changes in the program since 2013 that might affect how the program responded to climate change issues. We also consulted with organizations outside the Mministry to explore what kinds of new information about climate adaptation are being generated in the agriculture sector. With the benefit of this additional information, an opportunity matrix was constructed to identify programs that were already ~~engaged in~~ mainstreaming climate adaptation into their work, and those where significant new opportunities for mainstreaming could be identified. These issues and opportunities are presented in sSection 2 of this report.

Comment [MIPA9]: List them in text or footnote, e.g. CAI, FBC

Comment [MIPA10]: Ensure the correct section reference

The ~~Climate Adaptation~~ strategy ~~is~~ developed around a common set of tools or mechanisms which are applied to issues / approaches ~~that are~~ tailored to each program area. This ~~strategy~~ will allow the ministry to implement its climate policy commitments by capitalizing on emerging opportunities. The strategy is presented in Ssection 3. The

[2] Ministry of Agriculture, May 30, 2014. Carbon Neutral Action Report Overview.

final section of this report discusses implementation issues, with a focus on monitoring progress. Supporting documents are presented in ~~the~~ Annex 1 and Annex 2. ~~es.~~

Comment [MIPA11]: And/or reframe as "opportunities" or "considerations"?

2. Summary of Adaptation Issues and Opportunities

Comment [MIPA12]: Kayleigh – insert annex 1 at page 2

2.1. ADAPTool Assessment and Update

Comment [MIPA13]: Insert somewhere or attach as an annex, the recommendations from ADAPTool

The results of the ADAPTool Assessment[3] of 1~~4~~3 programs showed that agricultural producers in B.C. who face increased risks as a result of climate change will receive broad indirect support from this suite of programs already. The main interest ~~concern~~ of the assessment was the ability of programs to meet their programmatic and policy goals under conditions where climate change will affect the behaviour of producers and the demands on the program. Several of the programs were rated as highly adaptive, that is they provide good support to producers to adapt to *anticipated* climate change to maintain competitiveness, but they also are designed in a way that is likely to be responsive even to *unanticipated* climate-related stresses. These include the Range Management program in the Ministry of Forestry, Lands, and Natural Resource Operations (FLNRO), the Environmental Farm Plan and Beneficial Management Practices programs, Agri-Food Business Development and the *Water Act* development activities in the Ministry of Environment. The Agriculture Water Management program also provides services for the agriculture sector that are likely to prove increasingly valuable for local governments and water supply authorities as the B.C. climate changes.

The ADAPTool assessment found that other programs are potentially less adaptable to climate change. This means that the structure of the programs, or the nature of the services provided, is likely to be stressed under conditions of increasing climate variability and greater frequency of extreme climate events that affect the agriculture sector. Business Risk Management programs are likely to be affected by increasing climate risks, but the nature of potential impacts is difficult to assess without careful modelling and monitoring. Similarly, ~~when the province can expect~~ more frequent and severe extreme climate events will affect the ~~, the~~ Agricultural Emergency Management program ~~will also be affected~~. The program is already looking at more attention to preparedness as well as response, but as climate risks change, producer options for reducing risk from climate emergencies may need further consideration. In addition, the province's Pest Management / Plant Health and Invasive Alien Plants programs can expect to see increased incidence of both familiar and new types of threats to productive agro-ecosystems as ecological conditions change. The specific changes and the nature of threats will be difficult to predict, and may require additional resources for surveillance, monitoring and research.

s.13

Comment [MIPA15]: Delete? This is FLNRO program, not our ministry

[3] Pilot Application Adaptive Design and Assessment Policy Tool (ADAPTool) Government of British Columbia Agriculture Programs. Dec 2013.

Other programs examined were moderately adaptable in their current configurations, offering some support to adaptation measures by producers, and more or less responsive to changing climate stresses by virtue of program design and management. s.13

While this cClimate aAdaptation sstrategy ~~document~~ covers all the Ministry program areas selected for the ADAPTool assessment (i.e. those judged as having some potential vulnerability and relevance to climate change), the main focus is on those programs assessed as potentially most vulnerable / least adaptable to climate change. s.13

2.2. Opportunities to support integration of climate adaptation into programs

The starting point for this strategy is an overview of emerging opportunities ~~that are likely to generate~~ and new insights on climate adaptation that are ~~that would be~~ relevant to Ministry programs. These opportunities are of four main types:

- 1. studies and pilot projects on climate adaptation measures specifically for the agriculture sector that provide new information and experience that can be incorporated into Ministry programming;
- 2. innovative practices introduced as a result of local, regional or provincial initiatives;
- 3. climate related studies that may not specifically address agricultural activities but whose conclusions have important implications for agriculture; and
- 4. planned changes, revisions, or regular reviews of Ministry programming.

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New information on climate change and adaptation potential provided through recent studies or innovation efforts should be considered in programming decisions together with awareness of how climate risks interact with other business risks to affect producers. Potential opportunities for these linkages to current programs are summarized in the table in Annex 1. The most important of these are described in more detail below:

Comment [MIPA18]: Kayleigh suggested moving that table to here.

2.2.1. B.C. Agriculture and Food Climate Action Initiative

The Climate Action Initiative (CAI) was established in 2008 by the B.C. Agriculture Council, supported by the B.C. Agricultural Research and Development Corporation and the Investment Agriculture Foundation, with funding from Agriculture and Agrifood Canada and the B.C. Ministry of Agriculture under the Growing Forward program. The CAI develops tools and resources to enhance the ability of agricultural producers to adapt to climate change. The CAI released the *BC Agriculture Climate Change Action Plan* in 2010, and then produced six regional *Adaptation Risk and Opportunity Assessments*, published in 2012. Since 2013 CAI has been working on regional adaptation strategies and farm-level adaptation innovations.[4]

Comment [MIPA19]: They are sticky here about the periods in B.C.

2.2.1.1. Regional Agricultural Adaptation: studies of climate impacts and adaptation requirements have been undertaken in the Cowichan, Peace, Delta, and Cariboo regions. The Fraser Valley process is underway, and ~~with~~ work is planned for Okanagan in 2015. ~~two more~~

[4] The CAI is delivering the Ministry's climate change adaptation program, funded under Growing Forward 2.

~~regions to be identified in 2015~~. Once regional adaptation strategies are prepared, local partners become eligible for funding of implementation projects aligned with identified key actions prioritized by a local working group and the CAI. ~~research and farm adaptation innovator pilot projects.~~

2.2.1.2. Farm Adaptation Innovator Program ~~Pilot~~: Provides funding for piloting and demonstrating ~~tests~~ innovative farm-level adaptation practices that would ~~adaptation innovations for~~ help producers to improve~~d~~ productivity and competitiveness under changing climate conditions. Key considerations are cost-effectiveness~~,~~ and feasibility in on-farm application. The program also funds communication of results and sharing of lessons through industry associations, networks and farmer field schools on-site.

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The Ministry of Agriculture has partnered closely with the CAI since 2008~~its inception~~. Staff from Ministry programs and regional offices ~~have~~ played key advisory roles in the regional risk and opportunity assessments~~,~~ and in subsequent ~~CAI~~ Regional Adaptation Strategies and Farm Adaptation Innovator Fund p~~P~~rojects, together with industry partners from the BC Agriculture Council and local ~~regional~~ producer groups.

- To ~~In order to~~ meet Growing Forward 2 ~~GF2~~ objectives of strengthening competitiveness and innovation in the agriculture sector, M~~m~~inistry programs should incorporate the results of CAI efforts for their own programming, both in terms of identifying the implications of regional climate risks and considering how to factor in those sectoral adaptation responses shown to be effective.

Comment [MIPA21]: They are sticky on spelling it out in documents

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2.2.2. Fraser Basin Council Lower Mainland flood management study:~~.~~
The Fraser Basin Council is undertaking a comprehensive study of changing flood risks in the L~~l~~ower M~~m~~ainland. This is a major project involving all three ~~3~~ levels of government that will shape planning and investment measures for flood hazard in the lower mainland for the coming decades. Phase 1 of the project, which includes vulnerability assessment and management recommendations based on climate change and flood scenarios, will be completed by the end of 2015.

- As the L~~l~~ower Fraser Valley is the region of B.C. with the highest value agricultural production, the implications of this study should be of interest to th~~e~~is sector and are likely to interact with various ~~dimensions of~~ Ministry programs.

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2.2.3. Pacific Climate Impacts Consortium (PCIC)

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PCIC is a research group ~~based~~ at the University of Victoria that produces regional climate information for British Columbia and the Yukon, including specialized studies for specific groups or clients. Climate scientists at PCIC are actively involved in testing and downscaling global climate models (GCMs), linking climate and hydrological models for surface water management purposes and interpreting results for a variety of user groups. Recent work on projecting climate extremes may

be particularly useful for the Ministry because agricultural impacts are likely to be felt first through extreme events, e.g. drought, flood, heat stress (see Murdock and Sobie, 2013 as an example).

- PCIC climate projections are used extensively by CAI for their regional planning studies, but some studies generated by PCIC may be directly relevant to programming.

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2.2.4. *Water Sustainability Act* implementation measures

B.C.'s ~~The~~ *Water Sustainability Act* was approved in 2014 and includes a variety of new provisions for regulating groundwater use, protecting environmental flows, and for broad regulatory authority to implement Water Sustainability Plans (WSPs) that could override provisions in other legislation.

- As detailed regulations are being developed, and as various local and regional bodies become involved in developing WSPs, the implications for the agriculture sector and for specific Ministry programs should be actively explored.

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2.2.5. Growing Forward 3

In 2015 ~~the coming months,~~ federal and provincial preparations are ~~will get~~ underway for negotiating the next round of five-year ~~of~~ joint funding for agricultural programs. The reviews, background studies, reports and discussions linked to this strategy ~~this process~~ provide a good opportunity for considering the role that responding to climate risk will play in the sector's innovation and competitiveness agenda. Preparatory work will ensure that these provisions are appropriately considered in the context of a broader agenda.

Comment [MIPA23]: Is this what you mean?

Comment [MIPA24]: I don't quite understand this sentence.

NOTE TO STEPHEN: By the time we finalize this document we may be able to also align with the ministry service plan (proposed performance measure on # of regional strategies completed) and also with AgriFoods Strategy 2 (under development) which has actions to do regional and farm level adaptation. Finally, we may also be able to align with or allude to a climate action plan 2 that CAS may develop. Selma Lowe is a contact, as well as her manager Denis Paradine.

3. Strategy C~~c~~omponents

3.1. Approach:

This section is guided by the broad policy goal of Growing Forward 2; specifically "it is the basis for coordinated, cost-shared programs to help the sector become more competitive and innovative"., ~~namely to promote sustainable management of natural resources along the entire value chain to support competitiveness of the agriculture and agrifood industry in B.C.~~ Integrating climate change adaptation into Ministry of Agriculture sector programming will support resource management by improving adaptability of production systems and practices to changing environmental conditions, and will strengthen competitiveness by ensuring that business operations in this sector are better able to adopt innovative practices~~,~~ and identify and manage climate risks.

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It is proposed that ~~in~~ ~~The Ministry's approach to~~ integrating climate adaptation into its programs, the Ministry will ~~will be opportunistic,~~ build ~~ing~~ on anticipated program changes and updating opportunities that are expected to take place anyway, such as the future transition to Growing Forward 3. ~~GF3.~~ The proposed strategies will be synergistic, complementing or supplementing other programming initiatives. None of the programs are currently designed specifically to focus on climate change: they have other objectives and priorities reflecting central issues in the agriculture sector ~~in B.C~~. However, climate change is directly relevant to several programs and is already considered in some Ministry programs. ~~It should be emphasized that m~~Many elements of this strategy link as much as possible with actions already seen as a priority by program areas, ~~e proposed strategy are likely to take place anyway to some degree,~~ as Ministry staff keep informed of innovations and new information relevant to their own work. ~~TIn that sense,~~ This strategy is not primarily an attempt to define new and additional measures, but a way to make many existing opportunities and activities explicit so that resulting lessons can be formalized and better tracked to enhance program learning and demonstrate policy coherence.

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Comment [MIPA27]: Can this be made clearer?

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The purpose of this strategy is therefore not to introduce additional programming responsibilities or mandates, but rather to ensure that current programs remain effective and responsive to producer interests as climate risks change and producers respond to these. Climate adaptation strategies will be supported by the Innovation and Adaptation Services Branch climate action team, but will be driven by program leads and integrated into ongoing programming in a manner and schedule determined largely by the program areas ~~s~~ themselves.

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3.2. Integrating climate adaptation into Ministry programming

3.2.1. Why and How should Climate Change Adaptation be integrated into other programming?

Climate and weather risks are an inherent part of agricultural production, and producers have long sought to deal with those risks through innovations in crop varieties or production technologies and management practices. ~~Because c~~Climate variability is central to producer behaviour and business competitiveness.~~,~~ ~~t~~The implications of increasing climate variability, and of accelerating climate change, are important for strategic and operational decision making, ~~and~~ investment in agricultural production and agri-food processing and distribution at local, regional and ~~even~~ global scales.

Climate adaptation is ~~essentially~~ an issue of innovation and learning that will affect most players in the B.C. agriculture and agri-food sector. ~~to a greater or lesser extent.~~ Therefore a central element of integrating climate adaptation in Ministry programs is to recognize and support effective learning mechanisms. There are a number of climate adaptation initiatives closely linked to the agriculture and agri-food sector that are already underway. A key part of this ~~the~~ Ministry's c~~C~~limate a~~A~~daptation strategy is ~~should be~~ to strengthen linkages and learning mechanisms that can capture lessons from these initiatives. Program

staff in the Ministry of Agriculture should be able to integrate new information and experience about climate risks in ongoing program management and implementation.

The Ministry has already demonstrated ~~the~~ strong capacity to adapt and learn from experience in other areas ~~already~~. One example is its experience with avian influenza in the Fraser Valley, in which the 2008-9 outbreak in the L~~l~~ower M~~m~~ainland provided lessons that were applied to better control and manage the recent 2014 episode, e.g. through better spatial analysis, communications protocols and clarification of inter-agency roles and responsibilities.

Some learning ~~lessons~~ can be done through shared ~~transferred through~~ documentation, but learning also means sharing of experience and testing of assumptions through face-to-face interaction and field visits. Learning is best structured as a two-way (or multi-directional) exchange recognizing that different participants hold various kinds of knowledge ~~that is~~ relevant to decisions to manage climate risks in production and processing. Learning relies on evidence and new information, but also on communication.

This strategy proposes five ~~several~~ mechanisms for strengthening learning and communication about climate impacts and adaptation within the Ministry in order to integrate these into programming:

- 1. a~~A~~daptation contact group
- 2. a~~A~~daptation Dialogues
- 3. informational b~~B~~riefs and ~~/~~ digests highlighting recent lessons for programs
- 4. f~~F~~ield visits
- 5. s~~S~~upport to Regional Agrologists

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3.2.2. Adaptation Contact Group

As the Ministry moves forward with integrating climate adaptation into its ongoing programming, support from the Innovation and Adaptation Services Branch will be crucial to sustaining and encouraging program-based initiatives. ~~But w~~While adaptation is relevant to many of the Ministry's programs, and some programs are already ~~well engaged in~~ considering climate factors in their work, it would be helpful if the appropriate contacts were clearly identified ~~is not always clear to the IAB Adaptation Manager who within each program is the best contact~~ for providing support or updat~~es~~ing on recent external activities of relevance. In addition, it would be beneficial if ~~is often not clear to other~~ program~~s~~ areas could see how adaptation has been successfully integrated into some operational tasks already, and ~~there could be~~ benefit~~s~~ from sharing adaptation experience between different program areas or regions. For these purposes, it would be helpful to have an informal Adaptation Contact Group within the Ministry, with representation from each of the relevant programs.

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The main role of the contact group would be information sharing, serving as an entry point for ~~to~~ program or regional colleagues to identify relevant emerging climate opportunities or learnings~~ssons~~. At the regional or programmatic level, the contact person should be somebody with an interest in the topic and with working networks of Ministry colleagues. The intent is not to deliver a high volume of email or ~~to attempt to circulate~~ external links and ~~or~~ references on~~to~~ climate change, ~~of which there are no end. The point of the group is~~ but rather to focus on Ministry business, and new local adaptation studies and practices of direct relevance to programming, policy ~~analysis~~, federal-provincial engagement ~~negotiations~~ or inter-agency coordination. Content relevance should be high, and volume light. Membership in ~~of~~ this group would be up to each unit to determine, and could include program leads~~,~~ or designated expert staff, as well as staff who have a particular interest in the subject matter. Climate change will not be relevant to all programs, but those that may be affected should be members of this group. The group would be coordinated by the Ministry's climate action team. ~~IAB Adaptation Manager.~~ While there would be ~~There should be~~ no ~~need for~~ regular meetings, ~~but~~ the establishment ~~existence~~ of ~~a~~ designated contacts would make it easier ~~for the Adaptation Manager~~ to consult quickly on specific issues or opportunities. ~~with the relevant programs or regional units.~~

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3.2.3. Adaptation Dialogue Sessions~~s~~

The programs areas know their own context best, but they may not appreciate the interacting risks of accelerating climate change. A learning-oriented dialogue session provides a constructive format for introducing new knowledge based on recent studies or practices, identifying opportunities and discussing the potential for appropriate responses, or for additional monitoring, detailed studies or support mechanisms. The learning dialogue mechanism should be facilitated and led by the climate action team~~Innovation and Adaptation Branch~~, in response to program agendas and priorities. We would anticipate two or three of these per year as opportunities present themselves.

Preparation for an adaptation dialogue session will involve identification of a candidate program and a relevant topic for which new information has become available as a result of recent studies or practice. A climate change topic may be brought forward by the program, or by the climate action team~~IAB~~. With the ongoing work of CAI, ~~W~~we anticipate many opportunities in the coming two ~~2~~ years ~~with the ongoing work of CAI~~ to discuss and present recent results of interest to various programs, but other opportunities may also arise. ~~(see specific examples above).~~ For example, results from the CAI pilot project in the Peace Region to undertake c~~C~~ollaborative m~~M~~onitoring for pests, disease, weeds and invasive species ~~pilot project in the Peace region~~ may be of interest to the Pest Management / Plant Health group. ~~within the Ministry~~.

A detailed proposed outline for a typical adaptation dialogue is shown in Annex 2, as a guide to preparation and delivery of this learning tool. A key part of each dialogue will be the presentation of new information from a recent study or

practice, typically by an expert familiar with theat work whothat can comment and respond to questions.

3.2.4. Briefs / Digests of Kkey iinformation

The climate action team IAB Adaptation Manager already closely tracks activities of CAI and related initiatives fairly closely. We suggest that key results of potential programmatic interest should be summarized by the climate action team in conjunction with IAB, a regional agrologist and or interested program staff, in a simple two2-page format, with an emphasis on the possible implications for program areas. Each summary would focus on a single issue or project. It is anticipated that One could anticipate perhaps 4 or 5 of these could to be generated each year, mostly by IAB. The summary should conclude with two or three 2 or 3 discussion questions that could form the basis of a voluntary conference call discussion between interested respondents. These two 2-page briefs would be circulated broadly within the Ministry through using the aAdaptation cContacts gGroupin the first instance, and a follow-up conference call with those interested could be scheduled for sometime within about two 2 weeks of circulation. The follow-up discussions would review the content of the brief, providing a bit more detail about the project, and respond to any questions if possible, then focus on discussion of potential implications. CAI or other experts may or may not join the call, depending on availability. This mechanism is intended to flag interesting issues for additional follow-up. For example, if a particular project generates results of interest to one or more programs, but also generates a number of detailed questions, the climate action team IAB could use the specific issues raised and the particular aspects of interest to plan an aAdaptation dDialogue session that could brings in relevant expertise and allows for more substantive interaction.

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3.2.5. Field Vvisits

Field visits to consider new practices or climate impacts can be very effective learning tools, particularly if they involve producers and producer organizations as well as other stakeholders such as local government. These not only demonstrate practical issues, but allow discussion and interaction among the participants. For example, inspection of new drainage approaches could help illustrate the importance not only of on-site, farm-based measures for producers, but also of improved land use planning and municipal infrastructure management. The Adaptation Contact Group could provide a mechanism for informing colleagues of field visit opportunities and outcomes. Field visits will be developed as opportunities arise, largely opportunistic, and in particular will be coordinated with but through better communication and coordination, events scheduled by CAI or other organizations. can be shared and brought to the attention of key program staff.

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3.2.6. Key Catalytic Role of Regional Agrologists

All of these mechanisms should include an important role for regional agrologists, who are frequently the key Ministry partners for local and regional CAI initiatives,

and on the front lines of interaction with producers. The agroloists are often characterized as the "eyes and ears" of the Ministry. As active participants and advisors in CAI projects, they are well placed to critically review insights arising from these experiences about how current programming supports or constrains the implementation and replication of regional strategies and pilot experiences. These insights should ~~to~~ be exchanged with program leads and technical staff as appropriate. Key assumptions in fulfilling this potential communications and learning role are:

- regional agrologists are supported with time and resources to both engage in CAI and other adaptation initiatives and to review experiences with each other and with Ministry colleagues;
- program staff can create opportunities for interaction (preferably face-to-face) with regional agrologists to discuss relevant programming issues.

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These interaction opportunities are pre-requisites for effective learning and capitalizing on the potential role of regional agrologists in fostering the Ministry's innovation agenda. At a minimum this implies explicit management level recognition of the strategic and facilitative role played by regional agrologists in integrating adaptation into programming. This role could be supported through leveraging resources for:

- ~~R~~regular interaction between regional agrologists, the climate action team~~IAB manager for climate change~~, and CAI staff to update on project results and issues (e.g. conference call or face-to-face meeting for all, twice a year);
- ~~O~~opportunistic meetings between regional agrologists and program leads around specific regional or commodity-based program related issues flagged through these interactions;
- ~~R~~regional a~~A~~grologist participation in Adaptation Dialogues with program staff and external adaptation resource persons.

Note: see the matrix – does it summarize all these initiatives and who does what and why and intended benefit?

3.3. Sources of Knowledge and Innovation to be applied using these tools

Comment [MIPA32]: This section could be put in an annex??? It does repeat some of what has already been said.

The learning tools described above are the mechanisms through which the Ministry's Climate Adaptation Strategy will be implemented. This section describes some of the substantive content that could be delivered through these mechanisms. This list flags some of the sources of innovation related to climate adaptation that will have direct bearing on Ministry programs.

3.3.1. Learning from the Climate Action Initiative:
CAI has a high profile throughout the Ministry, and most program staff are aware of its work. Despite this, there has been limited attention to the lessons coming out of CAI, and the potential implications these have for programming. This is

partly because as adaptation strategies and projects are developed, the focus of CAI effort shifts to a smaller scale. Adaptation measures are ~~invariably local, because they are~~ specific to particular local contexts and therefore may ~~. Therefore they often~~ drop below the radar~~, so to speak, for~~ of provincial programs.

CAI's focus on adaptation strategies and pilot implementation provides crucial input for regional and larger scale programming by testing innovations at a small scale and building experience and knowledge of practitioners in context. But the rich lessons gained at the local level, through both technical monitoring and anecdotal experience, are difficult to capture at larger scales. Two strategic measures should be adopted to simplify this learning:

- ~~T~~the climate action team ~~IAB~~ should review CAI regional strategies and pilot project documentation as these become available and, together with other interested Ministry staff, develop a series of Program Briefs on specific topics that identify key insights and potential implications for programming. Each of these could serve as a basis for a voluntary one-hour conference call "brown bag" type discussion;
- ~~T~~the climate action team ~~IAB~~ should lead Adaptation Dialogue sessions to engage program staff in different locations with the insights coming out of CAI and other opportunities described above~~.~~;
- Ministry staff at the regional / program level should be made aware of CAI field sessions and field-oriented workshops where project results are demonstrated. These sessions may be linked to Program Briefs or Adaptation Dialogue sessions on the same or closely related topics.

Comment [MIPA33]: These are the same briefs you are talking about above, in 3.2.4, right?

In addition to CAI insights on climate adaptation measures and their relation to other ~~Ministry~~ programs of the Ministry, CAI methodologies, such as small group planning and structured focus group discussions, may be relevant for Ministry programs, such as EMP, as these shift to similar delivery approaches. Mechanisms for dialogue and shared learning could be applied for these methodological lessons as well.

Comment [MIPA34]: Say this more plainly

3.3.2. Assessment of new information and new practices, including planning and institutional changes

Climate change in B.C. is likely to lead, over time, to greater conflicts over water use; to more frequent and severe flooding in vulnerable areas; increased frequency and intensity of wildfires, especially in the southern Interior; and to more frequent and intense drought events in the southern part of the province, among other impacts. These all have implications for agricultural management practices, and the adoption of measures that can reduce risk to producers. But many of the adaptation responses to these changing risks are led outside ~~of~~ the Ministry of Agriculture, in the Ministries of Environment, FLNRO, or in multi-agency initiatives. In order for agricultural producers to adapt effectively to these

risks, and for the Ministry to coordinate and support the interests of the agricultural sector in multi-agency initiatives, it will be important for Ministry programs and staff to be well aware of emerging practices to respond to these issues, often led by other agencies. This section reviews some specific examples, but other similar issues may also arise in coming years.

The new *Water Sustainability Act* will take effect through development of regulations in the Ministry of Environment and through local multi-stakeholder planning processes. The Act creates new Water Sustainability Plans that can be developed by local governments or watershed management organizations, and could influence water allocations, extraction, groundwater pumping and other aspects of water management. These Plans are also now required to consider minimum flow requirements for aquatic ecosystems and habitat protection. These provisions may over-ride other legislative provisions including land use designations. While the Ministry of Agriculture has developed ~~improved~~ its capacity to model agricultural water use through the Water Management Program, and is well positioned to provide input for modelling water use, it is not yet clear how agricultural interests and land uses may be affected in these new planning processes. Monitoring and learning from such processes as they are introduced in agricultural watersheds will provide important opportunities to identify potential opportunities for program responses.

There is widespread recognition of increasing flood risks in many parts of the province, but these risks may be most serious in the Lower Fraser Valley ~~River~~ due to changing precipitation and hydrology regimes, and in the Fraser Delta as a result of the combined effects of river flow, sea level rise and storm surge. Local, provincial and federal governments are all likely to be involved in response measures because of the high value of urban land uses, strategic infrastructure such as highways, ports and rail lines, and the high cost and limited effectiveness of protective measures such as dikes. Inevitably, flood management interventions in the lower Fraser basin will involve trade-offs and recognition that some areas currently occupied and in use will not be defensible against ~~in the case of~~ extreme flooding. There are implications ~~here~~ for risk reduction strategies, from improving drainage infrastructure to livestock protection, farm building design and siting, and evacuation routes. These kinds of risk reduction measures may need to be incorporated into advisory services in vulnerable areas. ~~In order t~~To keep abreast of the changing flood management and planning context, Ministry staff should monitor planning processes led by other agencies, and be prepared to discuss implications for programming.

Similarly, the province has a draft wildfire management plan intended to build wildfire adapted communities and resilient forest and range ecosystems. The plan does not explicitly address agricultural areas adjacent to forested lands, or rangeland areas that are actively grazed. However, it anticipates that all vulnerable communities will undertake mapping and wildfire risk assessment, and within 10 years will adopt bylaws, zoning and development permits and

FireSmart implementation plans (https://www.firesmartcanada.ca). This could include requirements for forest management on private property as well as community-level interventions. Fuel management, evacuation route planning, structure design and construction, and access to water or fire response resources are all relevant considerations for agricultural producers in affected areas (FLNRO 2014). However, these measures only address the direct risks of fire damage and loss of property or livestock. An important related risk is that of damage to high-value crops from atmospheric smoke due to regional fires[5], which might best be addressed through insurance coverage rather than emergency preparedness. ~~In any case, t~~These issues represent another example of issues which are likely to increase in importance for agricultural producers, and where innovative local responses need to be monitored by the Ministry.

A final example is the province's Drought Management Plan, which requires local responses based on coordination and regulation at the provincial and federal levels. The Ministry of Agriculture will contribute to an inter-agency working group in the event of drought through coordinating technical inputs, regional staff engagement and linkages to industry and AAFC. In particular, the Ministry will be responsible for information/ guidance to producers to prepare for drought conditions, and to update Ministry policies and plans for drought response. Local governments will enforce provincial regulations, which for severe or extreme drought conditions will include restrictions on agricultural water use. In the event of a drought, the Ministry is expected to be prepared with detailed water conservation advice, guidelines and information materials for producers that may need to be updated. Most droughts take some time for onset, during which preparatory measures, such as reducing water extraction and prioritizing irrigation schedules, are gradually increased. Preparatory and technical lessons for risk reduction and water conservation in drought prone areas provide another example of where the Ministry will benefit from greater awareness of innovations, including planning practices, that may be led by other agencies.

3.3.3. Building resilience to uncertain impacts

A key issue with climate change is growing ~~that~~ uncertainty ~~is increasing~~. Seasonal variability (temperature, precipitation, growing season) is increasing. In different regions, extreme weather will occur more frequently, such as ~~seems to be getting more extreme:~~ heat waves, drought, violent storms, heavy rain or snow. Producers can deal with this by becoming more resilient – more able to adjust quickly to changing conditions and recover rapidly from unexpected events without catastrophic damage. Resilience is not the same ~~thing~~ as becoming more efficient. Efficiency means reducing redundancy, optimizing choices, increasing output through specialization. But resilience requires redundancy, diversity and flexibility. For example, ….. While details depend on the specific context, producer decisions that increase efficiency may reduce resilience and increase

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[5] Experience of Australian grape producers described here: http://www.trust.org/item/20150107205810-bm9pm/?source=shem

risks in a context of climate change. These are the kinds of issues that Ministry programs should be considering in relation to their own work, but they are not issues that have simple, checklist-style responses. They require discussion and expertise in the context of new information and producer experience.

3.4. Program specific strategies

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This section reviews potential strategies and opportunities to strengthen the integration of climate adaptation in each of the programs assessed in the ADAPTool study. These strategies will be implemented by the respective programs, with support from the climate action team ~~Adaptation Manager~~ as appropriate, using mechanisms such as those identified above or others better suited to the needs and resources of the program. The initial measures proposed here respond to opportunities already identified (see table in Annex 1) and should be relatively easy to implement.

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3.4.1. Agricultural Emergency Management

Disasters such as wildfires and flooding are likely to become more frequent and to have increasing impact on agricultural producers in different regions of the province. Risk reduction measures may be linked to planning at the farm or community level, and tied to EMP / BMP. The program has had discussions with CAI already about several projects: Flooding Preparedness and Mitigation in Delta (DL07), Extreme Weather Events Preparedness in Cowichan (CW04) and Wildfire Preparedness and Mitigation in the Cariboo (CB01). As these projects are completed in 2016, they could serve as the basis for a facilitated Adaptation Dialogue session with CAI to get beyond the content of reports, and to reflect on key learnings and replicable options. In the meantime, the program should follow the progress of the Fraser Basin Council's Lower Mainland Flood Management project.

3.4.2. Pest Management and Plant Health

Climate change is likely to lead to an expanded range for some pests and pathogens, as well as the introduction of new pests, as warmer winter conditions and higher moisture in spring and fall in many parts of B.C. create new opportunities that insects and pathogens will take advantage of. However, pest ecology is complex and difficult to model or predict. This suggests the potential value of improved monitoring and surveillance for key agricultural regions / crops. CAI's early experience (1 season) with Collaborative Monitoring in the Peace region may be instructive here. Consultation with AAFC would also be appropriate.

3.4.3. Production Insurance

To come

[Production Insurance: define ToRs for appropriate study / define data requirements and suggest data be organized for convenient period in order to

address this. To be drafted after further discussions with BRM program staff in Kelowna.]

3.4.4. Strengthening Farming

Both components of this program area likely to be affected by climate change. Water management is likely to be an early issue. Increased runoff and frequency of extreme events will probably lead to diverging interests, between urban communities and nearby agricultural areas. Issues of drainage and flood discharge; dike protection and flood retention areas; and risk reduction or planning all involve interaction between adjacent urban and rural areas.

Many of the program's current tools and procedures will be directly relevant in these situations. The program can assist in bringing together local government bodies and producers to gain agreement on what the issues are in order to develop solution strategies that may involve senior levels of government. The Agriculture Advisory Committees serve as an important source of intelligence on emerging issues. The program is already familiar with tools such as land use inventory and GIS, but may need to add applications that deal specifically with flood retention and runoff management in land use planning applications. Potential issues for consideration include emerging subdivision guidelines and stormwater runoff guidelines that rely more heavily on "green infrastructure"; wildfire protection planning; and Water Sustainability Plans.

3.4.5. Regional Agrologist Networks

As discussed above, regional agrologists have a key role to play in the Ministry's adaptation strategy because they are a vital link between programs and producers. Many are already engaged with CAI projects as members of the project advisory committees. They are well placed to provide critical and practical reviews of project lessons, and to interpret ways that other Ministry programs enable or constrain local adaptation actions. For these reasons the Ministry's adaptation strategy should seek opportunities to channel additional support and resources to regional agrologists to enable them to fulfill this important learning and advisory role.

3.4.6. Environmental Farm Plans and Beneficial Management Practices

These programs emphasize planning and practices for managing environmental risk to improve sustainability of agricultural practices. They already consider climate risks but need to be sensitive to how these are changing. These include flood risks, runoff and soil erosion, heat waves and drought protection measures. In all cases, the emphasis should be on risk reduction, both on individual farms and in agricultural communities where risks are affected by action on adjacent lands. Consideration should also be given to extending financial support to investments that reduce climate risks under this program in environmentally sustainable ways, e.g. funding for reservoir construction / inspection; funding for erosion management / levelling; agroforestry for slope stabilization, riparian integrity, and wetland protection and retention., etc. These programs already

Comment [MIPA41]: Do you mean a farm level water storage reservoir?

interact with CAI and could maximize their benefits from relevant projects through the proposed Adaptation Dialogues and other interactive learning tools. In particular, they are monitoring projects in the Cowichan Vvalley: Business case for regional agriculture extension services (CW03), and Integrated Farm Water planning Project (CW06).

Comment [MIPA42]: Include the full list of CAI projects as an appendix – see spreadsheet that Ian has from Emily.

3.4.7. Agriculture Water Management Program

The Water Management Program has implemented ADAPTool recommendations by expanding its services into new regions. It provides modelling support to agricultural water demand estimates, which are likely to become more widespread as local governments and water management organizations introduce Water Sustainability Plans under the new *Water Act*. This program is highly specialized, and provides analytical support to water management in agriculture, so it is already oriented to climate issues and adaptation. The program should keep informed of CAI project results that relate to water use, such as weather monitoring and support tools, and potential for irrigation in the Peace Region (PC05 and PC06). At the same time, drainage and flooding issues are also relevant to water demand modelling, and the program is already aware of the CAI work in Delta on drainage issues. As new planning processes are implemented for water management, AWMP will be particularly attentive to how issues of data sharing can be addressed to build confidence and trust between agencies while safeguarding privacy. Another issue for potential future consideration is that as water use efficiency increases, there is less scope for reductions in use under severe drought conditions. This has implications for provincial drought management responses in the agricultural sector.

Comment [MIPA43]: Again, have the list of CAI projects as a reference

3.4.8. Agroforestry

The Agroforestry program is small but already strongly oriented to climate adaptation. There is clear recognition already that agroforestry can contribute to landscape and ecosystem management to improve climate buffers, reduce erosion, manage runoff and modify extreme temperatures at a site level. The program is already structured to foster engagement, learning and support to regional colleagues and producer organizations, and in this respect may serve as a model for other groups. However, its potential impact is limited due to its small size. Changing climate projections, flooding and drainage projects, and changing water management planning may all have implications for agroforestry.

Comment [MIPA44]: See Adaptool recommendations

3.4.9. Agrifood Business Development

This program is already responsive to local producer and business priorities, so is well placed to identify emerging priorities as climate risks become more important to producers. But ~~at the moment~~ the program does not currently explicitly identify changing climate factors and how these would be likely to influence risk management or market opportunities. Increasing precipitation in spring and fall seasons in various regions could create challenges for harvesting, storage and processing of produce. At the same time, warmer, drier summers in many regions may create new market opportunities in B.C. at the same time as

production declines in other areas (e.g. California). The CAI project investigating enhanced local processing and storage in the Cowichan Valley, now complete, may be a helpful starting point.

3.5. Gaps and issues remaining where there seem to be few immediate opportunities to inform program activities [more elaboration needed here]

3.5.1. Production Insurance:
not obvious whether there are issues here or not. As it is likely to be examined by other provinces, would be wise to have some analysis in BC in preparation for GF3 negotiations. [this depends on results from BRM discussions]

3.5.2. AgriStability:
no action needed at this time. Program structure is deliberately standardized, rather than responsive to varying regional conditions. There is a logical case to be made that climate change could lead to greater variability in farm-gate revenue, which might point to greater demand for the program. But climate change is only one of many factors affecting producer revenues. These factors tend to interact in complex ways, and the program does not track the causes of farm income fluctuations. If variability increases and producer incomes trend downwards, the most appropriate response would be to encourage producers to adapt to new conditions, rather than increase stabilization payments.

3.5.3. Potential to commission specific studies:
may require additional funding (perhaps next round of CAI).

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4. Implementation and Monitoring

[to be elaborated]

4.1. Monitoring

The Innovation and Adaptation Services Branch should be able to report on ways in which Ministry programs have adjusted their approach or activities in order to incorporate climate change into their regular programming. In order to do this, some level of monitoring will be important, but it should not require special reporting just for this purpose.

4.1.1. Program level monitoring approach
participation in CAI events and followup tracked
Producer innovation to respond to increasing climate variability (i.e. adaptation measures)
Program identification of relevant climate risks

4.1.2. Ministry level monitoring and reporting
Activity level: Strategy implementation activities recommended above can be reported directly: number of program dialogue sessions held; program briefs produced; studies commissioned; programming followup measures identified as a result of learning opportunities.

Outcome level: examples of program integration of adaptation measures (these will mostly be obvious from staff interactions, but IAB should try to document these);

4.2. ADAPTool assessment repeated – 2017-18 (after GF3 in place, with a view to 2020 targets)
- Refine producer adaptation measures
- Identify changes in program recognition and response
- Include CAI: contributions to adaptive capacity as well as adaptation measures
- Learning mechanisms of programs
- Sensitivity of program itself to climate change

References

BC adaptation strategy

Hopefully we can add ministry service plan and Agrifoods strategy 2.

McLeman, R., & Smit, B. (2006). Vulnerability to climate change hazards and risks: Crop and flood insurance. *Canadian Geographer, 50*(2), 217-226.

Ministry of Forestry, Lands and Natural Resource Operations. *Climate Change Adaptation Action Plan for Wildfire Management, 2014-2024.* April 2014. http://docs.openinfo.gov.bc.ca/d63519414a_response_package_fnr-2014-00274.pdf

Murdock, T.Q. and Sobie, S. 2013. *Climate Extremes in the Canadian Columbia Basin: a Preliminary Assessment.* Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 52 pp. http://www.pacificclimate.org/sites/default/files/publications/Climate_Extremes_in_the_Canadian_Columbia_Basin-CBT_Report.pdf

Hamdi, Rhiannon MTIC:EX

From: McLachlan, Ian P AGRI:EX
Sent: Thursday, April 16, 2015 12:25 PM
Subject: BCTS docs are still internal RE: FOR REVIEW draft Ministry climate adaptation strategy (for April 24)

Hi everyone – I have discussed with FLNRO and found out that the BCTS documents that I attached below are still internal to government at this point, and have not yet been publicly released – so please do not distribute them externally.

Cheers, Ian

From: McLachlan, Ian P AGRI:EX
Sent: Wednesday, April 15, 2015 3:09 PM
To: Bartle, Gregory AGRI:EX; Hughes-Games, Geoff AGRI:EX; Trotter, David B AGRI:EX; MacDonald, Leslie S AGRI:EX; Tegart, Greg AGRI:EX; Barclay, Brent S. AGRI:EX; Schmidt, Orlando AGRI:EX; Hueppelsheuser, Tracy AGRI:EX; Jesperson, Gayle AGRI:EX; Halm, Grant AGRI:EX; Tam, Stephanie AGRI:EX
Cc: Falk, Gary AGRI:EX; Pritchard, Jane AGRI:EX; Nickel, Ken AGRI:EX; Thompson, Grant AGRI:EX; Stemberger, Anna AGRI:EX; Haycroft, Carly AGRI:EX
Subject: FOR REVIEW draft Ministry climate adaptation strategy (for April 24)

Hi everyone

Attached for review is the draft Ministry of Agriculture Climate Adaptation Strategy prepared by adaptation specialist Stephen Tyler. Most of you will have had discussion with Stephen and/or his colleague Kari Hansen Tyler. As described in my email of Sept 12 (below), the strategy is a deliverable for the deputy minister that must be signed off with the Carbon Neutral Action Report in mid/late May.
<< File: Climate_Adaptation_Strategy-review draft-14April2015.docx >>
Based on discussions with program areas, actions identified here are meant to align with your priorities and mostly to be feasible to initiate in the short term with current resources. Outside of this document, we can continue to have discussions about other actions that may require further resourcing and funding if opportunities arise.

A key focus of the strategy is collaborative knowledge sharing and capacity building, especially through more linkages between program staff and the work of the B.C. Agriculture and Food Climate Action Initiative (CAI). The CAI is delivering the GF2 industry-led climate adaptation programming and has many projects that will deliver relevant results over the next 1 – 3 years.
http://www.bcagclimateaction.ca/

FLNRO is doing a similar exercise, in which business areas are developing plans to integrate climate action into their work. I have attached the recently released climate action plan for B.C. Timber Sales in case you are interested.
<< File: BCTS Climate Change action plan_action table_Tier 1_Feb 03.pdf >> << File: BCTS Climate Change Action Plan_Feb 03.pdf >>
In reviewing the attached Ministry adaptation strategy:

- sections specific to your programs are clearly labelled (see exec summary Table 1, Section 3.3, and opportunity matrix Table 2 on p. 26)
- other references to your programs can be found by searching the document for the program name
- please look at the actions for your area and confirm or revise the wording
- start to think about what the next steps would be for implementing the actions

Note that the Premier announced on April 13 that B.C. will develop a new Climate Action Plan over the next few months. This will be a major interagency initiative with involvement of all sectors, including agriculture. The plan will likely include a focus on adaptation.
http://www2.news.gov.bc.ca/news_releases_2013-2017/2015PREM0022-000491.pdf

I will be in touch with each of you individually to discuss the strategy.

Our target for comments is **Friday, April 24**. This timing is required for us to meet the deadline of DM signoff in mid-May. Please respond to me and cc Anna.

Contact Anna or me anytime if you have questions or want to discuss.

Thanks, Ian

Ian McLachlan | Manager, Climate Action | (250) 356-1852
Innovation and Adaptation Services Branch – Ministry of Agriculture

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From: McLachlan, Ian P AGRI:EX
Sent: Friday, September 12, 2014 10:38 PM
To: van Dalfsen, Bert AGRI:EX; Hughes-Games, Geoff AGRI:EX; Trotter, David B AGRI:EX; MacDonald, Leslie S AGRI:EX; Barclay, Brent S. AGRI:EX; Schmidt, Orlando AGRI:EX; Hueppelsheuser, Tracy AGRI:EX; Jesperson, Gayle AGRI:EX; Halm, Grant AGRI:EX; DeBoer, Pat AGRI:EX; Tam, Stephanie AGRI:EX
Cc: Coney, David AGRI:EX; Donahue, Kayleigh AGRI:EX; 'Stephen Tyler'; 'kari@adaptiverm.ca'
Subject: NEXT STEPS implementation of BC ADAPTool report recommendations

Hi everyone

We now have the opportunity to develop the next steps to build on the ADAPTool assessment process and final report you contributed to last year.

In the attached Carbon Neutral Action Report (May 28) submitted for government reporting, DM Derek Sturko has committed that:

- *"The Ministry will build on the ADAPTool assessments by developing an action plan for implementing the priority recommendations. Implementation of the recommendations will support the ministry in planning for climate change.*

Following this, we have engaged Stephen Tyler and Kari Tyler of Adaptive Resource Management to:

- develop a strategy for implementing priority actions from the ADAPTool assessment
- get started on implementation in areas where there is interest and support already
- identify opportunities for programs to build their capacity to integrate adaptation into ongoing work

This work is being timed to provide input into strategic thinking about the funding and design of ministry programs in GF3.

Stephen or Kari will be in touch with you in the coming weeks. In advance of that discussion, it would be great if you could review the ADAPTool final report sections on your respective programs and consider action steps that could be taken to move forward with the recommendations. The focus will be on how to align those recommendations with actions you know will be beneficial for your programs.
http://www.iisd.org/pdf/2014/adaptool_bc_ag.pdf

Please contact me if you want to discuss beforehand.

Thanks again for your engagement last year and now on implementation.

Cheers, Ian

Ian McLachlan | Manager, Climate Action | (250) 356-1852
Innovation and Adaptation Services Branch – Ministry of Agriculture

<< File: CNAR Overview 2013 - FINAL - signed by DM - 28 May 2014.pdf >>

Hamdi, Rhiannon MTIC:EX

From: McLachlan, Ian P AGRI:EX
Sent: Wednesday, February 11, 2015 10:40 AM
To: Pouliotte, Jennifer ENV:EX
Subject: FW: Comments on Climate Adaptation Strategy
Attachments: strategy v2 first draft - 19 Jan 2015_Carly.docx; strategy v2 ANNEX draft 1 - 19 Jan 2015_Ian.docx; strategy v2 ANNEX2 draft 1 - 19 Jan 2015_Ian.docx

Follow Up Flag: Follow up
Flag Status: Completed

Hi Jen

Just wondering if you could give me your thoughts on this. s.22 s.22 and one of the main deliverables is a climate adaptation strategy for the ministry that builds on the ADAPTool recommendations as well as new dialogue. Attached is the track changes version of our comments on his first draft (very much a first draft intentionally). Stephen will be turning around another draft soon, and I wanted to get your thoughts so he can integrate them. We see this as a document that will be public.

Feb 24/25 we will be in Abbotsford for "adaptation dialogues" with Emergency Management and Plant Health. Emily will be there too.

Cheers, Ian

From: McLachlan, Ian P AGRI:EX
Sent: Tuesday, February 3, 2015 11:35 PM
To: 'Stephen Tyler'
Cc: Haycroft, Carly AGRI:EX; Romero, Jenny AGRI:EX
Subject: Comments on Climate Adaptation Strategy

Hi Stephen

Thanks for this draft of the strategy. I have made comments and edits throughout in track changes. In addition, here are some general or reinforced comments:

1. The DM commitment is for an action plan for implementing the priority recommendations of the ADAPTool report, so that needs to be in there. Specific actions, timelines, deliverables, accountabilities.

2. The Implementation and Monitoring section is very key and needs to be developed. I liked the way they did it in the CAI RAS documents – e.g. see p. 30 of Cariboo strategy.

3. Add info from the attached CAI update into the strategy as an appendix (let me know if you want Carly or me to create that appendix).

4. Have an exec summary upfront with key elements.

5. Make 3.3 an annex and pull the existing Annex 1 into the front section as a table.

6. Can any graphics be used to illustrate key points, e.g. the structure of the adaptation contact group.

The next step would be to turn around a new draft, run it by me and Carly quickly, then send to program leads and Emily/Samantha for comment before finalizing (and letting them know it is a DM deliverable).

We will have the benefit of the first two adaptation dialogues to perhaps inform the final version of the strategy.

Let me know if you want to have a call to go over these comments.

Cheers, Ian

Ministry of Agriculture
Climate Adaptation Strategy
DRAFT report (incomplete)
Jan 16, 2015

Comment [MIPA1]: Turn this into a title page

Comment [MIPA2]: And add executive summary that includes action list and highlights the ones for the coming year

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Have some context upfront about 1) climate stressors, 2) agricultural effects, and 3) the need for producer adaptive action. e.g. changes in temperatures and precipitation, as well as variability and extremes. see below:

(and see climate stressors described in ADAPTool – drought, excess moisture, heat, flooding, seal level rise.

- Climate change will result in increased management complexity, business costs, and uncertainty. BC farmers will have to deal with impacts such as rising water tables, soil salinity, limited water supplies, lower productivity and quality of crops and livestock, drought, excess moisture, flood risk, and increases in pests and diseases.
- There will also be an increase in growing days and opportunities for new crops.

Adaptation to climate change is a priority for the ministry and the industry.

- Successful adaptation to climate change will be necessary for the agriculture industry to continue to grow and be an important contributor to the BC economy.

Ministry role to help that adaptation.

1. Introduction and background

Comment [MIPA4]:

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1.1. Provincial policy

The Province of British Columbia adopted and published a Climate Change Adaptation Strategy in 2010. One of the three foundational commitments in this strategy was to "make adaptation a part of the Government's business, ensuring that climate change impacts are considered in planning and decision-making across government." This includes:

- Incorporating adaptation into Ministry Service Plans and business planning, where relevant;
- Integrating adaptation into policies, legislation and regulations;
- Considering climate change impacts and adaptation when drafting new or amending existing legislation.[1]

1.2. Ministry of Agriculture actions and commitments

In 2013, the Ministry commissioned a study of 14 ~~of~~ program areas to assess their adaptability to changing climate conditions in the province. This study was led by the

[1] Ministry of Environment, Feb 2010. British Columbia's Adaptation Strategy.

International Institute for Sustainable Development, with funding support from Natural Resources Canada, using the innovative Adaptive Design and Assessment Policy Tool (ADAPTool). The study included consultations with all the subject program areas, and results were discussed and shared with them. The ministry has committed to developing a strategic plan to implement recommendations from this assessment in order to mainstream adaptation in relevant program actions.[2]

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1.3. Growing Forward 2

The five-year GF2 agreement for British Columbia coordinates federal and provincial funding to the agriculture and agri-foods sector to help producers and processors to become more competitive and innovative. GF2 provides funding for the Climate Action Initiative coordinated by the BC Agriculture Council, which undertakes regional scale assessments of climate change risks and opportunities. This initiative also supports farm-level adaptation pilot projects together with other stakeholder organizations, through the Farm Adaptation Innovator Fund.

1.4. Purpose of this Climate Adaptation Sstrategy

The purpose of this strategy is to provide guidance to the Innovation and Adaptation Services Branch in coordinating the ministry's implementation of the B.C. ~~provincial climate change adaptation strategy~~~~Climate Change Adaptation Strategy and~~ ensuring that ministry programs consider the effects of climate change, using available resources and emerging information. The strategy also contains and action plan for implementation of the recommendations of the ADAPTool assessment.

Comment [MIPA7]: This should not be abbreviated as CAS, as this already refers to Climate Action Secretariat.

1.5. Approach to strategy and content of this report

The starting point for this study was the 2013 ADAPTool Assessment, and its conclusions about program adaptability. These are summarized below, and presented in Annex 1. With these considerations in mind, the consultants interviewed program leads to determine whether there had been any significant changes in the program since 2013 that might affect how the program responded to climate change issues. We also consulted with organizations outside the Mministry to explore what kinds of new information about climate adaptation are being generated in the agriculture sector. With the benefit of this additional information, an opportunity matrix was constructed to identify programs that were already ~~engaged in~~ mainstreaming climate adaptation into their work, and those where significant new opportunities for mainstreaming could be identified. These issues and opportunities are presented in ~~s~~Section 2 of this report.

Comment [MIPA8]: General comment throughout: use more bullets in the format, rather than paragraphs

Comment [MIPA9]: List them in text or footnote, e.g. CAI, FBC

Comment [MIPA10]: Ensure the correct section reference

The ~~Climate Adaptation~~ strategy ~~is~~ developed around a common set of tools or mechanisms which are applied to issues / approaches ~~that are~~ tailored to each program area. This ~~strategy~~ will allow the ministry to implement its climate policy commitments by capitalizing on emerging opportunities. The strategy is presented in ~~S~~section 3. The

[2] Ministry of Agriculture, May 30, 2014. Carbon Neutral Action Report Overview.

final section of this report discusses implementation issues, with a focus on monitoring progress. Supporting documents are presented in ~~the~~ Annex 1 and Annex 2. ~~es.~~

2. Summary of Adaptation Issues and Opportunities

2.1. ADAPTool Assessment and Update

The results of the ADAPTool Assessment[3] of 1~~4~~3 programs showed that agricultural producers in B.C. who face increased risks as a result of climate change will receive broad indirect support from this suite of programs already. The main interest ~~concern~~ of the assessment was the ability of programs to meet their programmatic and policy goals under conditions where climate change will affect the behaviour of producers and the demands on the program. Several of the programs were rated as highly adaptive, that is they provide good support to producers to adapt to *anticipated* climate change to maintain competitiveness, but they also are designed in a way that is likely to be responsive even to *unanticipated* climate-related stresses. These include the Range Management program in the Ministry of Forestry, Lands, and Natural Resource Operations (FLNRO), the Environmental Farm Plan and Beneficial Management Practices programs, Agri-Food Business Development and the *Water Act* development activities in the Ministry of Environment. The Agriculture Water Management program also provides services for the agriculture sector that are likely to prove increasingly valuable for local governments and water supply authorities as the B.C. climate changes.

The ADAPTool assessment found that other programs are potentially less adaptable to climate change. This means that the structure of the programs, or the nature of the services provided, is likely to be stressed under conditions of increasing climate variability and greater frequency of extreme climate events that affect the agriculture sector. Business Risk Management programs are likely to be affected by increasing climate risks, but the nature of potential impacts is difficult to assess without careful modelling and monitoring. Similarly, ~~when the province can expect~~ more frequent and severe extreme climate events will affect the ~~, the~~ Agricultural Emergency Management program ~~will also be affected~~. The program is already looking at more attention to preparedness as well as response, but as climate risks change, producer options for reducing risk from climate emergencies may need further consideration. In addition, the province's Pest Management / Plant Health and Invasive Alien Plants programs can expect to see increased incidence of both familiar and new types of threats to productive agro-ecosystems as ecological conditions change. The specific changes and the nature of threats will be difficult to predict, and may require additional resources for surveillance, monitoring and research.

[3] Pilot Application Adaptive Design and Assessment Policy Tool (ADAPTool) Government of British Columbia Agriculture Programs. Dec 2013.

Comment [MIPA11]: And/or reframe as "opportunities" or "considerations"?

Comment [MIPA12]: Kayleigh – insert annex 1 at page 2

Comment [MIPA13]: Insert somewhere or attach as an annex, the recommendations from ADAPTool

s.13

Comment [MIPA15]: Delete? This is FLNRO program, not our ministry

Other programs examined were moderately adaptable in their current configurations, offering some support to adaptation measures by producers, and more or less responsive to changing climate stresses by virtue of program design and management.

While this cClimate aAdaptation sstrategy ~~document~~ covers all the Ministry program areas selected for the ADAPTool assessment (i.e. those judged as having some potential vulnerability and relevance to climate change), the main focus is on those programs assessed as potentially most vulnerable / least adaptable to climate change.

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2.2. Opportunities to support integration of climate adaptation into programs

The starting point for this strategy is an overview of emerging opportunities ~~that are likely to generate~~ and new insights on climate adaptation that are ~~that would be~~ relevant to Ministry programs. These opportunities are of four main types:

- 1. studies and pilot projects on climate adaptation measures specifically for the agriculture sector that provide new information and experience that can be incorporated into Ministry programming;
- 2. innovative practices introduced as a result of local, regional or provincial initiatives;
- 3. climate related studies that may not specifically address agricultural activities but whose conclusions have important implications for agriculture; and
- 4. planned changes, revisions, or regular reviews of Ministry programming.

New information on climate change and adaptation potential provided through recent studies or innovation efforts should be considered in programming decisions together with awareness of how climate risks interact with other business risks to affect producers. Potential opportunities for these linkages to current programs are summarized in the table in Annex 1. The most important of these are described in more detail below:

2.2.1. B.C. Agriculture and Food Climate Action Initiative

The Climate Action Initiative (CAI) was established in 2008 by the B.C. Agriculture Council, supported by the B.C. Agricultural Research and Development Corporation and the Investment Agriculture Foundation, with funding from Agriculture and Agrifood Canada and the B.C. Ministry of Agriculture under the Growing Forward program. The CAI develops tools and resources to enhance the ability of agricultural producers to adapt to climate change. The CAI released the *BC Agriculture Climate Change Action Plan* in 2010, and then produced six regional *Adaptation Risk and Opportunity Assessments*, published in 2012. Since 2013 CAI has been working on regional adaptation strategies and farm-level adaptation innovations.[4]

2.2.1.1. Regional Agricultural Adaptation: studies of climate impacts and adaptation requirements have been undertaken in the Cowichan, Peace, Delta, and Cariboo regions. The Fraser Valley process is underway, and ~~with~~ work is planned for Okanagan in 2015. ~~two more~~

[4] The CAI is delivering the Ministry's climate change adaptation program, funded under Growing Forward 2.

Comment [MIPA16]: Also summarize the 4 key gaps – see ADAPTool exec summary

Formatted: Numbered + Level: 1 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0.63 cm + Indent at: 1.27 cm

Comment [MIPA18]: Kayleigh suggested moving that table to here.

Comment [MIPA19]: They are sticky here about the periods in B.C.

regions to be identified in 2015. Once regional adaptation strategies are prepared, local partners become eligible for funding of implementation projects aligned with identified key actions prioritized by a local working group and the CAI. research and farm adaptation innovator pilot projects.

2.2.1.2. Farm Adaptation Innovator Program Pilot: Provides funding for piloting and demonstrating tests innovative farm-level adaptation practices that would adaptation innovations for help producers to improved productivity and competitiveness under changing climate conditions. Key considerations are cost-effectiveness, and feasibility in on-farm application. The program also funds communication of results and sharing of lessons through industry associations, networks and farmer field schools on-site.

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The Ministry of Agriculture has partnered closely with the CAI since 2008its inception. Staff from Ministry programs and regional offices have played key advisory roles in the regional risk and opportunity assessments, and in subsequent CAI Regional Adaptation Strategies and Farm Adaptation Innovator Fund pProjects, together with industry partners from the BC Agriculture Council and local regional producer groups.

- To In order to meet Growing Forward 2 GF2 objectives of strengthening competitiveness and innovation in the agriculture sector, Mministry programs should incorporate the results of CAI efforts for their own programming, both in terms of identifying the implications of regional climate risks and considering how to factor in those sectoral adaptation responses shown to be effective.

Comment [MIPA21]: They are sticky on spelling it out in documents

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2.2.2. Fraser Basin Council Lower Mainland flood management study:

The Fraser Basin Council is undertaking a comprehensive study of changing flood risks in the Llower Mmainland. This is a major project involving all three 3 levels of government that will shape planning and investment measures for flood hazard in the lower mainland for the coming decades. Phase 1 of the project, which includes vulnerability assessment and management recommendations based on climate change and flood scenarios, will be completed by the end of 2015.

- As the Llower Fraser Valley is the region of B.C. with the highest value agricultural production, the implications of this study should be of interest to theis sector and are likely to interact with various dimensions of Ministry programs.

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2.2.3. Pacific Climate Impacts Consortium (PCIC)

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PCIC is a research group based at the University of Victoria that produces regional climate information for British Columbia and the Yukon, including specialized studies for specific groups or clients. Climate scientists at PCIC are actively involved in testing and downscaling global climate models (GCMs), linking climate and hydrological models for surface water management purposes and interpreting results for a variety of user groups. Recent work on projecting climate extremes may

be particularly useful for the Ministry because agricultural impacts are likely to be felt first through extreme events, e.g. drought, flood, heat stress (see Murdock and Sobie, 2013 as an example).

- PCIC climate projections are used extensively by CAI for their regional planning studies, but some studies generated by PCIC may be directly relevant to programming.

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2.2.4. *Water Sustainability Act* implementation measures

B.C.'s ~~The~~ *Water Sustainability Act* was approved in 2014 and includes a variety of new provisions for regulating groundwater use, protecting environmental flows, and for broad regulatory authority to implement Water Sustainability Plans (WSPs) that could override provisions in other legislation.

- As detailed regulations are being developed, and as various local and regional bodies become involved in developing WSPs, the implications for the agriculture sector and for specific Ministry programs should be actively explored.

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2.2.5. Growing Forward 3

In 2015 ~~the coming months,~~ federal and provincial preparations are ~~will get~~ underway for negotiating the next round of five-year ~~of~~ joint funding for agricultural programs. The reviews, background studies, reports and discussions linked to this strategy ~~this process~~ provide a good opportunity for considering the role that responding to climate risk will play in the sector's innovation and competitiveness agenda. Preparatory work will ensure that these provisions are appropriately considered in the context of a broader agenda.

Comment [MIPA23]: Is this what you mean?

Comment [MIPA24]: I don't quite understand this sentence.

NOTE TO STEPHEN: By the time we finalize this document we may be able to also align with the ministry service plan (proposed performance measure on # of regional strategies completed) and also with AgriFoods Strategy 2 (under development) which has actions to do regional and farm level adaptation. Finally, we may also be able to align with or allude to a climate action plan 2 that CAS may develop. Selma Lowe is a contact, as well as her manager Denis Paradine.

3. Strategy C~~c~~omponents

3.1. Approach:

This section is guided by the broad policy goal of Growing Forward 2; specifically "it is the basis for coordinated, cost-shared programs to help the sector become more competitive and innovative"., ~~namely to promote sustainable management of natural resources along the entire value chain to support competitiveness of the agriculture and agrifood industry in B.C.~~ Integrating climate change adaptation into Ministry of Agriculture sector programming will support resource management by improving adaptability of production systems and practices to changing environmental conditions, and will strengthen competitiveness by ensuring that business operations in this sector are better able to adopt innovative practices~~,~~ and identify and manage climate risks.

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It is proposed that ~~in~~ ~~The Ministry's approach to~~ integrating climate adaptation into its programs, the Ministry will ~~will be opportunistic,~~ build ~~ing~~ on anticipated program changes and updating opportunities that are expected to take place anyway, such as the future transition to Growing Forward 3. ~~GF3.~~ The proposed strategies will be synergistic, complementing or supplementing other programming initiatives. None of the programs are currently designed specifically to focus on climate change: they have other objectives and priorities reflecting central issues in the agriculture sector ~~in B.C~~. However, climate change is directly relevant to several programs and is already considered in some Ministry programs. ~~It should be emphasized that m~~Many elements of this strategy link as much as possible with actions already seen as a priority by program areas, ~~e proposed strategy are likely to take place anyway to some degree,~~ as Ministry staff keep informed of innovations and new information relevant to their own work. ~~TIn that sense,~~ This strategy is not primarily an attempt to define new and additional measures, but a way to make many existing opportunities and activities explicit so that resulting lessons can be formalized and better tracked to enhance program learning and demonstrate policy coherence.

The purpose of this strategy is therefore not to introduce additional programming responsibilities or mandates, but rather to ensure that current programs remain effective and responsive to producer interests as climate risks change and producers respond to these. Climate adaptation strategies will be supported by the Innovation and Adaptation Services Branch climate action team, but will be driven by program leads and integrated into ongoing programming in a manner and schedule determined largely by the program areas ~~s~~ themselves.

3.2. Integrating climate adaptation into Ministry programming

3.2.1. Why and How should Climate Change Adaptation be integrated into other programming?

Climate and weather risks are an inherent part of agricultural production, and producers have long sought to deal with those risks through innovations in crop varieties or production technologies and management practices. ~~Because c~~Climate variability is central to producer behaviour and business competitiveness., ~~t~~The implications of increasing climate variability, and of accelerating climate change, are important for strategic and operational decision making, ~~and~~ investment in agricultural production and agri-food processing and distribution at local, regional and ~~even~~ global scales.

Climate adaptation is ~~essentially~~ an issue of innovation and learning that will affect most players in the B.C. agriculture and agri-food sector. ~~to a greater or lesser extent.~~ Therefore a central element of integrating climate adaptation in Ministry programs is to recognize and support effective learning mechanisms. There are a number of climate adaptation initiatives closely linked to the agriculture and agri-food sector that are already underway. A key part of this ~~the~~ Ministry's ~~c~~Climate ~~a~~Adaptation strategy is ~~should be~~ to strengthen linkages and learning mechanisms that can capture lessons from these initiatives. Program

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Comment [MIPA27]: Can this be made clearer?

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staff in the Ministry of Agriculture should be able to integrate new information and experience about climate risks in ongoing program management and implementation.

The Ministry has already demonstrated ~~the~~ strong capacity to adapt and learn from experience in other areas ~~already~~. One example is its experience with avian influenza in the Fraser Valley, in which the 2008-9 outbreak in the Llower Mmainland provided lessons that were applied to better control and manage the recent 2014 episode, e.g. through better spatial analysis, communications protocols and clarification of inter-agency roles and responsibilities.

Some learning ~~lessons~~ can be done through shared ~~transferred through~~ documentation, but learning also means sharing of experience and testing of assumptions through face-to-face interaction and field visits. Learning is best structured as a two-way (or multi-directional) exchange recognizing that different participants hold various kinds of knowledge ~~that is~~ relevant to decisions to manage climate risks in production and processing. Learning relies on evidence and new information, but also on communication.

This strategy proposes five ~~several~~ mechanisms for strengthening learning and communication about climate impacts and adaptation within the Ministry in order to integrate these into programming:

- 1. aAdaptation contact group
- 2. aAdaptation Dialogues
- 3. informational bBriefs and /digests highlighting recent lessons for programs
- 4. fField visits
- 5. sSupport to Regional Agrologists

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3.2.2. Adaptation Contact Group

As the Ministry moves forward with integrating climate adaptation into its ongoing programming, support from the Innovation and Adaptation Services Branch will be crucial to sustaining and encouraging program-based initiatives. ~~But w~~While adaptation is relevant to many of the Ministry's programs, and some programs are already ~~well engaged in~~ considering climate factors in their work, it would be helpful if the appropriate contacts were clearly identified ~~is not always clear to the IAB Adaptation Manager who within each program is the best contact~~ for providing support or updatesing on recent external activities of relevance. In addition, it would be beneficial if ~~is often not clear to other~~ programs areas could see how adaptation has been successfully integrated into some operational tasks already, and ~~there could be~~ benefits from sharing adaptation experience between different program areas or regions. For these purposes, it would be helpful to have an informal Adaptation Contact Group within the Ministry, with representation from each of the relevant programs.

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The main role of the contact group would be information sharing, serving as an entry point for ~~to~~ program or regional colleagues to identify relevant emerging climate opportunities or learningss~~sons~~. At the regional or programmatic level, the contact person should be somebody with an interest in the topic and with working networks of Ministry colleagues. The intent is not to deliver a high volume of email or ~~to attempt to circulate~~ external links and ~~or~~ references on~~to~~ climate change, ~~of which there are no end. The point of the group is~~ but rather to focus on Ministry business, and new local adaptation studies and practices of direct relevance to programming, policy ~~analysis~~, federal-provincial engagement ~~negotiations~~ or inter-agency coordination. Content relevance should be high, and volume light. Membership in ~~of~~ this group would be up to each unit to determine, and could include program leads~~,~~ or designated expert staff, as well as staff who have a particular interest in the subject matter. Climate change will not be relevant to all programs, but those that may be affected should be members of this group. The group would be coordinated by the Ministry's climate action team. ~~IAB Adaptation Manager.~~ While there would be ~~There should be~~ no ~~need for~~ regular meetings, ~~but~~ the establishment ~~existence~~ of ~~a~~ designated contacts would make it easier ~~for the Adaptation Manager~~ to consult quickly on specific issues or opportunities. ~~with the relevant programs or regional units.~~

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3.2.3. Adaptation Dialogue Sessions~~s~~

The programs areas know their own context best, but they may not appreciate the interacting risks of accelerating climate change. A learning-oriented dialogue session provides a constructive format for introducing new knowledge based on recent studies or practices, identifying opportunities and discussing the potential for appropriate responses, or for additional monitoring, detailed studies or support mechanisms. The learning dialogue mechanism should be facilitated and led by the climate action team~~Innovation and Adaptation Branch~~, in response to program agendas and priorities. We would anticipate two or three of these per year as opportunities present themselves.

Preparation for an adaptation dialogue session will involve identification of a candidate program and a relevant topic for which new information has become available as a result of recent studies or practice. A climate change topic may be brought forward by the program, or by the climate action team~~IAB~~. With the ongoing work of CAI, ~~W~~we anticipate many opportunities in the coming two ~~2~~ ~~y~~ears ~~with the ongoing work of CAI~~ to discuss and present recent results of interest to various programs, but other opportunities may also arise. ~~(see specific examples above).~~ For example, results from the CAI pilot project in the Peace Region to undertake c~~C~~ollaborative m~~M~~onitoring for pests, disease, weeds and invasive species ~~pilot project in the Peace region~~ may be of interest to the Pest Management / Plant Health group. ~~within the Ministry~~.

A detailed proposed outline for a typical adaptation dialogue is shown in Annex 2, as a guide to preparation and delivery of this learning tool. A key part of each dialogue will be the presentation of new information from a recent study or

practice, typically by an expert familiar with theat work whothat can comment and respond to questions.

3.2.4. Briefs / Digests of Kkey iinformation

The climate action team IAB Adaptation Manager already closely tracks activities of CAI and related initiatives fairly closely. We suggest that key results of potential programmatic interest should be summarized by the climate action team in conjunction with IAB, a regional agrologist and or interested program staff, in a simple two2-page format, with an emphasis on the possible implications for program areas. Each summary would focus on a single issue or project. It is anticipated that One could anticipate perhaps 4 or 5 of these could to be generated each year, mostly by IAB. The summary should conclude with two or three 2 or 3 discussion questions that could form the basis of a voluntary conference call discussion between interested respondents. These two 2-page briefs would be circulated broadly within the Ministry through using the aAdaptation cContacts gGroupin the first instance, and a follow-up conference call with those interested could be scheduled for sometime within about two 2 weeks of circulation. The follow-up discussions would review the content of the brief, providing a bit more detail about the project, and respond to any questions if possible, then focus on discussion of potential implications. CAI or other experts may or may not join the call, depending on availability. This mechanism is intended to flag interesting issues for additional follow-up. For example, if a particular project generates results of interest to one or more programs, but also generates a number of detailed questions, the climate action team IAB could use the specific issues raised and the particular aspects of interest to plan an aAdaptation dDialogue session that could brings in relevant expertise and allows for more substantive interaction.

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3.2.5. Field Vvisits

Field visits to consider new practices or climate impacts can be very effective learning tools, particularly if they involve producers and producer organizations as well as other stakeholders such as local government. These not only demonstrate practical issues, but allow discussion and interaction among the participants. For example, inspection of new drainage approaches could help illustrate the importance not only of on-site, farm-based measures for producers, but also of improved land use planning and municipal infrastructure management. The Adaptation Contact Group could provide a mechanism for informing colleagues of field visit opportunities and outcomes. Field visits will be developed as opportunities arise, largely opportunistic, and in particular will be coordinated with but through better communication and coordination, events scheduled by CAI or other organizations. can be shared and brought to the attention of key program staff.

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3.2.6. Key Catalytic Role of Regional Agrologists

All of these mechanisms should include an important role for regional agrologists, who are frequently the key Ministry partners for local and regional CAI initiatives,

and on the front lines of interaction with producers. The agroloists are often characterized as the "eyes and ears" of the Ministry. As active participants and advisors in CAI projects, they are well placed to critically review insights arising from these experiences about how current programming supports or constrains the implementation and replication of regional strategies and pilot experiences. These insights should ~~to~~ be exchanged with program leads and technical staff as appropriate. Key assumptions in fulfilling this potential communications and learning role are:

- regional agrologists are supported with time and resources to both engage in CAI and other adaptation initiatives and to review experiences with each other and with Ministry colleagues;
- program staff can create opportunities for interaction (preferably face-to-face) with regional agrologists to discuss relevant programming issues.

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These interaction opportunities are pre-requisites for effective learning and capitalizing on the potential role of regional agrologists in fostering the Ministry's innovation agenda. At a minimum this implies explicit management level recognition of the strategic and facilitative role played by regional agrologists in integrating adaptation into programming. This role could be supported through leveraging resources for:

- ~~R~~regular interaction between regional agrologists, the climate action team~~IAB manager for climate change~~, and CAI staff to update on project results and issues (e.g. conference call or face-to-face meeting for all, twice a year);
- ~~O~~opportunistic meetings between regional agrologists and program leads around specific regional or commodity-based program related issues flagged through these interactions;
- ~~R~~regional a~~A~~grologist participation in Adaptation Dialogues with program staff and external adaptation resource persons.

Note: see the matrix – does it summarize all these initiatives and who does what and why and intended benefit?

3.3. Sources of Knowledge and Innovation to be applied using these tools

Comment [MIPA32]: This section could be put in an annex??? It does repeat some of what has already been said.

The learning tools described above are the mechanisms through which the Ministry's Climate Adaptation Strategy will be implemented. This section describes some of the substantive content that could be delivered through these mechanisms. This list flags some of the sources of innovation related to climate adaptation that will have direct bearing on Ministry programs.

3.3.1. Learning from the Climate Action Initiative:
CAI has a high profile throughout the Ministry, and most program staff are aware of its work. Despite this, there has been limited attention to the lessons coming out of CAI, and the potential implications these have for programming. This is

partly because as adaptation strategies and projects are developed, the focus of CAI effort shifts to a smaller scale. Adaptation measures are ~~invariably local, because they are~~ specific to particular local contexts and therefore may ~~. Therefore they often~~ drop below the radar~~, so to speak, for~~ of provincial programs.

CAI's focus on adaptation strategies and pilot implementation provides crucial input for regional and larger scale programming by testing innovations at a small scale and building experience and knowledge of practitioners in context. But the rich lessons gained at the local level, through both technical monitoring and anecdotal experience, are difficult to capture at larger scales. Two strategic measures should be adopted to simplify this learning:

- ~~T~~the climate action team ~~IAB~~ should review CAI regional strategies and pilot project documentation as these become available and, together with other interested Ministry staff, develop a series of Program Briefs on specific topics that identify key insights and potential implications for programming. Each of these could serve as a basis for a voluntary one-hour conference call "brown bag" type discussion;
- ~~T~~the climate action team ~~IAB~~ should lead Adaptation Dialogue sessions to engage program staff in different locations with the insights coming out of CAI and other opportunities described above~~.~~;
- Ministry staff at the regional / program level should be made aware of CAI field sessions and field-oriented workshops where project results are demonstrated. These sessions may be linked to Program Briefs or Adaptation Dialogue sessions on the same or closely related topics.

In addition to CAI insights on climate adaptation measures and their relation to other ~~Ministry~~ programs of the Ministry, CAI methodologies, such as small group planning and structured focus group discussions, may be relevant for Ministry programs, such as EMP, as these shift to similar delivery approaches. Mechanisms for dialogue and shared learning could be applied for these methodological lessons as well.

Comment [MIPA33]: These are the same briefs you are talking about above, in 3.2.4, right?

Comment [MIPA34]: Say this more plainly

3.3.2. Assessment of new information and new practices, including planning and institutional changes

Climate change in B.C. is likely to lead, over time, to greater conflicts over water use; to more frequent and severe flooding in vulnerable areas; increased frequency and intensity of wildfires, especially in the southern Interior; and to more frequent and intense drought events in the southern part of the province, among other impacts. These all have implications for agricultural management practices, and the adoption of measures that can reduce risk to producers. But many of the adaptation responses to these changing risks are led outside ~~of~~ the Ministry of Agriculture, in the Ministries of Environment, FLNRO, or in multi-agency initiatives. In order for agricultural producers to adapt effectively to these

risks, and for the Ministry to coordinate and support the interests of the agricultural sector in multi-agency initiatives, it will be important for Ministry programs and staff to be well aware of emerging practices to respond to these issues, often led by other agencies. This section reviews some specific examples, but other similar issues may also arise in coming years.

The new *Water Sustainability Act* will take effect through development of regulations in the Ministry of Environment and through local multi-stakeholder planning processes. The Act creates new Water Sustainability Plans that can be developed by local governments or watershed management organizations, and could influence water allocations, extraction, groundwater pumping and other aspects of water management. These Plans are also now required to consider minimum flow requirements for aquatic ecosystems and habitat protection. These provisions may over-ride other legislative provisions including land use designations. While the Ministry of Agriculture has developed ~~improved~~ its capacity to model agricultural water use through the Water Management Program, and is well positioned to provide input for modelling water use, it is not yet clear how agricultural interests and land uses may be affected in these ~~se~~ new planning processes. Monitoring and learning from such processes as they are introduced in agricultural watersheds will provide important opportunities to identify potential opportunities for program responses.

There is widespread recognition of increasing flood risks in many parts of the province, but these risks may be most serious in the Lower Fraser Valley ~~River~~ due to changing precipitation and hydrology regimes, and in the Fraser Delta as a result of the combined effects of river flow, sea level rise and storm surge. Local, provincial and federal governments are all likely to be involved in response measures because of the high value of urban land uses, strategic infrastructure such as highways, ports and rail lines, and the high cost and limited effectiveness of protective measures such as dikes. Inevitably, flood management interventions in the lower Fraser basin will involve trade-offs and recognition that some areas currently occupied and in use will not be defensible against ~~in the case of~~ extreme flooding. There are implications ~~here~~ for risk reduction strategies, from improving drainage infrastructure to livestock protection, farm building design and siting, and evacuation routes. These kinds of risk reduction measures may need to be incorporated into advisory services in vulnerable areas. ~~In order t~~To keep abreast of the changing flood management and planning context, Ministry staff should monitor planning processes led by other agencies, and be prepared to discuss implications for programming.

Similarly, the province has a draft wildfire management plan intended to build wildfire adapted communities and resilient forest and range ecosystems. The plan does not explicitly address agricultural areas adjacent to forested lands, or rangeland areas that are actively grazed. However, it anticipates that all vulnerable communities will undertake mapping and wildfire risk assessment, and within 10 years will adopt bylaws, zoning and development permits and

FireSmart implementation plans (https://www.firesmartcanada.ca). This could include requirements for forest management on private property as well as community-level interventions. Fuel management, evacuation route planning, structure design and construction, and access to water or fire response resources are all relevant considerations for agricultural producers in affected areas (FLNRO 2014). However, these measures only address the direct risks of fire damage and loss of property or livestock. An important related risk is that of damage to high-value crops from atmospheric smoke due to regional fires[5], which might best be addressed through insurance coverage rather than emergency preparedness. ~~In any case, t~~These issues represent another example of issues which are likely to increase in importance for agricultural producers, and where innovative local responses need to be monitored by the Ministry.

A final example is the province's Drought Management Plan, which requires local responses based on coordination and regulation at the provincial and federal levels. The Ministry of Agriculture will contribute to an inter-agency working group in the event of drought through coordinating technical inputs, regional staff engagement and linkages to industry and AAFC. In particular, the Ministry will be responsible for information/ guidance to producers to prepare for drought conditions, and to update Ministry policies and plans for drought response. Local governments will enforce provincial regulations, which for severe or extreme drought conditions will include restrictions on agricultural water use. In the event of a drought, the Ministry is expected to be prepared with detailed water conservation advice, guidelines and information materials for producers that may need to be updated. Most droughts take some time for onset, during which preparatory measures, such as reducing water extraction and prioritizing irrigation schedules, are gradually increased. Preparatory and technical lessons for risk reduction and water conservation in drought prone areas provide another example of where the Ministry will benefit from greater awareness of innovations, including planning practices, that may be led by other agencies.

3.3.3. Building resilience to uncertain impacts

A key issue with climate change is growing ~~that~~ uncertainty ~~is increasing~~. Seasonal variability (temperature, precipitation, growing season) is increasing. In different regions, extreme weather will occur more frequently, such as ~~seems to be getting more extreme:~~ heat waves, drought, violent storms, heavy rain or snow. Producers can deal with this by becoming more resilient – more able to adjust quickly to changing conditions and recover rapidly from unexpected events without catastrophic damage. Resilience is not the same ~~thing~~ as becoming more efficient. Efficiency means reducing redundancy, optimizing choices, increasing output through specialization. But resilience requires redundancy, diversity and flexibility. For example, ….. While details depend on the specific context, producer decisions that increase efficiency may reduce resilience and increase

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[5] Experience of Australian grape producers described here: http://www.trust.org/item/20150107205810-bm9pm/?source=shem

risks in a context of climate change. These are the kinds of issues that Ministry programs should be considering in relation to their own work, but they are not issues that have simple, checklist-style responses. They require discussion and expertise in the context of new information and producer experience.

3.4. Program specific strategies

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This section reviews potential strategies and opportunities to strengthen the integration of climate adaptation in each of the programs assessed in the ADAPTool study. These strategies will be implemented by the respective programs, with support from the climate action team ~~Adaptation Manager~~ as appropriate, using mechanisms such as those identified above or others better suited to the needs and resources of the program. The initial measures proposed here respond to opportunities already identified (see table in Annex 1) and should be relatively easy to implement.

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3.4.1. Agricultural Emergency Management

Disasters such as wildfires and flooding are likely to become more frequent and to have increasing impact on agricultural producers in different regions of the province. Risk reduction measures may be linked to planning at the farm or community level, and tied to EMP / BMP. The program has had discussions with CAI already about several projects: Flooding Preparedness and Mitigation in Delta (DL07), Extreme Weather Events Preparedness in Cowichan (CW04) and Wildfire Preparedness and Mitigation in the Cariboo (CB01). As these projects are completed in 2016, they could serve as the basis for a facilitated Adaptation Dialogue session with CAI to get beyond the content of reports, and to reflect on key learnings and replicable options. In the meantime, the program should follow the progress of the Fraser Basin Council's Lower Mainland Flood Management project.

3.4.2. Pest Management and Plant Health

Climate change is likely to lead to an expanded range for some pests and pathogens, as well as the introduction of new pests, as warmer winter conditions and higher moisture in spring and fall in many parts of B.C. create new opportunities that insects and pathogens will take advantage of. However, pest ecology is complex and difficult to model or predict. This suggests the potential value of improved monitoring and surveillance for key agricultural regions / crops. CAI's early experience (1 season) with Collaborative Monitoring in the Peace region may be instructive here. Consultation with AAFC would also be appropriate.

3.4.3. Production Insurance

To come

[Production Insurance: define ToRs for appropriate study / define data requirements and suggest data be organized for convenient period in order to

address this. To be drafted after further discussions with BRM program staff in Kelowna.]

3.4.4. Strengthening Farming

Both components of this program area likely to be affected by climate change. Water management is likely to be an early issue. Increased runoff and frequency of extreme events will probably lead to diverging interests, between urban communities and nearby agricultural areas. Issues of drainage and flood discharge; dike protection and flood retention areas; and risk reduction or planning all involve interaction between adjacent urban and rural areas.

Many of the program's current tools and procedures will be directly relevant in these situations. The program can assist in bringing together local government bodies and producers to gain agreement on what the issues are in order to develop solution strategies that may involve senior levels of government. The Agriculture Advisory Committees serve as an important source of intelligence on emerging issues. The program is already familiar with tools such as land use inventory and GIS, but may need to add applications that deal specifically with flood retention and runoff management in land use planning applications. Potential issues for consideration include emerging subdivision guidelines and stormwater runoff guidelines that rely more heavily on "green infrastructure"; wildfire protection planning; and Water Sustainability Plans.

3.4.5. Regional Agrologist Networks

As discussed above, regional agrologists have a key role to play in the Ministry's adaptation strategy because they are a vital link between programs and producers. Many are already engaged with CAI projects as members of the project advisory committees. They are well placed to provide critical and practical reviews of project lessons, and to interpret ways that other Ministry programs enable or constrain local adaptation actions. For these reasons the Ministry's adaptation strategy should seek opportunities to channel additional support and resources to regional agrologists to enable them to fulfill this important learning and advisory role.

3.4.6. Environmental Farm Plans and Beneficial Management Practices

These programs emphasize planning and practices for managing environmental risk to improve sustainability of agricultural practices. They already consider climate risks but need to be sensitive to how these are changing. These include flood risks, runoff and soil erosion, heat waves and drought protection measures. In all cases, the emphasis should be on risk reduction, both on individual farms and in agricultural communities where risks are affected by action on adjacent lands. Consideration should also be given to extending financial support to investments that reduce climate risks under this program in environmentally sustainable ways, e.g. funding for reservoir construction / inspection; funding for erosion management / levelling; agroforestry for slope stabilization, riparian integrity, and wetland protection and retention., etc. These programs already

Comment [MIPA41]: Do you mean a farm level water storage reservoir?

interact with CAI and could maximize their benefits from relevant projects through the proposed Adaptation Dialogues and other interactive learning tools. In particular, they are monitoring projects in the Cowichan Vvalley: Business case for regional agriculture extension services (CW03), and Integrated Farm Water planning Project (CW06).

3.4.7. Agriculture Water Management Program

The Water Management Program has implemented ADAPTool recommendations by expanding its services into new regions. It provides modelling support to agricultural water demand estimates, which are likely to become more widespread as local governments and water management organizations introduce Water Sustainability Plans under the new *Water Act*. This program is highly specialized, and provides analytical support to water management in agriculture, so it is already oriented to climate issues and adaptation. The program should keep informed of CAI project results that relate to water use, such as weather monitoring and support tools, and potential for irrigation in the Peace Region (PC05 and PC06). At the same time, drainage and flooding issues are also relevant to water demand modelling, and the program is already aware of the CAI work in Delta on drainage issues. As new planning processes are implemented for water management, AWMP will be particularly attentive to how issues of data sharing can be addressed to build confidence and trust between agencies while safeguarding privacy. Another issue for potential future consideration is that as water use efficiency increases, there is less scope for reductions in use under severe drought conditions. This has implications for provincial drought management responses in the agricultural sector.

3.4.8. Agroforestry

The Agroforestry program is small but already strongly oriented to climate adaptation. There is clear recognition already that agroforestry can contribute to landscape and ecosystem management to improve climate buffers, reduce erosion, manage runoff and modify extreme temperatures at a site level. The program is already structured to foster engagement, learning and support to regional colleagues and producer organizations, and in this respect may serve as a model for other groups. However, its potential impact is limited due to its small size. Changing climate projections, flooding and drainage projects, and changing water management planning may all have implications for agroforestry.

3.4.9. Agrifood Business Development

This program is already responsive to local producer and business priorities, so is well placed to identify emerging priorities as climate risks become more important to producers. But ~~at the moment~~ the program does not currently explicitly identify changing climate factors and how these would be likely to influence risk management or market opportunities. Increasing precipitation in spring and fall seasons in various regions could create challenges for harvesting, storage and processing of produce. At the same time, warmer, drier summers in many regions may create new market opportunities in B.C. at the same time as

Comment [MIPA42]: Include the full list of CAI projects as an appendix – see spreadsheet that Ian has from Emily.

Comment [MIPA43]: Again, have the list of CAI projects as a reference

Comment [MIPA44]: See Adaptool recommendations

production declines in other areas (e.g. California). The CAI project investigating enhanced local processing and storage in the Cowichan Valley, now complete, may be a helpful starting point.

3.5. **Gaps and issues remaining where there seem to be few immediate opportunities to inform program activities** [more elaboration needed here]

3.5.1. Production Insurance:
not obvious whether there are issues here or not. As it is likely to be examined by other provinces, would be wise to have some analysis in BC in preparation for GF3 negotiations. [this depends on results from BRM discussions]

3.5.2. AgriStability:
no action needed at this time. Program structure is deliberately standardized, rather than responsive to varying regional conditions. There is a logical case to be made that climate change could lead to greater variability in farm-gate revenue, which might point to greater demand for the program. But climate change is only one of many factors affecting producer revenues. These factors tend to interact in complex ways, and the program does not track the causes of farm income fluctuations. If variability increases and producer incomes trend downwards, the most appropriate response would be to encourage producers to adapt to new conditions, rather than increase stabilization payments.

3.5.3. Potential to commission specific studies:
may require additional funding (perhaps next round of CAI).

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4. Implementation and Monitoring

[to be elaborated]

4.1. Monitoring

The Innovation and Adaptation Services Branch should be able to report on ways in which Ministry programs have adjusted their approach or activities in order to incorporate climate change into their regular programming. In order to do this, some level of monitoring will be important, but it should not require special reporting just for this purpose.

4.1.1. Program level monitoring approach
participation in CAI events and followup tracked
Producer innovation to respond to increasing climate variability (i.e. adaptation measures)
Program identification of relevant climate risks

4.1.2. Ministry level monitoring and reporting
Activity level: Strategy implementation activities recommended above can be reported directly: number of program dialogue sessions held; program briefs produced; studies commissioned; programming followup measures identified as a result of learning opportunities.

Outcome level: examples of program integration of adaptation measures (these will mostly be obvious from staff interactions, but IAB should try to document these);

4.2. ADAPTool assessment repeated – 2017-18 (after GF3 in place, with a view to 2020 targets)
- Refine producer adaptation measures
- Identify changes in program recognition and response
- Include CAI: contributions to adaptive capacity as well as adaptation measures
- Learning mechanisms of programs
- Sensitivity of program itself to climate change

References

BC adaptation strategy

Hopefully we can add ministry service plan and Agrifoods strategy 2.

McLeman, R., & Smit, B. (2006). Vulnerability to climate change hazards and risks: Crop and flood insurance. *Canadian Geographer, 50*(2), 217-226.

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Murdock, T.Q. and Sobie, S. 2013. *Climate Extremes in the Canadian Columbia Basin: a Preliminary Assessment.* Pacific Climate Impacts Consortium, University of Victoria, Victoria, BC, 52 pp. http://www.pacificclimate.org/sites/default/files/publications/Climate_Extremes_in_the_Canadian_Columbia_Basin-CBT_Report.pdf

Annex 2 Min of Agriculture – Climate Adaptation Strategy
Adaptation Dialogue sessions

As part of its commitment to integrating climate change adaptation into all ministry programs, the Ministry of Agriculture will plan a series of informal, program-focused dialogues on the subject. We can foresee one of these events approximately each quarter, but the timing will be flexible to take advantage of other meeting opportunities and respond to program priorities.

Climate change is beginning to affect agricultural producers in B.C. and these effects are expected to accelerate. Do these changes affect your program? What issues do you see from the program side? What are producers or producer groups noticing or getting concerned about?

We propose a 2 – 3 hour dialogue that allows program staff to explore issues of concern to them and to agricultural producers, based on their own experience, and evidence from CAI regional profiles and pilot projects. The expected result will be improved understanding of the program risks posed by climate change and the implications (if any) for program planning and management. Where there are significant implications for programming, this will allow program managers to plan for any adjustments necessary to ensure program effectiveness. Where there are no significant implications for programming, this exercise will provide confidence and evidence of how the ministry has assessed the issues.

Guiding principles:

1. Sessions are scheduled based on program interest and Ministry priorities
2. Program staff bring their questions and concerns
3. External resource persons bring new knowledge about recent studies or producer practices in the sector
4. Both managers and regional staff to be involved. Regional agrologists should be invited wherever possible.
5. Content specific to program or theme
6. Process is light and low-cost
7. Application of "process improvement techniques" will demonstrate due diligence and program responsiveness to climate change

Session structure (in relation to specific programs to be determined e.g. Emergency Management; Pest Management; Strengthening Farming~~, etc~~):

1. Changing climate risks – what do we see already in relation to this topic? (~30 min). External resource persons set the stage, with open discussion about interactions between climate risk and other agricultural business risks in relation to the specific topic and program focus. Particular attention paid to the producer perspective.

2. What are the Ministry's legal or regulatory responsibilities in relation to existing programming; and / or public profile or perceived responsibility that could expose it to ~~political~~ liability (~10 min)

3. Presentation of new knowledge or practices related to climate adaptation in agriculture sector (~30 min) e.g. CAI projects

4. How might these issues affect Ministry functions and programming? (~20 min)

5. What strategies would be appropriate to ensure that programs continue to meet producer needs under a changing risk profile? This could include program actions, further consultation, monitoring, or detailed studies, if any action required. (~30 min)

6. Follow-up measures (if any required)

Potential session participants (depends on theme / location):

- Innovation and Adaptation Branch management
- Ian M~~a~~cL~~l~~achlan
- Program Lead(s)
- Regional staff
- Regional Agrologist(s) – relevant to theme
- CAI
- External resource person (depending on topic)
- Facilitator
- Total of a~~A~~bout 10 – 12 people

The first two of these events will be scheduled before March 12, 2015 to take advantage of the resources available through the current strategic planning consultancy. It is proposed that these sessions be organized for the Agriculture Emergency Management Program and Plant Health Unit and take place in Abbotsford.

Annex 1: Opportunities for integrating adaptation into key program areas

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Program Areas	Key Opportunities	Potential for Integrating Adaptation
Regional Agrologists	- agrologists are often involved in project management committees for CAI projects and identify local connections to many other programs. - key contacts for in-depth regional studies such as FBC Lower Mainland Flood Management . - local issues arising from Water Sustainability Plans; FireSmart planning; regional drought management	- regional agrologists are a strategic priority across programs; familiar with local and regional issues / innovations and are key to effective implementation of many other programs - front lines for regional interaction with other agencies (wildfire, water, drought management) - support more frequent opportunities for team learning and development - use agrologists to help identify emerging issues of climate risk and adaptation
AgriStability **Production Insurance**	- GF3 negotiations in coming months will consider terms and criteria	- useful to monitor program data by region to help determine whether climate variability is contributing to program demand
Agricultural Emergency Management	- links/lessons from CAI projects including Delta Flooding Preparedness, Extreme Weather Preparedness in the Cowichan and Widlfire Preparedness and Mitigation in the Cariboo - FBC Lower Mainland flood management project - PCIC extreme event analyses - FireSmart program	- studies can point to regional hazards that are likely to be exacerbated to climate change, to focus information strategies with producer groups - growing need for consideration of risk reduction measures at farm or community scale - potential to coordinate with EMP / BMP to harmonize messaging
Plant Health / Invasive species / Pest Management	CAI Collaborative monitoring project in the Peace (underway) - opportunities to commission new studies around specific questions	- how to maintain and build on knowledge gains of 2 yr CAI project to strengthen surveillance - identify emerging research or monitoring issues in collaboration with AAFC
Strengthening Farming	- CAI sStudy defining a new approach to Agricultural Land Use Inventory in the BC Peace (PC04) - *Water Act* implementation - FBC Lower Mainland Flood Management study: implications for land use and local planning	- monitor emerging issues in local planning (particularly dealing with subdivision, drainage, flood retention, etc) - potential FireSmart connections to agricultural producers for wildfire planning

Program Areas	Key Opportunities	Potential for Integrating Adaptation
Agroforestry	- FBC Lower Mainland Flood Management study - PCIC extreme events studies	- links to EMP / BMP for flood management, streambank erosion control, runoff management, etc
Environmental Farm Plan & Beneficial Management Practices	- relevant CAI projects: Business case for regional agriculture extension services in Cowichan (CW03), Integrated Farm Water planning Project (CW06) - FBC Lower Mainland Flood Management study	- emerging concerns with runoff, erosion control, water management, flood risk reduction - monitor relevant information from related activities - collaborate with AEM, other programs
Agriculture Water Management	- relevant CAI projects: PC02 Increasing availability of agriculturally relevant weather data, Possibly connect wt Delta drainage and sub-irrigation project (DL09) - FBC Lower Mainland Flood Management study	- anticipate increasing demand for program - more effort to simplifying data sharing protocols between different agencies - update models with new information from climate models and other research projects
Agrifood Business Development	- CAI projects: Enhancing Local Processing and Storage in Cowichan (5- complete March 2014) & Farm adaptation innovator fund	- support to explore business and market risks (and opportunities) associated with increasing climate variability and climate change

Hamdi, Rhiannon MTIC:EX

From: McLachlan, Ian P AGRI:EX
Sent: Wednesday, April 15, 2015 6:52 PM
To: Pouliotte, Jennifer ENV:EX
Cc: White, Thomas ENV:EX; Low, Selma ENV:EX; Tyler, Kari ENV:EX
Subject: FW: FOR REVIEW draft Ministry climate adaptation strategy (for April 24)

Follow Up Flag: Follow up
Flag Status: Completed

Hi Jen

Attached for review is our draft adaptation strategy for the Ministry. We have asked program leads to comment by April 24 I have also sent it to Emily and Samantha. We are turning our mind more to the implementation and monitoring (see Anna's table) – and hoping you have some ideas about how we could develop that.

Selma, Thomas, Kari – FYI, and any thoughts welcome.

Cheers, Ian

From: McLachlan, Ian P AGRI:EX
Sent: Wednesday, April 15, 2015 6:42 PM
To: 'Stephen Tyler'
Cc: 'Kari Hansen Tyler (kari@adaptiverm.ca)'
Subject: FW: FOR REVIEW draft Ministry climate adaptation strategy (for April 24)

Hi Stephen

See email below, distributing the draft strategy for review. Anna and I made revisions to create a more concise and engaging presentation with use of bullets, text boxes, and graphics (hope you agree!).

Getting closer to the deputy minister briefing, we are turning our minds to further concrete development of the implementation and monitoring. Anna created the attached draft table, based on the BCTS table, that shows goals, objectives, risks/opportunities addressed, actions, indicators and target, and responsibilities. We are thinking about getting program areas to do something like this to make the plan for their actions more explicit. But first we want to go through the exercise for the climate action team so we can model it for them. Do you think this table is a useful way to move further on implementation and monitoring, or do you think there are more effective ways to do so? Anna – please chime in if you have more to add.

We have given program leads until April 24 to respond with comments. We have already heard back from Stephanie Tam! I have also sent it to Emily and Samantha and CAS.

Cheers, Ian and Anna

From: McLachlan, Ian P AGRI:EX

Sent: Wednesday, April 15, 2015 3:09 PM
To: Bartle, Gregory AGRI:EX; Hughes-Games, Geoff AGRI:EX; Trotter, David B AGRI:EX; MacDonald, Leslie S AGRI:EX; Tegart, Greg AGRI:EX; Barclay, Brent S. AGRI:EX; Schmidt, Orlando AGRI:EX; Hueppelsheuser, Tracy AGRI:EX; Jesperson, Gayle AGRI:EX; Halm, Grant AGRI:EX; Tam, Stephanie AGRI:EX
Cc: Falk, Gary AGRI:EX; Pritchard, Jane AGRI:EX; Nickel, Ken AGRI:EX; Thompson, Grant AGRI:EX; Stemberger, Anna AGRI:EX; Haycroft, Carly AGRI:EX
Subject: FOR REVIEW draft Ministry climate adaptation strategy (for April 24)

Hi everyone

Attached for review is the draft Ministry of Agriculture Climate Adaptation Strategy prepared by adaptation specialist Stephen Tyler. Most of you will have had discussion with Stephen and/or his colleague Kari Hansen Tyler. As described in my email of Sept 12 (below), the strategy is a deliverable for the deputy minister that must be signed off with the Carbon Neutral Action Report in mid/late May.

Based on discussions with program areas, actions identified here are meant to align with your priorities and mostly to be feasible to initiate in the short term with current resources. Outside of this document, we can continue to have discussions about other actions that may require further resourcing and funding if opportunities arise.

A key focus of the strategy is collaborative knowledge sharing and capacity building, especially through more linkages between program staff and the work of the B.C. Agriculture and Food Climate Action Initiative (CAI). The CAI is delivering the GF2 industry-led climate adaptation programming and has many projects that will deliver relevant results over the next 1 – 3 years.
http://www.bcagclimateaction.ca/

FLNRO is doing a similar exercise, in which business areas are developing plans to integrate climate action into their work. I have attached the recently released climate action plan for B.C. Timber Sales in case you are interested.

In reviewing the attached Ministry adaptation strategy:

- sections specific to your programs are clearly labelled (see exec summary Table 1, Section 3.3, and opportunity matrix Table 2 on p. 26)
- other references to your programs can be found by searching the document for the program name
- please look at the actions for your area and confirm or revise the wording
- start to think about what the next steps would be for implementing the actions

Note that the Premier announced on April 13 that B.C. will develop a new Climate Action Plan over the next few months. This will be a major interagency initiative with involvement of all sectors, including agriculture. The plan will likely include a focus on adaptation.
http://www2.news.gov.bc.ca/news_releases_2013-2017/2015PREM0022-000491.pdf

I will be in touch with each of you individually to discuss the strategy.

Our target for comments is **Friday, April 24**. This timing is required for us to meet the deadline of DM signoff in mid-May. Please respond to me and cc Anna.

Contact Anna or me anytime if you have questions or want to discuss.

Thanks, Ian

Ian McLachlan | Manager, Climate Action | (250) 356-1852
Innovation and Adaptation Services Branch – Ministry of Agriculture

---

From: McLachlan, Ian P AGRI:EX
Sent: Friday, September 12, 2014 10:38 PM
To: van Dalfsen, Bert AGRI:EX; Hughes-Games, Geoff AGRI:EX; Trotter, David B AGRI:EX; MacDonald, Leslie S AGRI:EX; Barclay, Brent S. AGRI:EX; Schmidt, Orlando AGRI:EX; Hueppelsheuser, Tracy AGRI:EX; Jesperson, Gayle AGRI:EX; Halm, Grant AGRI:EX; DeBoer, Pat AGRI:EX; Tam, Stephanie AGRI:EX
Cc: Coney, David AGRI:EX; Donahue, Kayleigh AGRI:EX; 'Stephen Tyler'; 'kari@adaptiverm.ca'
Subject: NEXT STEPS implementation of BC ADAPTool report recommendations

Hi everyone

We now have the opportunity to develop the next steps to build on the ADAPTool assessment process and final report you contributed to last year.

In the attached Carbon Neutral Action Report (May 28) submitted for government reporting, DM Derek Sturko has committed that:

- *"The Ministry will build on the ADAPTool assessments by developing an action plan for implementing the priority recommendations. Implementation of the recommendations will support the ministry in planning for climate change.*

Following this, we have engaged Stephen Tyler and Kari Tyler of Adaptive Resource Management to:

- develop a strategy for implementing priority actions from the ADAPTool assessment
- get started on implementation in areas where there is interest and support already
- identify opportunities for programs to build their capacity to integrate adaptation into ongoing work

This work is being timed to provide input into strategic thinking about the funding and design of ministry programs in GF3.

Stephen or Kari will be in touch with you in the coming weeks. In advance of that discussion, it would be great if you could review the ADAPTool final report sections on your respective programs and consider action steps that could be taken to move forward with the recommendations. The focus will be on how to align those recommendations with actions you know will be beneficial for your programs.
http://www.iisd.org/pdf/2014/adaptool_bc_ag.pdf

Please contact me if you want to discuss beforehand.

Thanks again for your engagement last year and now on implementation.

Cheers, Ian

Ian McLachlan | Manager, Climate Action | (250) 356-1852
Innovation and Adaptation Services Branch – Ministry of Agriculture

MINISTRY OF AGRICULTURE CLIMATE ACTION PLAN FOR ADAPTATION STRATEGY

Goal	Objective	Risk and Opportunity Addressed	Action	Indicator and Target	Responsibility
Build Adaptive capacity	Increase adaptive capacity of the Ministry's program areas by integrating climate change	Opportunity-increase knowledge transfer between program areas and CAI	Facilitate adaptation Dialogue Sessions	• Number of dialogue sessions *Target: 2 – 4 sessions per year* • Number of implemented actions formulated in sessions	• The Dialogue sessions will be facilitated by the Climate Action Team
	Reduce climate related risks and vulnerabilities to producers	Manage for increased frequency of extreme weather events			
		Manage for changing distributions of pests			
	Promote innovative adaptive farm practices	Reduce the vulnerabilities of produces to extreme weather event risks			

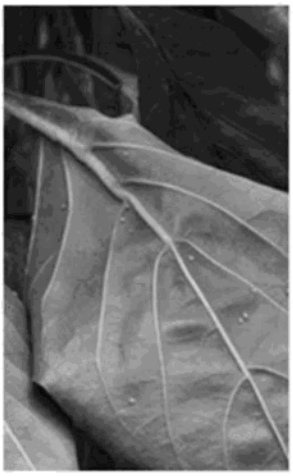
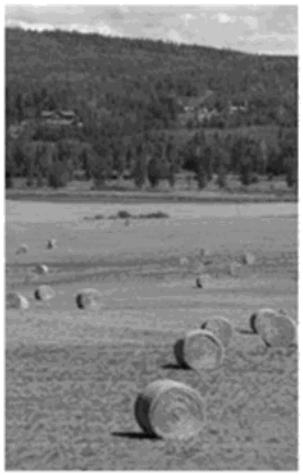
Goal-Should show alignment with goals outlined in Ministry Adaptation Strategy.
Objective-Should be
Risk and Opportunity-Should be specific to business area
Actions- These should be short term actions that do not require any additional resources and can be carried out within this fiscal year.
Indicator and Target- Should be able to quantify outcomes of actions
Responsibility-

MINISTRY OF AGRICULTURE CLIMATE ACTION PLAN-(CLIMATE ACTION TEAM)

Goal	Objective	Risk and Opportunity Addressed	Action	Indicator and Target	Responsibility
Build Adaptive capacity	Increase adaptive capacity of the Ministry's program areas by integrating climate change	Opportunity-increase knowledge transfer between Ministry program areas and CAI	Facilitate adaptation Dialogue Sessions	• Number of dialogue sessions *Target: 2 – 4 sessions per year* • Number of implemented actions formulated in sessions	Climate Action Team
			Organize adaptation contact group	• Track number of deliverables shared • A survey will be sent out annually for continual improvement of program	Climate Action Team
			Information briefs on CAI projects	• Target: 6-10 briefs per year depending on projects	Climate Action Team
	Develop climate change adaptation expertise across the ministry, particularly in LSOs positions	Opportunity-increase the capacity of program areas to self-identify and implement climate adaptation strategies and practices	Organize training session in Climate Insights 101 for Ministry Staff with emphasis on climate change impacts in BC and adaptation	• Number of staff attending	Climate Action Team
	To measure effectiveness of Ministry's Adaptation Strategy	Opportunity to measure Ministry Progress in integrating adaptation	Second ADAPTool assessment in 2018.	• Target- demonstrate improved adaptation expertise by completing ADAPTool with minimal external contractor guidance • Target- participation by all relevant business areas	Climate Action Team

Climate Change Adaptation Strategy
B.C. Ministry of Agriculture



DRAFT FOR REVIEW
14 April 2015

Produced for:
Innovation and Adaptation Services Branch
British Columbia Ministry of Agriculture

Adaptive Resource Management Ltd.

Stephen Tyler
Kari Hansen Tyler

Acknowledgements

To be completed….

Program area contacts

Emily MacNair and Samantha Charlton of the B.C. Agriculture and Food Climate Action Initiative

Climate Action Secretariat

FLNRO reviewers

Authors

Stephen Tyler, PhD, RPP, MCIP
Stephen is the President of Adaptive Resource Management. He holds a PhD in urban and regional planning from the University of California, Berkeley, and for over 25 years has led projects that support community-level innovations in natural resource management, urban planning, adaptive management and climate adaptation. His focus is on complex public policy problems that lack simple technical solutions and require new tools, new ways of thinking and collaboration. He has worked with various levels of government and other local partners in Canada, Southeast Asia, China and West Africa.

Kari Hansen Tyler, MEd
Kari holds a Master's Degree in Adult Education from the University of Toronto. From 2011-2014 she worked with Adaptive Resource Management to develop and apply professional training in climate resilience and adaptation, assess policy and program adaptability, and work in multi-stakeholder process to create collaborative learning experiences. She has over a decade of experience in facilitation and leadership development.

Executive Summary

Climate Change & B.C. Agriculture
In 2013 B.C. agricultural sales revenues were $2.7 billion, and combined agrifoods revenues (including seafood, and food and beverage sales) were $11.6 billion. The B.C. government has a target to increase annual agrifoods revenues to $14 billion by 2017.

Projections indicate accelerating climate change in British Columbia in the coming decades, leading to changing temperature, precipitation, climate variability and extremes. These changes will increase the risk and operational complexity for B.C. agricultural producers. To maintain profitability and increase the value of agricultural output, the sector will need to effectively adapt.

Adaptation Strategy Purpose
This strategy serves as a guide to integrating the effects of climate change into the Ministry of Agriculture's business planning and program implementation. This strategy is aligned with *British Columbia's Climate Change Adaptation Strategy* (2010) deliverable to "Make adaptation part of Government's business" and with the Ministry's *Service Plan 2015-16 / 2017-18* (Objective 2.2) commitment to support "the efforts of industry to develop innovative products, tools and processes to reduce and mitigate greenhouse gas emissions and adapt to climate change."

Building Linkages
The adaptation strategy builds on the results of an assessment of the adaptability of 14 Ministry of Agriculture programs, undertaken in 2013 using the ADAPTool methodology. The strategy recommends a collaborative learning-oriented approach to increase knowledge and capacity in the area of adaptation. A key focus is to increase linkages between the Ministry's business areas and new studies and practices for climate adaptation in the agriculture sector.

An important adaptation learning opportunity for agriculture sector programs is through the B.C. Agriculture and Food Climate Action Initiative (CAI). The CAI is delivering the industry-led climate change adaptation program funded by the Ministry through Growing Forward 2, a federal-provincial-territorial initiative. As results are reported from the CAI's regional scale and farm-level projects underway, a systematic effort by both the Ministry and CAI to share and interpret the learning is essential to the success of this strategy.

Other organizations whose work provides an opportunity for program learning about climate change adaptation include:

- Fraser Basin Council – Lower Mainland flood management study
- Pacific Climate Impacts Consortium – Plan2Adapt, studies on extreme events
- Ministry of Environment – Water Sustainability Act implementation
- Ministry of Forests, Lands and Natural Resource Operations – climate action plans for regions and business units

The Ministry of Agriculture's preparation for Growing Forward 3 discussions with the federal government also provides an important opportunity to identify mechanisms for better integration of climate change adaptation in programming.

Alignment with Program Areas' Priorities
The purpose of this strategy is not to introduce additional programming responsibilities or mandates, but to ensure that current programs remain effective and responsive to the needs of the agriculture sector as climate risks change and producers respond. Actions for each program

area will be supported by the Ministry's climate action team, but will be driven by program leads and integrated into ongoing programming in a manner and schedule determined largely by the program areas themselves.

Five Key Mechanisms
The strategy provides a platform for engagement and shared learning about climate impacts and potential adaptation measures, and for program area discussions about the integration of climate adaptation into business planning. Five mechanisms are proposed for strengthening learning and communication:

1. Ministry adaptation contact group
2. adaptation dialogues
3. information briefs highlighting recent lessons for programs
4. field visits
5. key role of regional agrologists and industry specialists

Initial Actions
Suggested initial actions for programs have been identified through the ADAPTool assessment, subsequent consultation with program leads, and exploratory dialogue sessions with some program staff. The initial measures proposed here respond to existing opportunities (see Table 1, below) and most can be implemented in the short term with existing resources. These actions are a starting point – climate adaptation is an ongoing process that will evolve with additional information and experience, and as new collaborative opportunities arise.

Monitoring & Implementation
The strategy includes a streamlined monitoring report template that can be used by program leads and the Ministry's climate action team to track the actions of program areas for reporting purposes.

- For each program, the monitoring should be updated every 2 years and form the basis of reports to senior management.
- The climate action team should also assess the adaptability of programming by repeating the ADAPTool assessment in 2018, once Growing Forward 3 is in place.

Outcomes
The results from implementing this strategy will be a suite of Ministry of Agriculture programs that integrate climate adaptation considerations effectively into service delivery, providing better support to producer innovation and competitiveness.

In the long term, indicators of success in climate adaptation include:

- measures of agricultural output and revenue
- recorded insured and uninsured losses from weather events
- level of losses and speed or recovery from climate disasters

Table 1: Summary of recommendations and actions for integrating adaptation

Core Groups	Recommendations
Ministry of Agriculture Climate Action Team	1. Establish and coordinate adaptation contact group with Ministry programs 2. Facilitate programs' access to CAI products, tools, and knowledge: • Lead 2 - 4 climate adaptation dialogue sessions per year • Prepare up to 4 adaptation briefs / digests per year 3. Monitor how adaptation measures are being implemented in programs 4. Assess adaptability of programming by repeating ADAPTool assessment (2018)
B.C. Agriculture and Food Climate Action Initiative (CAI)	1. Support adaptation dialogue sessions and information sharing opportunities 2. Publicize field events and invite Ministry staff 3. Work with Ministry climate action team to develop information packages targeted at specific program and management audiences
Program Areas	**Proposed Initial Actions**
Regional Agrologists & Industry Specialists	• Continue to support CAI projects • Create more frequent opportunities for agrologists' team learning and interaction • Help identify emerging issues of climate risk and adaptation for other programs • Share knowledge of CAI projects within the Ministry
Agricultural Emergency Management	• Provide more information to producers and local government on risk reduction measures for extreme climate events (flood, wildfire, drought) • Strengthen communication of specific risks with local government and producers • Coordinate farm-level messaging on risk reduction and site planning • Promote emergency planning and risk reduction in local government AAPs • Appoint a representative to Fraser Basin Council Joint Program Committee to monitor Lower Mainland flood management study
Plant Health & Pest Management	• Identify specific emerging pest threats with industry • Continue collaborative monitoring and research projects with industry, focusing on pests relevant to a variety of crops • Review results from CAI collaborative monitoring project in Peace Region and consider how to improve monitoring information for high-value crops
Production Insurance	• Monitor Manitoba task force on BRM programs and evaluate implications for B.C. • Ensure that premium subsidies do not create disincentives for producer adaptation • Implement proposed database enhancements (geospatial / weather data) to provide better information on climate-related losses • Explore emerging producer concerns on climate risk management with CAI
Strengthening Farming	• Recognize and build program knowledge about climate risks related to land use planning • Bring together local governments and producers (e.g. through Agricultural Advisory Committees) to gain agreement on adaptation issues and to develop solutions • Monitor emerging experience with Water Sustainability Plans
Agroforestry	• Identify ecosystem services and climate buffering functions of agroforestry at site and landscape scales • Promote agroforestry where relevant to meet land use objectives • Monitor agroforestry demand and interest related to climate • Foster demonstrations and extension through partnerships with producers and local groups
Environmental Farm Plan & Beneficial Management Practices	• Explore how to incorporate changing climate risks and disaster risk reduction at farm and community level (together with Agricultural Emergency Management) • Consider linkages to the national FireSmart program for assessment of fire risk • Review results of relevant CAI projects to consider how to incorporate drought planning, drainage and flood protection measures
Agriculture Water Management	• Anticipate increasing demand for program • Collaborate to simplify data sharing protocols between different agencies • Update models with new information from climate models and research projects • Expand program availability in new regions
Agrifood Business Development	• Review results from relevant CAI projects • Work with industry to explore opportunities / impacts of changing climate conditions

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List of Acronyms

AAFC	Agriculture and Agri-Foods Canada
AAP	Agriculture Area Plan
ADAPTool	Adaptative Design and Assessment Policy Tool
AEM	Agricultural Emergency Management program
B.C.	British Columbia
BMP	Best Management Practices program
BRM	Business Risk Management programs
CAI	B.C. Agriculture and Food Climate Action Initiative
CAS	Ministry of Environment Climate Action Secretariat
EFP	Environmental Farm Plan program
FBC	Fraser Basin Council
FLNRO	Ministry of Forests, Lands and Natural Resource Operations
IASB	Ministry of Agriculture Innovation and Adaptation Services Branch
IISD	International Institute for Sustainable Development
NRCan	Natural Resources Canada
PCIC	Pacific Climate Impact Consortium
PICS	Pacific Institute for Climate Solutions
WSP	Water Sustainability Plan

1. Introduction

British Columbia has a diverse and important agriculture sector, with over 200 commodities being produced on approximately 2.8 million hectares. The major producing regions are the Fraser Valley (field vegetables, berries, dairy, poultry, greenhouse vegetables, horticulture), Vancouver Island (livestock and horticulture crops), the Okanagan (tree fruits and wine grapes), the Peace Region (grains and oilseeds), and the Central Interior (cattle and forage). In 2013 B.C. agricultural sales revenues were $2.7 billion, and combined agrifoods revenues (including seafood, and food and beverage sales) were $11.6 billion. The B.C. government has a target to increase annual agrifoods revenues to $14 billion by 2017.[1]

Climate change is already occurring in British Columbia, with mean annual temperatures having warmed by about 1.4 degrees Celsius across the province in the past century. Projections indicate accelerating climate change in the coming decades, requiring the province's agricultural producers to adapt to changing conditions that include:

- **warmer minimum temperatures, particularly at night and in winter**
- **reduced winter snowfall, leading to earlier spring runoff and in some regions declining late summer streamflow**
- **increased, and more intense, spring and fall precipitation**
- **increased variability in weather conditions (figure 1) and seasonal boundaries**
- **warmer and drier summer conditions in the southern Interior**
- **increased uncertainty and instability of local climate**
- **sea level rise on the coast**

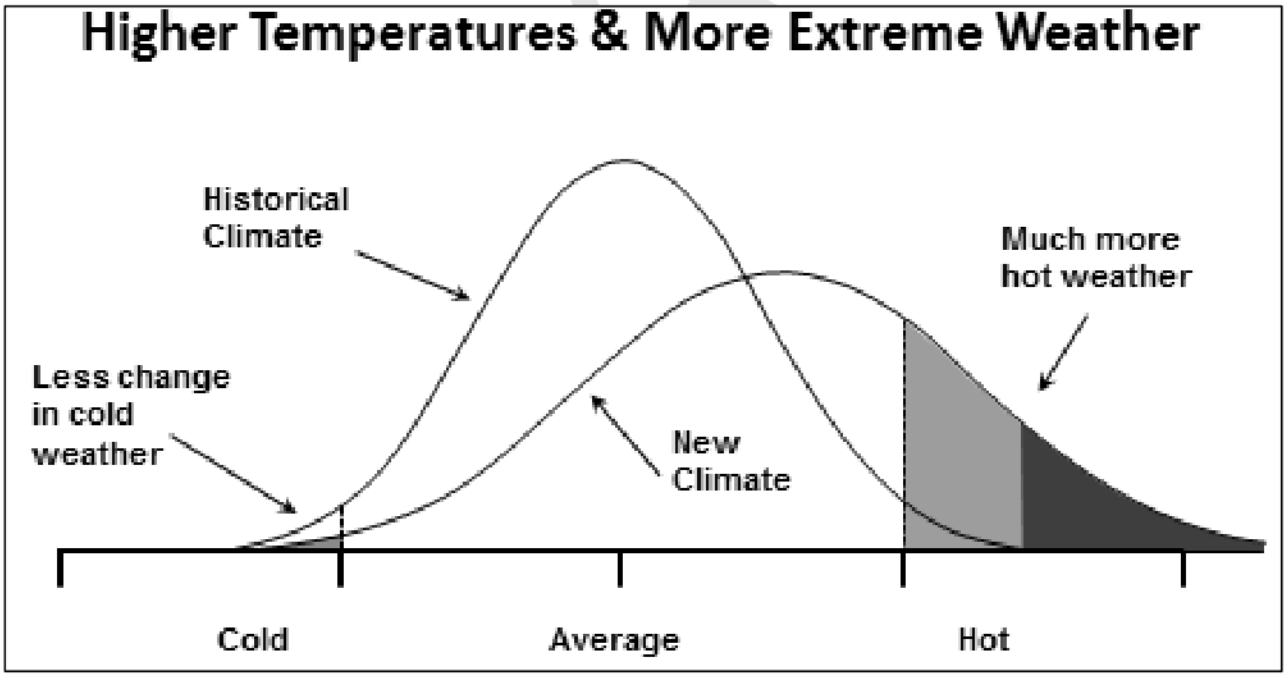


Figure 1: Increasing variability and shifting means in weather events as a result of climate change (Trevor Murdock, 2014).

[1] B.C. Ministry of Agriculture. 2013. *British Columbia Agrifood Industry Year in Review.*

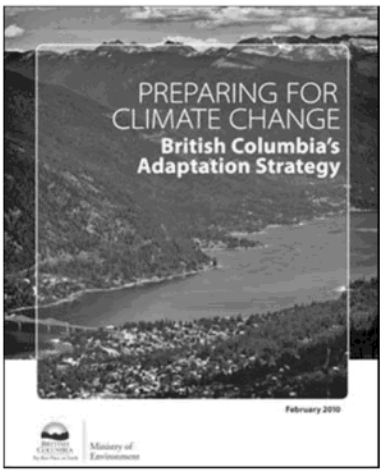
Changing climatic conditions will affect agricultural producers in a variety of ways depending on their location and production systems. Growing seasons will increase, especially in the north, but changing soil moisture conditions will affect production systems. Some regions will experience more frequent drought and increased wildfire hazard, while others may see more frequent spring flooding.[2] These changes will mean increased risk and operational complexity for B.C. farmers. To maintain profitability and continue to increase the value of output, the agriculture sector will need to adapt. A report prepared in 2014 indicated that climate change could present a significant risk to B.C. agriculture revenues and that adaptation measures would have substantial economic benefit.[3]

The Ministry of Agriculture Service Plan (Objective 2.2) commits to supporting producers to innovate and adapt in a changing climate:

"The Ministry supports the efforts of industry to develop innovative products, tools and processes to reduce and mitigate greenhouse gas emissions and adapt to climate change."[4]

In 2013, the Ministry commissioned a study of 14 of its program areas to assess their adaptability to changing climate conditions in the province. This study was led by the International Institute for Sustainable Development (IISD), with funding from Natural Resources Canada, using the Adaptive Design and Assessment Policy Tool (ADAPTool). The Ministry has committed to developing an action plan to implement priority recommendations from this assessment in order to mainstream adaptation in relevant program actions.[5]

The Ministry's commitments respond to the Province of British Columbia's 2010 Climate Change Adaptation Strategy. One of the three foundational commitments in that strategy was to "*make adaptation a part of the Government's business, ensuring that climate change impacts are considered in planning and decision-making across government.*"[6] Key deliverables are summarized in Annex 6.



Climate adaptation is a component of the innovation focus area under Growing Forward 2 (GF2), the five-year federal-provincial-territorial initiative that provides funding for the agriculture and agri-foods sector to help producers and processors to manage business risks and to become more innovative and competitive.

Through GF2, an industry-led climate change adaptation program is funded by the Ministry through GF2 and delivered by the B.C. Agriculture and Food Climate Action Initiative (CAI), set up by the B.C. Agriculture Council.

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[2] Pacific Institute for Climate Solutions (E. Crawford and R. Beverige) (2013). *Strengthening BC's Agriculture Sector in the Face of Climate Change.* http://pics.uvic.ca/sites/default/files/uploads/publications/Strengthening%20BC%27s%20Agriculture%20Sector_0.pdf

[3] Ministry of Agriculture climate action team (K. Donahue) (2014) at http://pics.uvic.ca/sites/default/files/Climate%20Stressor%20Scenarios-%20Final%20Report%20pdf.pdf

[4] Ministry of Agriculture, *2015-16 / 2017-18 Ministry Service Plan, p. 11* – Objective 2.2 http://bcbudget.gov.bc.ca/2015/sp/pdf/ministry/agri.pdf

[5] Ministry of Agriculture, May 30, 2014. Carbon Neutral Action Report Overview.

[6] Ministry of Environment, Feb 2010. British Columbia's Adaptation Strategy.

1.1 Purpose and Structure of this Climate Adaptation Strategy

This strategy provides guidance on implementing the Ministry's commitment to integrate climate change effects into business planning and program implementation. The strategy includes an action plan for implementation of priority measures to follow up from the ADAPTool assessment. The purpose of this strategy is **not** to introduce additional responsibilities or mandates to existing program areas of the Ministry, but to ensure that current programs remain effective and responsive to producer needs as climate risks change and producers respond. Climate adaptation strategies will be supported by the Ministry's climate action team, but will be driven by program leads and integrated into ongoing programming as determined largely by the program areas themselves.

The document is structured as follows:

- Section 2 summarizes the 2013 ADAPTool report findings and followup interviews with program leads, and consultations with external organizations.
- Section 3 presents program specific components of the strategy.
- Section 4 discusses implementation and monitoring.
- Supporting information is presented in Annexes 1 - 6.
    - Annex 1: Recommendations of ADAPTool Assessment (2013)
    - Annex 2: Climate Action Initiative and Ministry of Agriculture
    - Annex 3: List of CAI projects
    - Annex 4: Proposed Structure for Climate Dialogue Sessions
    - Annex 5: External Organizations Consulted
    - Annex 6: Ministry of Agriculture Program Contacts
    - Annex 7: B.C. Climate Change Adaptation Strategy: Core Deliverables

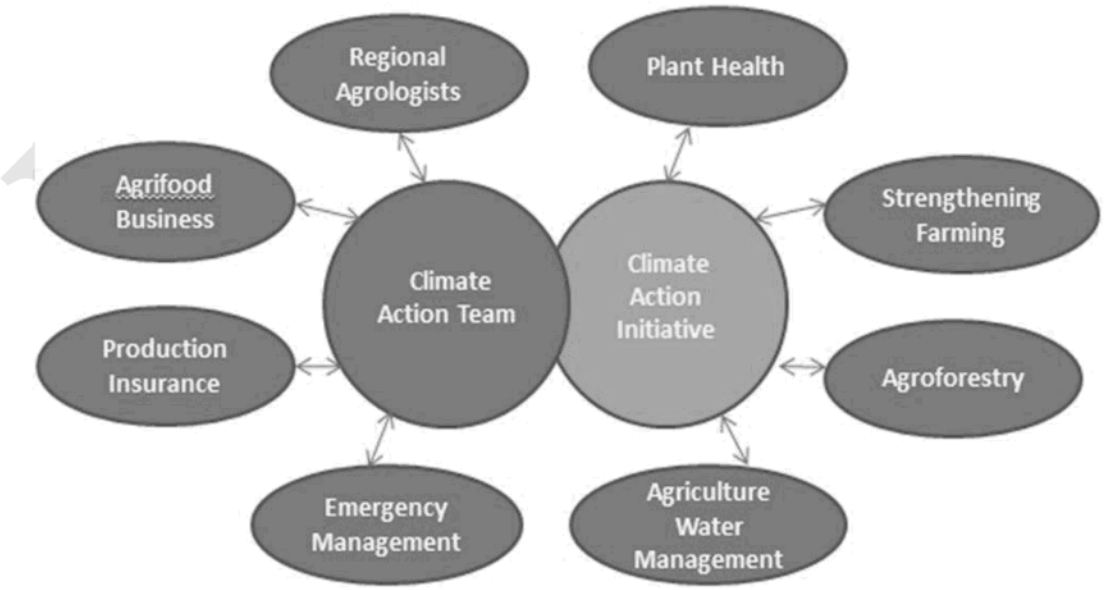
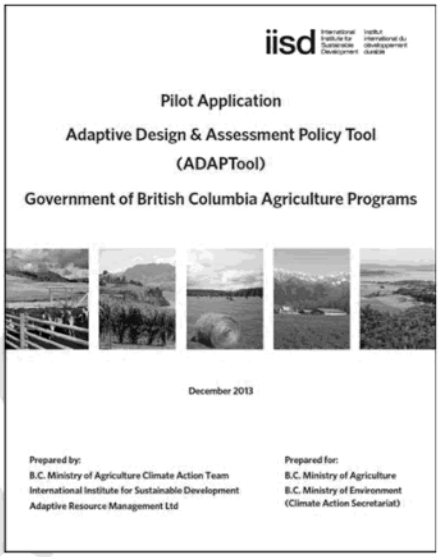


Figure 2: Ministry of Agriculture climate change adaptation network includes program areas, the Ministry's climate action team, and the B.C. Agriculture and Food Climate Action Initiative.

2. Climate Adaptation Opportunities for Ministry Programs

2.1 ADAPTool Assessment

In 2013, the ADAPTool was used to assess the ability of Ministry programs to meet their objectives under conditions where climate change will affect producer behaviour and demands on programs.



- The assessment showed that agricultural producers will already receive broad *indirect* support for adaptation from the Ministry's programs.[7]
- Several of the programs were rated as highly adaptive, providing support to producers to adapt to *anticipated* climate change as well as being sufficiently flexible to be responsive to *unanticipated* climate-related stresses. These programs include: Environmental Farm Plan, Beneficial Management Practices, and Agri-Food Business Development, and the Agriculture Water Management program.

The ADAPTool assessment found that other programs are likely to be challenged under conditions of increasing climate variability and extreme weather events.

- More frequent and severe extreme climate events will significantly affect the Agricultural Emergency Management program. The program is already paying more attention to preparedness as well as response, but as climate risks change, producer options for reducing climate related risks may need further consideration.
- The Pest Management and Plant Health program can expect to see increased incidence of both familiar and new types of threats to productive agro-ecosystems. The specific changes and the nature of threats will be difficult to predict, and may require additional resources for surveillance, monitoring and research.

Other programs examined were moderately adaptable, offering some support to adaptation measures by producers, and some responsiveness to changing climate stresses by virtue of program design and management. These programs may benefit from considering specific climate issues within their mandates.

The ADAPTool assessment also found that:

- few programs supported producers to improve their adaptive capacity;
- changing climate risks could impact the effectiveness of business risk management programs; and
- research and extension needs would likely increase as climate change accelerates.[8]

[7] Pilot Application Adaptive Design and Assessment Policy Tool (ADAPTool) Government of British Columbia Agriculture Programs. Dec 2013.

[8] In the ADAPTool assessment "adaptive capacity" is related to access to financial resources, technology, information and skills, infrastructure, and to institutions and networks.

2.2 Opportunities to Integrate Climate Adaptation into Programs

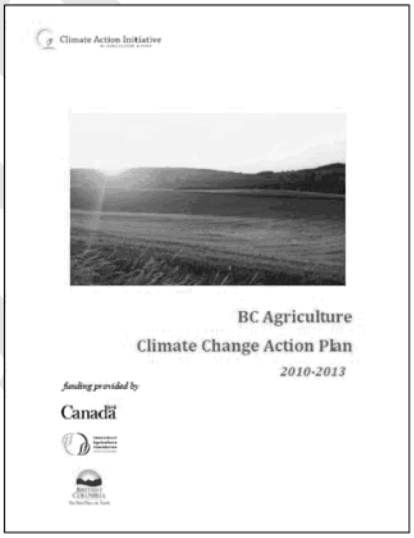
This section provides an overview of emerging opportunities and new insights on climate adaptation that are relevant to Ministry programs. These opportunities include:

1. Studies and pilot projects on climate adaptation measures for the agriculture sector
2. Innovative practices introduced as a result of local, regional or provincial initiatives
3. Climate related studies that may not specifically address agricultural activities but have important implications for agriculture, and
4. Planned changes or regular reviews of Ministry programming.

These opportunities are described here so that they may be followed up using the tools described in the implementation and monitoring section of this document.

2.2.1 B.C. Agriculture and Food Climate Action Initiative

CAI is nationally recognized as a leader in climate change adaptation in the agricultural sector. The CAI was established in 2008 as a joint initiative by the Ministry of Agriculture, the B.C. Agriculture Council, and the Investment Agriculture Foundation. CAI supports producers with a wide range of tools and resources on its website and through social media.[9]



The CAI released the BC Agriculture Climate Change Action Plan in 2010, and then in 2012 produced six regional/commodity sector adaptation risk and opportunity assessment reports.

Since 2013, CAI has delivered the Ministry's climate adaptation programming funded by the Province and the federal government through the innovation component of the Growing Forward 2 initiative. Focus areas are regional adaptation strategies and farm-level adaptation innovations.

- **Regional Agricultural Adaptation**: Comprehensive regional adaptation strategies have been developed for the Cowichan, Peace, Delta, Cariboo, and Fraser Valley areas. A regional strategy process for the Okanagan is planned for 2015. Once regional adaptation strategies are prepared, funding is available to implement projects aligned with priority actions identified by a local working group and the CAI.
- **Farm Adaptation Innovator Program**: Provides funding for innovative farm-level adaptation, risk reduction practices and new production opportunities. The program also emphasizes communication of results and sharing of knowledge and resources through industry associations, networks and support organizations.

The CAI is the main vehicle through which the Ministry supports agricultural climate change adaptation.

- In addition to the GF2 funding provided, technical staff from Ministry programs and regional offices play key advisory roles in the regional and farm-level projects.

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[9] Climate Action Initiative. 2010. *BC Agriculture Climate Change Action Plan.* http://www.bcagclimateaction.ca/wp/wp-content/media/BC-Agriculture-Climate-Change-Action-Plan.pdf

- Key roles are also played by local governments, industry partners and local producer groups. The CAI shares updates on relevant projects with Ministry program leads and seeks their input and feedback on project development.

The CAI has a large number of projects underway, which will generate considerable useful knowledge as they are completed in the next two years. Annex 3 provides a list of CAI projects, and Annex 2 provides background on the partnership between the CAI and the Ministry.

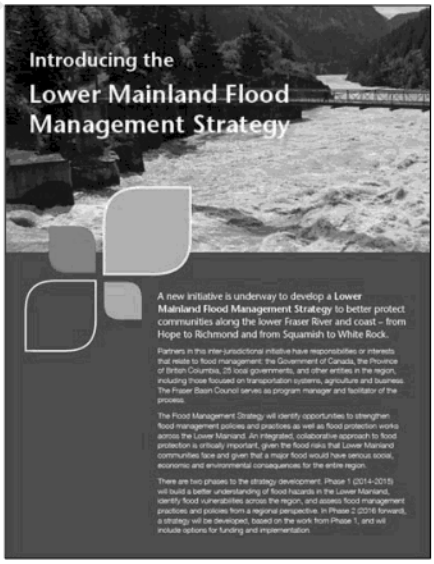
While there are already linkages between the Ministry's programs and CAI, there is a clear need to extend the learnings from CAI projects beyond the current technical contacts to reach other Ministry programs for which they are relevant. Both the Ministry and CAI can take measures to strengthen the knowledge sharing.

2.2.2 Fraser Basin Council Lower Mainland Flood Management Study

There is growing recognition of the need for flood management in the lower Fraser River basin.

- Local, provincial and federal governments are all likely to be involved in response measures due to the high value of urban land uses, strategic infrastructure such as highways, ports and rail lines, and the high cost and limited effectiveness of protective measures such as dikes.
- Flood management interventions in this region will involve trade-offs, and some agricultural areas will not be defensible against future extreme flooding.
- Risk reduction strategies, such as improving drainage infrastructure, livestock protection, farm building design and siting, and evacuation routes may need to be incorporated into advisory services in vulnerable areas.

The Fraser Basin Council (FBC) is undertaking a comprehensive study of changing flood risks in the Lower Mainland.[10] This is a major project involving all three levels of government that will shape planning and investment measures for flood hazard in the Lower Mainland for the coming decades. Phase 1 of the project, which includes vulnerability assessment and management recommendations based on climate change and flood scenarios, has a target completion of December 2015.



- As the Lower Fraser Valley is the region of B.C. with the highest value agricultural production, the implications of this FBC study should be of interest to the sector and are likely to interact with various Ministry programs.
- Participation on the study's Joint Program Committee would provide the Ministry with greater insight into key issues in vulnerability assessment for the agriculture sector, and highlight potential issues for various industry groups or programs.

To keep current with work on flood management and planning, Ministry staff should monitor planning processes led by other agencies and discuss implications for Ministry programming.

[10] http://www.fraserbasin.bc.ca/_Library/Media/backgrounder_lmfls.pdf

2.2.3 Pacific Climate Impacts Consortium (PCIC)

PCIC is a research group at the University of Victoria that produces regional climate information for British Columbia and the Yukon. Climate scientists at PCIC test and downscale global climate models (GCMs), linking climate and hydrological models for surface water management purposes and interpreting results for a variety of user groups. Recent work on projecting climate extremes is particularly useful for the Ministry because agricultural impacts are likely to be felt first through extreme events such as drought, flooding, and heat stress.[11]

PCIC maintains the user-friendly online Plan2Adapt Tool, which provides climate projections and maps for each region of the province. The PCIC website provides further information and access to its resource library and climate data bases.

PCIC climate projections are summarized and presented by CAI in their regional adaptation strategies, but other studies generated by PCIC are also be directly relevant to Ministry programming and should be monitored, summarized and communicated to staff.

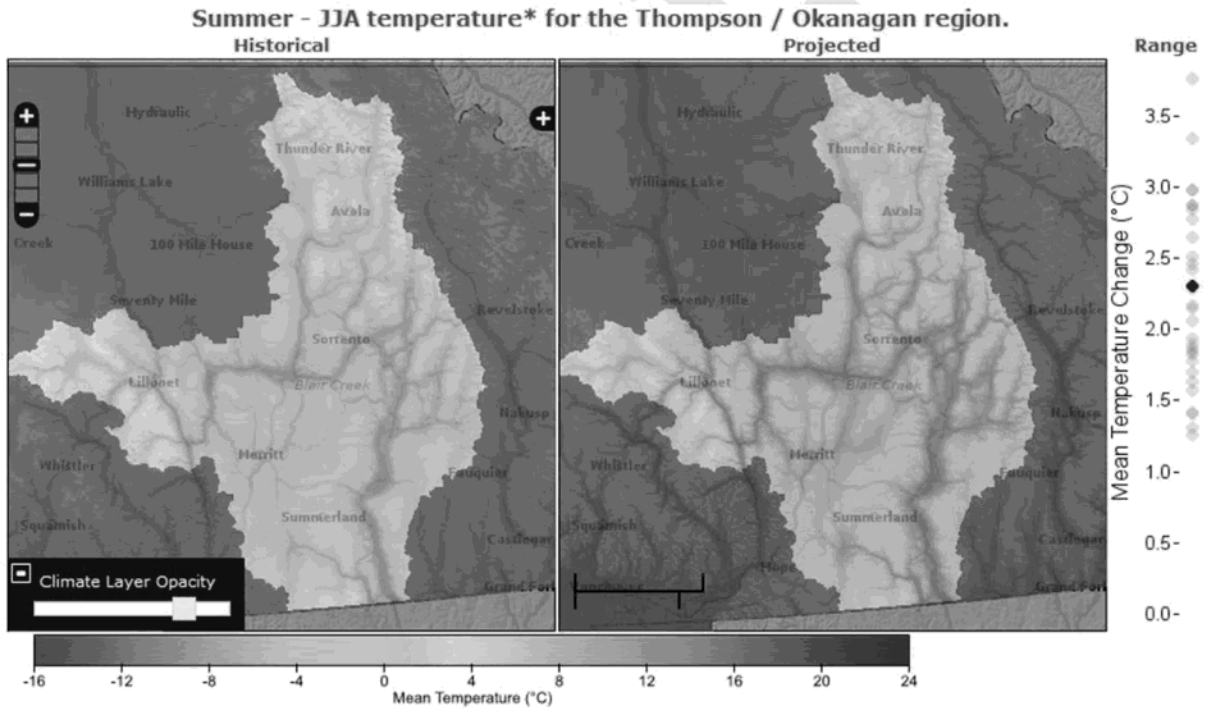


Figure 3: Average summer temperatures for the 2080sin the Thompson / Okanagan region are projected to be 2.4 degrees higher than historical averages, as shown by PCIC's online Plan2Adapt tool.

[11] Murdock and Sobie, 2013.

2.2.4 Water Sustainability Act Implementation Measures

For agricultural producers to adapt effectively to climate risks, and for the Ministry to coordinate and support the interests of the agricultural sector in multi-agency initiatives, it is important for Ministry staff to be aware of and respond to emerging practices led by other agencies.

B.C.'s 2014 *Water Sustainability Act* includes new provisions for regulating groundwater use, protecting water flows, and for broad regulatory authority to implement Water Sustainability Plans (WSPs) that could override provisions in other legislation. While the Ministry is well positioned to provide input for modelling water demand, it is not yet clear how agricultural interests and land uses may be affected under new WSPs, which may legally override other legislative provisions.

As detailed regulations are being developed, and as various local and regional bodies become involved in developing WSPs, the implications for the agriculture sector and for specific Ministry programs should be explored. Monitoring and learning from such processes as they are introduced in agricultural watersheds will provide important opportunities to identify needed program responses.

2.2.5 Ministry of Forests, Lands and Natural Resource Operations

The Competitiveness and Innovation Branch in FLNRO provides technical and policy advisory services on climate change. Guided by its Climate Change Steering Committee, FLNRO is implementing a climate change strategy that includes three goals:

1. Climate change is integrated in ministry core business.
2. Climate-relevant science, data and knowledge guide and inform the identification of the ministry's environmental, social, and economic risks, opportunities, and priorities for climate change action.
3. Climate change action is undertaken through collaboration, partnerships, communication and outreach with First Nations, communities and the natural resource sector.[12]

With the large operational and regional components of FLNRO services, that ministry has chosen to require major programs and regions to produce their own climate action plans that integrate climate change adaptation into their ongoing operational plans. The program action plans and regional action plans will be integrated into business plans for funding opportunities and priority implementation.[13]

The FLNRO action plans are especially relevant to agricultural producers and Ministry of Agriculture programs in regions with extensive grazing leases and forest / agriculture interfaces.

- The climate action plans produced by the Wildfire Management Branch addresses the anticipated increase in fire severity and size in the Interior.
- Other key points of overlap with the agricultural sector are range management, where the issues are drought and forage supply, and invasive species.

The Ministry of Agriculture Climate Action Team will review FLNRO climate action plans should and communicate them to relevant Ministry of Agriculture staff.

[12] FLNRO 2013. http://www.for.gov.bc.ca/het/climate/strategy/ClimateChangeStrategy_2013-2018.pdf
[13] Hopkins, K., Techical Advisor, Climate Change, FLNRO – pers comm Mar 12, 2015

2.2.6 Growing Forward 3

In 2015 federal and provincial preparations will get underway for negotiating the joint funding of agricultural programs for the period 2018 - 2023. The reviews, background studies, reports and discussions linked to this planning process provide a good opportunity for considering the role that changes in climate risk will play in the sector's innovation and competitiveness.

Preparatory studies or specific reviews of relevant factors for these negotiations should be undertaken to ensure that appropriate consideration of climate adaptation measures, as related to sector innovation and competitiveness, can be incorporated in the design of GF3 program elements.

3. Strategy Components

2.3 Approach

The Ministry of Agriculture climate adaptation strategy is guided by the broad policy goal of Growing Forward 2 to help the agriculture sector become more competitive and innovative. Integrating climate change adaptation into Ministry of Agriculture sector programming will strengthen competitiveness by ensuring that business operations are better able to adopt innovative practices and identify and manage climate risks.

Approach:

1. **Builds on anticipated program changes and updating opportunities that are already planned, or can be reasonably anticipated, such as the planned extension of Water Demand Modelling to the Peace region, or future transitions to Growing Forward 3.**
2. **Synergistic: complementing or supplementing other programming initiatives.**
3. **Focus on maximizing the value of existing activities and opportunities, so resulting learnings can be better integrated into programming.**

The purpose of this strategy is not to introduce additional responsibilities or mandates for Ministry programs, but to ensure that current programs remain effective and responsive to producer needs as climate risks change and producers respond. Climate adaptation strategies will be supported by the Ministry's climate action team, but will be driven by program leads and integrated into ongoing programming largely as determined by program areas themselves.

2.4 Integrating Climate Change into Ministry Programming

2.4.1 The Need for Integrating Adaptation

Adaptation planning in agriculture is crucial to address the adverse impacts of climate change on the sector. The Ministry's role in promoting innovative practices and planning will build the capacity of the sector to deal with climate change challenges through more informed strategic and operational decision making resulting in increased business competitiveness.

A key part this climate adaptation strategy is the strengthening of linkages and learning mechanisms so that program staff are able to integrate the new information and experiences about climate risks into program management and implementation.

Linkages between Ministry programs and CAI must be strengthened. CAI offers a unique opportunity to build on strong local collaboration and industry investment in innovation. Efforts should be made by both CAI and the Ministry to systematically integrate relevant learnings from CAI into programming. It should be recognized that adaptation is a slow and on-going process: initial results will require confirmation and replication, and early progress will be slow.

Moving forward, several actions have been identified for CAI and the Ministry's climate action team to ensure more effective communication and knowledge sharing between Ministry staff and CAI. The intention would be to support for broader interaction between Ministry staff and CAI, where CAI can be clearly seen as a resource for Ministry programming (just as the Ministry is a resource for CAI programming). In addition to CAI insights on climate adaptation, CAI engagement practices such as small group planning and structured focus group discussions may be relevant for Ministry programs.

CAI action on key elements relating to the Ministry:

- identification of emerging adaptation issues
- share publications, reports, and planning tools
- outreach to industry, extension or field schools, as relevant
- presentations and communications materials
- serve as a resource for discussion of implications of CAI work with ministry programs and management

Ministry's Climate Action Team actions:

- develop program-focused summaries of CAI results
- organize and facilitate dialogue sessions with program units
- help to identify funding for relevant staff engagement and learning opportunities, where possible

The Ministry has strong demonstrated strong capacity to adapt and learn. One example is its experience with avian influenza in the Fraser Valley. The 2008-9 outbreak provided lessons that were applied to better control and manage the 2014 episode, such as through better spatial analysis and premises identification, communications protocols, and clarification of inter-agency roles and responsibilities.

Some learning can be accomplished through shared documentation, but learning also means shared experience and testing of assumptions through face-to-face interaction and field visits. Learning is best structured as a two-way (or multi-directional) exchange recognizing that different participants hold various kinds of knowledge relevant to decisions to manage climate risks.

This strategy proposes five mechanisms for strengthening learning and communication about climate impacts and adaptation within the Ministry in order to integrate these into programming:

1. **adaptation contact group**
2. **multi-party adaptation dialogues**
3. **information briefs and digests highlighting recent lessons for programs**
4. **field visits**
5. **key role of the Ministry's regional agrologists and industry specialists**

2.4.2 Adaptation Contact Group

As the Ministry integrates climate adaptation into its ongoing programming, support from the climate action team will be crucial.

- While adaptation is relevant to many Ministry programs, and some programs are already considering climate change in their work, it would be helpful if contacts were clearly identified for providing support or updates.
- It would also be beneficial if program areas were to see how adaptation has been successfully integrated into operational tasks, and benefit from sharing adaptation experience between different program areas.

For these purposes, it would be helpful to have an informal adaptation contact group in the Ministry, with representation from each of the relevant programs. The main role of the contact group would be information sharing, serving as an entry point for program or regional colleagues to identify relevant emerging climate opportunities or practical lessons.

- At the regional or program level, the contact person should be somebody with an interest in the topic and with working networks of Ministry colleagues.
- Content should be of direct relevance to Ministry program areas
- Membership in the group would be up to each program area to determine, and could include program leads or designated expert staff, as well as staff who have a particular interest in the subject matter and those that were part of the ADAPTool assessment.
- The group would be coordinated by the Ministry's climate action team.
- While regular meetings may not be required, the establishment of designated contacts would make it easier to consult quickly on specific issues or opportunities.

2.4.3 Adaptation Dialogue Sessions

The program areas know their own context best, and would benefit from knowledge about the interacting risks of accelerating climate change.

- A learning-oriented dialogue session provides a constructive format for introducing new knowledge, identifying opportunities, and discussing appropriate responses and follow-up actions (such as additional monitoring, detailed studies or support mechanisms).
- The learning dialogues should be facilitated and led by the Ministry's climate action team, in response to program agendas and priorities.
- A key part of each dialogue would be the presentation of new information from a recent study or practice, typically by an expert familiar with the work who can respond to questions.
- The type of information delivered can be best targeted if organizers are clear on who the participants will be and the program's current strategic plans.
- A proposed outline for an adaptation dialogue is shown in Annex 4.
- A target of two to four dialogue sessions per year could be held.

Preparation for an adaptation dialogue session will involve identification of a candidate program and a relevant topic for which new information has become available as a result of recent studies or practice. A climate change topic may be brought forward by the program or by the climate action team.

With the ongoing work of CAI, there will be many opportunities in the next two years to discuss and present results of interest to programs. For example, results from the CAI pilot project in the Peace Region to undertake collaborative monitoring for pests, disease, weeds and invasive species will be of interest to the Pest Management / Plant Health group.

2.4.4 Information Briefs

The climate action team already closely tracks activities of CAI and related initiatives. Key results of potential program area interest should be summarized by the Ministry's climate action team in a concise 2 - 3 page format, with Ministry staff as the target audience. The briefs should focus on new information relevant to agricultural management decisions in B.C., and be clearly targeted at specific program issues.

- Each summary would focus on a single issue or CAI project. It is anticipated that 2 - 4 of these could be generated each year.
- The summary should conclude with 2 - 3 questions that would form the basis discussion with interested respondents.
- For example, a discussion brief could be developed based on results from the CAI Delta Flood Preparation and Mitigation Pilot, highlighting potential implications and recommendations for EFP and BMP programming and documentation.
- Another example would be to produce a brief review of the forthcoming Climate Action Plan for FLNRO's Wildfire Management Branch, highlighting practical implications for ranching operations, the Agricultural Emergency Management Program, and for regional agrologists.

The informational briefs would be circulated in the Ministry through the adaptation contact group, and a conference call with those interested would be scheduled. Follow-up discussions would review the content of the brief, provide more detail, respond to questions, and identify potential implications. CAI or other experts may join the call, depending on availability.

2.4.5 Field Visits

Field visits to consider new practices or climate impacts can be very effective learning tools, particularly if they involve producers and producer organizations as well as other stakeholders such as local government.

- These field visits not only demonstrate practical issues, but allow discussion and interaction among the participants. For example, inspection of new drainage approaches could help illustrate the importance not only of on-site, farm-based measures for producers, but also of improved land use planning and municipal infrastructure management.

The adaptation contact group would provide a mechanism for informing colleagues of field visit opportunities and outcomes. Field visits will be developed as opportunities arise, but are likely to be infrequent and should be coordinated with events scheduled by CAI or producer organizations.

2.4.6 Key Role of Regional Agrologists and Industry Specialists

All of these mechanisms (Adaptation Contact Group, adaptation dialogues, informational briefs, and field visits) should include an important role for regional agrologists, who are frequently the key Ministry partners for local and regional CAI initiatives, and are on the front lines of interaction with producers. Industry specialists may also play a similar role in relation to particular production systems.

The agrologists are the "eyes and ears" of the Ministry. As active participants and advisors in CAI projects, they are well placed to provide critical insight into programmatic implications of regional and farm-level adaptation projects. These insights should be exchanged with appropriate program leads and technical staff. Key requirements for this communications and learning role are:

- Regional agrologists and industry specialists are supported with time and resources to engage in CAI and other adaptation initiatives and to review experiences with each other and with Ministry colleagues.
- Program staff can create opportunities for interaction (preferably face-to-face) with regional agrologists to discuss relevant issues.

These interaction opportunities are necessary for effective learning and capitalizing on the opportunity for regional agrologists and industry specialists to facilitate adaptation into programming. This role could be supported through leveraging resources for:

- **Regular interaction between regional agrologists, the climate action team, and CAI to update on project results and issues (e.g. conference calls or face-to-face meetings twice a year).**
- **Meetings between agrologists or industry specialists and program leads about specific regional or commodity-based program related issues flagged through these interactions.**
- **Regional agrologist or industry specialist participation in Adaptation Dialogues with program staff and external adaptation resource persons.**

2.4.7 Program Capacity Building

The impacts of climate change on the agriculture sector, and the ability of producers to adapt and respond, will be a recurring theme for the sector in coming decades. Over time, climate adaptation will become, like other aspects of agricultural innovation, a continuing process that demands relevant and updated information, transparent analysis, and ongoing professional development. But for now the field is still novel and unfamiliar.

While there is a high level of general awareness of the issue of climate change and its relevance, the recognition of specific implications for programming responsibilities is variable. Gaps in basic knowledge of climate impacts are not widely recognized.

- Reliable general scientific information about climate change is readily available in the on-line Climate Insights 101 course, designed by the Pacific Institute for Climate Solutions (PICS) at the University of Victoria. This course allows the user to review several modules explaining the scientific basis of climate change and its impacts in B.C. This would be a useful resource to provide a common foundation for program staff to engage in further detailed discussions on adaptation measures.
- The climate action team has facilitated previous webinar presentations from CAI for Ministry staff, introducing the program and providing examples of recent work. These webinars should be continued.
- Learning and capacity building mechanisms that focus more specifically on programmatic issues can be initiated by the climate action team, in response to emerging opportunities. Program audiences will have different needs and varying levels of background, so planning for such activities should include an assessment of participants and learning needs related to the particular subject matter.

The climate action team should be recognized by the rest of the Ministry as a resource for supporting this learning and helping to build program capacities to integrate adaptation.

2.5 Program Specific Strategies and Actions

This section provides initial strategies and opportunities to integrate climate adaptation in each of the Ministry programs assessed in the ADAPTool study.

- The suggestions presented here have been identified through the ADAPTool assessment, through further consultation with program leads, or through exploratory dialogue sessions with the program staff.
- These actions would be implemented by the respective programs, with support from the climate action team as appropriate.
- The measures proposed here respond to opportunities already identified (see Table 2 below) and should be relatively easy to implement. The action details will be determined by the programs themselves and suitably incorporated into business plans.
- The actions proposed here are just a starting point – climate adaptation is an ongoing process that will evolve with additional information, experience, and new collaborative opportunities.

2.5.1 Regional Agrologist Network

Regional agrologists have a key role to play in the Ministry's adaptation strategy because they are a vital link between programs and producers. Several regional agrologists are engaged with CAI projects as members of the regional adaptation strategy working groups and project management committees. They are well placed to provide critical and practical reviews of project lessons, and to interpret ways that other Ministry programs enable or constrain local adaptation actions.

This strategy recommends that additional support and resources be provided to enable regional agrologists fulfill this important learning and advisory role.

2.5.2 Agricultural Emergency Management (AEM)

Disasters such as wildfires, flooding and drought are likely to become more frequent and to have increasing impact on agricultural producers. Many flooding events are small scale, but can have a big impact on individual producers.

- The AEM program is working with local governments to promote emergency management and disaster risk reduction measures in Agricultural Area Plans (AAPs).
- The program may wish to encourage agricultural interests to become involved in FLNRO's Landscape Fire Management Plans, which will be undertaking stakeholder consultations after the risk and threat assessment phase of their work in the Cariboo and Central Okanagan Shuswap regions in future.[14]
- There are also potential links to FLNRO's Strategic Wildfire Prevention Initiative, which includes planning, technical support, fuel management training and funding for local governments and First Nations.

The AEM program has had discussions with CAI about several projects: Flooding Preparedness and Mitigation in Delta (DL07), Extreme Weather Events Preparedness in Cowichan (CW04) and Wildfire Preparedness and Mitigation in the Cariboo (CB01) (see list of CAI projects in Annex 3).

[14] L. Gawalko, Manager – Wildfire Management, FLNRO, pers comm. March 9, 2015.

- **As CAI's emergency management related projects are completed, they should serve as the basis for a facilitated adaptation dialogue session to share the content of project reports and to reflect on key learnings and transferrable options for both risk reduction and emergency response.**
- **The AEM program should follow the progress of the Fraser Basin Council's Lower Mainland Flood Management project to ensure that agricultural issues are adequately considered.**

2.5.3 Pest Management and Plant Health

Climate change is likely to lead to an expanded range for pests and pathogens, as well as the introduction of new pests. Increasing variability will complicate pest management practices and treatment advice. However, pest ecology is complex and difficult to model or predict. This suggests the high value of improved monitoring and surveillance for key agricultural regions and crops.

Results from CAI's collaborative pest monitoring project in the Peace Region should be shared with the Plant Health program.

The Plant Health program pursues opportunities for funding for 1 - 5 year projects on emerging issues in monitoring and management research, often in collaboration with producer associations who maintain their own monitoring networks. These efforts should continue, with climate change and variability issues in mind, and with a focus on pests of relevance to multiple crops.

There is potential for more collaborative monitoring and research, and for networking with other provinces and jurisdictions around pest management issues, but even this level of collaboration would be challenging without additional provincial resources for networking and engagement.

2.5.4 Production Insurance

Although climate change will mean increased likelihood of extreme weather events, the production insurance program is not at financial risk in the near term for several reasons:

- Diversity of crops grown and of regional climates mean that any single extreme weather event or disaster is unlikely to affect a large area of insured crops.
- The program is financially sound and has not seen catastrophe claims in over a decade.
- The program structure ensures that in the event of high claims from an extreme weather event, premiums will go up and coverage will decline. This provides both financial recovery and an incentive for producers to adapt.
- The highest exposure to widespread weather damage for high value crops is for risks of frost and winterfreeze, which are declining in frequency.

While the Production Insurance program appears robust and supportive of climate adaptation, if several severe weather events occurred in different regions in the same or consecutive years, this could strain the program and expose producers to much higher levels of risk due to reduced coverage. Although such a combination of events may become more likely under a changing climate, this likelihood in any given year would still be very low in the near term. In fact, recent trends have been the opposite: claims are steady or declining while participation in the program has stayed relatively constant. Moreover, producers have adopted technologies and practices to reduce typical climate risk exposure (e.g. varietal selection in fruit trees and vines; zero-tillage and more robust seed stock for grains and oilseeds), which also appears to have moderated claims.

The production insurance program is structured to support producer adaptation and innovation. However, there are premium subsidies may deter desirable producer adaptation and lead to problems of adverse selection. Improved information about the effects of changing climate risk on claims and coverage in future would be helpful for producers.

A key issue as climate risks increase is to obtain more information from producers about affordability and the level of uninsured losses, recognizing that premium subsidies and lower incentives for adaptation are also challenges.

Potential actions to support the integration of climate change adaptation in the Production Insurance program include:

- **Support efforts to improve digital claims database with geo-referencing and weather event data, and explore how to share this data more effectively with the industry.**
- **Monitor producer responses to climate risks, particularly if claims increase and coverage declines.**
- **A key issue is the question of continued affordability and uninsured losses. This may include consultation with existing producer advisory groups or with CAI, based on their networks of regional contacts.**
- **For GF3 considerations, monitor the outcomes of the Manitoba provincial task force on BRM programs, and similar assessments being undertaken by other provinces, to evaluate implications for B.C. and ensure that premium subsidies do not create disincentives for producer adaptation.**

2.5.5 Strengthening Farming

The program supports resolution of land-use conflicts and community planning for a sustainable agriculture industry in B.C. Both components of the program will be affected by climate change. Water management is likely to be an early issue. Increased runoff and frequency of extreme events will lead to diverging interests between urban communities and nearby agricultural areas. Issues of drainage and flood discharge, dike protection and flood retention areas, and risk reduction or planning all involve interaction between adjacent urban and rural areas. Many of the Strengthening Farming program's current tools and procedures will be directly relevant in these situations.

- **The Strengthening Farming program can assist in bringing together local government bodies and producers to gain agreement on what the issues are in order to develop solution strategies that may involve senior levels of government. The Agriculture Advisory Committees serve as an important source of intelligence on emerging issues.**
- **The program produces valuable tools such as land use inventory and GIS, and should add applications that deal specifically with flood retention and runoff management in land use planning applications.**
- **Potential issues for consideration include: emerging subdivision guidelines and stormwater runoff guidelines that rely more heavily on "green infrastructure"; wildfire protection planning; and emerging Water Sustainability Plans under the new *Water Act*.**

2.5.6 Agroforestry

The Agroforestry program is small but already oriented to climate adaptation.

- There is a recognition that agroforestry can contribute to landscape and ecosystem management to improve climate buffers, reduce erosion, manage runoff and modify extreme temperatures at a site level.

- The program is structured to foster engagement, learning and support to regional colleagues and producer organizations, and in this respect serves as a model. However, the program's potential influence is limited due to its small size.

Extreme heat and cold, wind and winter storms, flooding and drainage projects, and changing water management planning may all have implications for agroforestry.

- **Program actions should include assessing CAI regional adaptation strategies to identify opportunities for agroforestry measures, and monitoring agroforestry demand and interest related to climate.**
- **Agroforestry should be promoted where relevant to meet land use objectives and ecosystem services at site and landscape scales to help meet climate buffering demands under increased threat of extreme climate conditions (e.g. flood and erosion control; water management; shade management).**
- **Regional demonstrations and extension materials related to adaptation applications should be expanded as possible and new partnerships with producers explored in response to demand.**
- **New watershed management and local integrated water sustainability planning processes may provide further opportunities for agroforestry promotion.**

2.5.7 Environmental Farm Plan and Beneficial Management Practices Programs

These programs emphasize planning and practices for managing environmental risk to improve sustainability of agricultural practices. They already consider climate risks but need to be sensitive to how these risks are changing. Examples include flood risks, runoff and soil erosion, heat waves and drought protection measures. In all cases, the emphasis should be on risk reduction, both on individual farms and in agricultural communities where risks are affected by action on adjacent lands.

- **In light of growing wildfire risk, the program should consider linkages to the national FireSmart program and its on-line tools for assessment of fire risk to buildings and yards in forest interface areas.[15]**
- **Consideration should also be given to extending financial support to investments that reduce climate risks under this program in environmentally sustainable ways, e.g. funding for farm level reservoir construction and inspection; funding for erosion management and levelling; agroforestry for slope stabilization, riparian integrity, and wetland protection and retention.**
- **The EFP and BMP programs already interact with CAI and could maximize their benefits from relevant CAI projects through the proposed Adaptation Dialogues and other interactive learning tools. The programs should monitor the CAI's Integrated Farm Water Planning Project (CW06); Delta Flood Preparedness and Mitigation (DL07); and Cariboo Livestock Surface Water Assessment (CB04).**

2.5.8 Agriculture Water Management Program

The Agriculture Water Management Program provides analytical support for water management in agriculture, so it is already oriented to climate issues and adaptation. The program's services are likely to be increasingly valuable as the B.C. climate changes.

The program has implemented ADAPTool recommendations by expanding its services into new regions. It provides modelling support to agricultural water demand estimates, which are likely to

[15] http://bcwildfire.com/Prevention/FireSmart.htm

become more widespread as local governments and water management organizations introduce Water Sustainability Plans under the new *Water Act*.

- **The program should keep informed on CAI projects that relate to water use, such as weather monitoring and support tools (PC05) and potential for irrigation in the Peace Region (PC06).**
- **Drainage and flooding issues are also relevant to water demand modelling, and the program is already aware of the CAI work in Delta on drainage issues.**
- **As new planning processes are implemented for water management, the program should be attentive to how issues of data sharing can be addressed to build confidence and trust between agencies while safeguarding privacy.**
- **Another issue for future consideration is that as water use efficiency increases, there is less scope for reductions in use under severe drought conditions. This has implications for provincial drought management responses in the agricultural sector.**

2.5.9 Agrifood Business Development

This program is already responsive to local producer and business priorities, so is well placed to identify emerging priorities as climate risks become more important to producers. But the program does not explicitly identify changing climate factors and how these would be likely to influence risk management or market opportunities.

- Increasing precipitation in spring and fall seasons in various regions could create challenges for harvesting, storage and processing of produce.
- Warmer, drier summers in southern regions may create new market opportunities in B.C. at the same time as production declines in other areas (e.g. California).

The CAI project investigating enhanced local processing and storage in the Cowichan Valley, now complete, may be a helpful starting point. Competitive opportunities for the industry will change as production shifts in other regions of North America, and globally. These issues may be relevant for the Agrifood Business Development program in the longer term.

Table 2: Review of opportunities and proposed initial actions for integrating adaptation into program areas

Program Areas	Current Opportunities	Potential for Integrating Adaptation	Proposed Initial Actions
Ministry of Agriculture Climate Action Team	- mandate to support climate mitigation and adaptation responses within the Ministry	- role is to support integration in other programs	- Establish and coordinate Adaptation Contact Group - Lead 2 - 4 climate adaptation dialogue sessions per year - Prepare up to 4 adaptation briefs / digests per year
B.C. Agriculture and Food Climate Action Initiative (CAI)	- delivers Regional Adaptation Enhancement Program and Farm Adaptation Innovator Program - collaboratively develops Regional Adaptation Strategies, implements priority projects - supports farm-level adaptation through competitive grant applications - documents and shares project results	- adaptation is the key focus of the program already	- Support adaptation dialogue sessions and information sharing opportunities. - Invite ministry staff to field events. - Support climate action team to develop information packages targeted at specific program and management audiences.
Regional Agrologists & Industry Specialists	- agrologists are often involved in project management for CAI projects and identify local connections to many other programs. - contacts for local issues arising from Water Sustainability Plans; FireSmart planning; regional drought management	- familiar with local and regional issues / innovations and are key to effective implementation of many other programs - front lines for regional interaction with other agencies (wildfire, water, drought management)	- Continue to support CAI pilot projects. - Create more frequent opportunities for team learning and interaction. - Help identify emerging issues of climate risk and adaptation for other programs. - Share knowledge of CAI projects.
Agricultural Emergency Management	- links/lessons from CAI projects including Delta Flooding Preparedness and Mitigation, Extreme Weather Event Preparedness and Mitigation in the Cowichan and Widlfire Preparedness and Mitigation in the Cariboo - FBC Lower Mainland flood management project - FireSmart program: FLNRO	- CAI studies can point to regional hazards that are likely to be exacerbated by climate change, to focus information strategies with producer groups - growing need for consideration of risk reduction measures at farm and community scale - potential to coordinate with EFP / BMP to harmonize messaging - collaborate with FLNRO and local	- Provide more information to producers and local government on risk reduction measures for extreme climate events (flood, wildfire, drought). - Strengthen communication of specific risks with local government and producers (e.g. drought situation on VI). - Coordinate farm-level messaging on risk reduction, site planning, EM with EFP. - Promote emergency planning and risk

Program Areas	Current Opportunities	Potential for Integrating Adaptation	Proposed Initial Actions
	connection - drought management a growing issue in the interior (forage, livestock watering)	governments on planning for wildfire risk reduction	reduction in local government AAPs. - Develop a system for better tracking local government coordination of agricultural EM. - Appoint a representative to FBC Joint Program Committee to monitor Lower Mainland flood management study.
Plant Health & Pest Management	- CAI Collaborative monitoring project in the Peace (underway) - opportunities to commission new studies around specific questions, perhaps in collaboration with industry	- how to maintain and build on knowledge gains of 2 yr CAI project to strengthen surveillance - identify emerging research or monitoring issues in collaboration with producers, AAFC	- Identify specific emerging pest threats with industry. - Continue collaborative monitoring and research projects with industry, focusing on pests relevant to a variety of crops. - Review lessons from CAI collaborative monitoring project in Peace Region and consider how to improve monitoring information for high-value crops.
Production Insurance	- Manitoba BRM Task Force: reviewing changing climate risks and program performance (some interest in other provinces as well)	- efforts to improve data base to ensure geospatial and weather event data are tied to claims - consult with producers around issue of premium subsidies as disincentive for adaptation	- Monitor outcomes of MB Task Force. - Implement proposed database enhancements (geospatial / weather data) to provide better information on climate-related losses. - Explore emerging producer concerns on climate risk management with CAI. - Monitor farmer advisory committees to assess whether coverage meets risk management needs while providing incentives for adaptation as climate risks increase.
Strengthening Farming	- CAI study defining a new approach to Agricultural Land Use Inventory in the BC Peace (PC04) - CAI regional adaptation strategies - *Water Act* implementation - FBC Lower Mainland Flood Management study: implications for land use and local planning	- monitor emerging issues in local planning (particularly dealing with subdivision, drainage, flood retention, etc) - potential FireSmart connections to agricultural producers for wildfire planning	- Recognize and build program knowledge about climate risks related to land use planning: e.g. flood management, drainage, water consumption. - Monitor emerging experience with Water Sustainability Plans.

Program Areas	Current Opportunities	Potential for Integrating Adaptation	Proposed Initial Actions
Agroforestry	- FBC Lower Mainland Flood Management study - PCIC extreme events studies - CAI assessment of Shelterbelts.	- links to EMP / BMP for flood management, streambank erosion control, runoff management, etc	- Identify ecosystem services and climate buffering functions of agroforestry at site and landscape scales. - Foster demonstrations and extension through partnerships with producers and local groups.
Environmental Farm Plan & Beneficial Management Practices	- relevant CAI projects: Delta Flood Preparedness and Mitigation pilot (DL07); Cariboo Livestock Suface Water Assessment (CB04); Integrated Farm Water planning Project (CW06); … - FBC Lower Mainland Flood Management study	- emerging concerns with runoff, erosion control, water management, flood risk reduction - monitor relevant information from related activities - collaborate with AEM, other programs	- Explore how to incorporate changing climate risks and disaster risk reduction at farm and community level (with AEM). - Review results of relevant CAI projects to consider how to incorporate drought planning, drainage and flood protection measures.
Agriculture Water Management	- relevant CAI projects: PC02 Increasing availability of agriculturally relevant weather data, Possibly connect wt Delta drainage and sub-irrigation project (DL09) - FBC Lower Mainland Flood Management study	- more effort to simplifying data sharing protocols between different agencies - update models with new information from climate models and other research projects	- Anticipate increasing demand for program. - Collaborate to simplify data sharing protocols between different agencies. - Update models with new information from climate models and other research projects. - Expand program availability in new regions.
Agrifood Business Development	- CAI projects: Enhancing Local Processing and Storage in Cowichan (complete March 2014)	- support to explore business and market risks (and opportunities) associated with increasing climate variability and climate change	- Review results from relevant CAI projects. - Work with industry to explore new opportunities and impacts of changing local climate conditions.

3. Implementation and Monitoring

Implementation
Integration of climate adaptation into Ministry programming is primarily the responsibility of program leads and should be undertaken as part of ongoing business processes. The main goal of these efforts should be to support broader learning by program staff and management.

- Adaptation actions should be seen as part of continuous improvement and corporate learning processes.
- The Ministry's climate action team will support this process by facilitating adaptation dialogues, sharing new information in the form of information notes, and coordinating information exchange.
- The Climate Action Initiative will serve as a resource to these efforts, and will undertake outreach to Ministry programs by supporting the information sharing efforts of the climate action team and by collaborating directly with relevant program staff in the field.

Monitoring
Strategy implementation can be monitored using the template shown below, which can be maintained by the climate action team in collaboration with program leads.

- **For each program, the monitoring should be updated every 2 years. This can form the basis of periodic reports by the climate action team to senior management.**
- **In addition to regular monitoring of how adaptation measures are being implemented in programs, the climate action team should reassess the adaptability of programming by repeating the ADAPTool assessment in 2018, once Growing Forward 3 is in place.**
- **The next ADAPTool assessment should include both the Agricultural Land Reserve and the Climate Action Initiative. The CAI program in particular should be able to demonstrate substantial contributions to producer adaptive capacity.**
- **In the next iteration of ADAPTool, producer adaptation measures and vulnerability assessments should be updated based on the latest information from CAI.**

Summary information from the monitoring template (below) can be used to describe specific changes that have been incorporated into programs since the ADAPTool assessment. These changes can be incorporated in the analysis for the next iteration of the ADAPTool assessment, to ensure that programs are credited with the adaptation efforts they have undertaken.

- Learning mechanisms, such as those recommended in this strategy, that have been adopted and implemented at the program level should be explicitly taken into consideration in the assessment.
- The ADAPTool may also be used in the early stages of policy and program design for new program initiatives, to test their adaptability to climate change stresses.

The Ministry can anticipate that new adaptation issues will arise from several sources over time.

- Increasing producer experience with climate variability in different regions of B.C.
- New information from CAI programming: regional strategies, specific studies, pilots
- Industry initiatives to advise and support producers
- Initiatives promoted by other provinces and territories under FPT agreements

These issues will affect different programs and services offered by the Ministry.

- Because adaptation will be an ongoing process, is central to producer behaviour, and affects many different program areas, it will be important for the Ministry to assess new and existing activities to ensure that they foster producer adaptation and innovation.
- The shared learning tools recommended in this strategy can provide mechanisms for collaborative assessment of emerging opportunities. ADAPTool can also be applied to planned or existing programs to assess their adaptability as conditions change.

The Ministry's success in fostering innovation and adaptive responses to climate change by producers will be reflected in the performance of the agriculture sector. This is not just a matter of Ministry programs, but also about producer associations and services in the industry that support innovation and competitiveness.

The climate action team should identify and track actionable issues that arise from CAI's regional strategies and farm pilot projects, share these with program staff using the learning mechanisms recommended above, and then jointly assess the need for followup measures.

In the long term, indicators of success in climate adaptation will include:
- measures of agricultural output and revenue (farm cash receipts)
- recorded insured and uninsured losses from weather events (BRM data)
- level of losses and speed or recovery from climate disasters (BRM data)

These measures will fluctuate in the short term, but significant variations should be examined critically. If there were high future levels of climate losses and significant losses from natural disasters, the Ministry should re-appraise adaptation measures, producer risk reduction behaviour, and related information resources provided by the Ministry's programs.

Table 3: Monitoring Template for Integrating Adaptation into Programs

Date:	**Program Name:**
1. Climate implications for program are identified	- list most important issues from CAI regional adaptation strategies, or other studies, relevant to the program - producer concerns raised in recent consultations or through CAI - areas of potential weakness or vulnerability relative to these climate impacts / demands
2. Program has explored recent innovations or lessons	- summary of documented output from adaptation dialogue, field visit, study, publication review or other knowledge sharing mechanism - potential opportunities for collaboration or innovation with external organizations
3. Actions identified to address priority adaptation issues	- 3 to 5 feasible actions over short to medium term - Program areas should identify metrics to assess the implementation of their actions - may be conditional on resources
4. Actions implemented	- document actions implemented
5. Explanatory notes / plans for upcoming period	- actions planned for next 2 years

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Annex 1: Recommendations of ADAPTool Assessment (2013)

ADAPTool Assessment – Actions for 5 Key Programs

AgriStability

1. Monitor the program to assess whether increasing climate variability and extremes are affecting the AgriStability program's ability to meet its policy objectives, as a means of preparing for future program design discussions.
2. Employ greater use of multistakeholder deliberation in implementation and decentralize decision making to aid in responding to regional diversity and increasing climate variability.

Production Insurance

1. In regular actuarial certifications, consider whether the effects of climate change are affecting recent loss experience to an extent that shifts in coverage and/or premium rates are required. The certifications should also consider if self-sustainability mechanisms remain adequate.
2. Evaluate production insurance to determine if the program and the premium structure adequately support the introduction of new and potentially better-adapted crops and cultivars and encourage other innovative adaptation measures that farmers adopt due to climate change.
3. Evaluate production insurance governance models in other jurisdictions to determine options for increased decentralization of decision making.

Agricultural Emergency Management

1. Conduct a review of provincial agricultural vulnerabilities to extreme events, including identification of significant gaps in preparedness and risk mitigation at the broad scale (e.g., infrastructure issues).
2. Collaborate with the B.C. Agriculture and Food Climate Action Initiative on projects to pilot risk reduction measures with producers.
3. Expand engagement with local authorities and agriculture sectors to increase their emergency preparedness and recovery for events that affect agriculture, and continue to conduct after-action event reviews.

Invasive Alien Plant Program and Pest Management/Plant Health (for both programs)

1. Conduct further study of program needs and available resourcing within the next 12 months to ensure that emerging priorities are addressed.
2. Consider whether current monitoring of invasive plants and emerging pests is sufficient to ensure that highest priorities and risks are being tackled as new threats emerge.
3. Identify priority areas for research.

Additional action:

1. Create a climate adaptation contact group with a designated representative from each program area, coordinated by the ministry's climate action team, to support the government's strategic direction to mainstream adaptation across ministry programs.

Annex 2: Climate Action Initiative and Ministry of Agriculture

CAI was initiated by the B.C. Agriculture Council in 2008, with funding from Investment Agriculture Foundation and the Ministry. Over the past five years CAI has been very productive, undertaking regional climate change risk and opportunity assessments, and regional adaptation strategies, implementing pilot projects based on producer-identified priorities, and initiating the Farm Adaptation Innovator program, all undertaken in close collaboration with producer and industry groups, and with the support of Ministry staff. In 2013 the CAI was engaged by the Ministry to deliver its industry-led climate change adaptation program, funded by the innovation component of Growing Forward 2, a federal-provincial-territorial initiative.

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CAI has been very effective at engaging Ministry staff on regional strategies and projects. As a result, these staff are familiar with CAI work. However, neither the Ministry nor CAI have devoted much effort yet to determining how lessons from CAI projects will be systematically integrated into regular Ministry programming. This is understandable as there has been a tremendous effort involved in setting up the program, undertaking regional studies, establishing relations with stakeholder groups, defining priorities for pilots, initiating the Farm Adaptation Innovator funding, defining projects, managing competitions, awarding contracts and assuring deliverables. However, it would be timely to consider how best to make use of program results now that a large number of projects are underway and delivering valuable results.

Annex 3: List of CAI projects

Regional Adaptation Projects			
Region	***Proj #***	***Title and Description***	***Timeline***
Delta	1	**Potential economic and agricultural production impacts of climate change related flooding in the Fraser Delta** *Evaluation of economic and food security implications of climate change related flooding in Delta, Richmond and Surrey.*	Oct 2013 - Mar 2014
Delta	3	**Flooding preparedness and mitigation pilot project (Phase 1)** *Identify risks and develop materials and process for on-farm flooding preparedness and mitigation.*	Nov 2013 - Mar 2014
Delta	5	**Collaborative Climate Change and Agriculture Communications Strategy** *Strategy to increase public knowledge and understanding of local agriculture and climate change adaptation.*	Jan 2014- Mar 2014
Delta	DL06	**Forum: Agricultural vulnerabilities to coastal flooding** *A forum to bring together the agriculture sector and partners to share findings of project #1 and discuss plans and options for addressing climate change related flood risk.*	Nov 2014- Feb 2015
Delta	DL07	**Flooding preparedness and mitigation pilot project (Phase 2)** *Pilot individualized on-farm flood preparedness and mitigation. Evaluate pilot and develop transferable tools.*	Aug 2014 - April 2015
Delta	DL08	**Agriculture and Climate Change Outreach and Education Pilot Project** *Implement priority outreach and education activities from strategy developed in project Delta 5.*	Nov 2014 - Nov 2015
Delta	DL09	**Delta drainage and sub-irrigation project** *Analyze existing knowledge of in-field management to increase drainage and improve irrigation.*	Aug 2014 - Apr 2015
Cowichan	1	**Integrated Farm Water Planning Pilot (Phase 1)** *Develop integrated water management and planning process and toolkit*	Nov 2013- Mar 2014
Cowichan	3	**Business case for regional agriculture extension services** *Scan and evaluate extension delivery options across jurisdictions, develop and evaluate various models for extension and recommend a sustainable business model.*	Nov 2013 - Mar 2014
Cowichan	4	**Extreme Weather Events preparedness (Phase 1)** *Identify areas of vulnerability to extreme events across the region. Develop agriculture specific informational materials and strategies to prepare for an mitigate impacts of events.*	Nov 2013 - Mar 2014
Cowichan	5	**Enhancing Local Processing and Storage** *Strategy for the region to improve local processing, storage and value-added capacity through an assets inventory and options analysis.*	Nov 2013 - Mar 2014
Cowichan	CW03	**Business case for regional agriculture extension services** *Scan and evaluate extension delivery options across jurisdictions, develop and evaluate various models for extension and recommend a sustainable business model.*	Mar 2014- July 2014
Cowichan	CW04	**Extreme Weather Events preparedness and mitigation pilot project (Phase 2)***Pilot a group approach to planning, preparedness and mitigation for extreme events.*	May 2014 - Mar 2015
Cowichan	CW06	**Integrated Farm Water Planning Pilot (Phase 2)** *Undertake integrated farm water planning process and plan development with 5-10 farms.*	Sep 2014 - Apr 2015
Peace	2	**Increasing availability of agriculturally relevant weather data (Phase 1)** *Determine gaps in weather monitoring network and provide recommendations for filling gaps and developing decision support tools*	Jan 2014- Mar 2014

Peace	PC02	**Increasing availability of agriculturally relevant weather data (Phase 1)** *Determine gaps in weather monitoring network and recommendations for filling gaps and developing decision support tools*	Mar 2014- June 2014
Peace	3	**Collaborative monitoring pilot project in the BC Peace** *Implement collaborative monitoring strategy for pests, disease, weeds and invasive species.*	Jan 2014- Mar 2014
Peace	PC03	**Collaborative monitoring pilot project in the BC Peace** *Implement collaborative monitoring strategy for pests, disease, weeds and invasive species.*	Apr 2014 - Apr 2016
Peace	PC04	**Feasibility study: Defining a new approach to Agricultural Land use Inventory in the BC Peace** *Evaluate feasibility of an alternative form of Land Use Inventory process in the Peace.*	Aug 2014 - Sept 2015
Peace	PC05	**Evaluation of irrigation potential in the BC Peace region** *A study will be conducted (including four distinct areas of analysis) to support improved understanding of the irrigation potential in the Peace Region.*	Nov 2014- July 2015
Peace	PC06	**Peace agriculture weather monitoring and decision support tools** *This project will implement actions to address significant monitoring and data gaps identified in project 2 and PC02, and will develop a collaborative approach to maintaining a network over time.*	Nov 2014- Nov 2016
Cariboo	CB01	**Wildfire preparedness and mitigation planning and resources** *Complete 8-10 individual plans and 2-3 group plans for wildfire preparedness/mitigation and development of agriculture-specific resources.*	Feb 2015 - June 2016
Cariboo	CB02	**Cooperative maintenance and enhancement of agriculturally significant dams** *Complete agricultural dams inventory, identifiy priority dams, and document issues and secondary benefits. Provide recommendations for cooperative approaches to dam maintenance and enhancement.*	Nov 2014- May 2015
Cariboo	CB04	**Livestock surface water assessment and options** *Assessment of surface water available for livestock and options for access.*	Feb 2015 - Nov 2015

Farm Adaptation Projects

	Proj #	*Title and Description*	*Timeline*
FAIF	FI01	**Using Management-intensive Grazing for Adapting to and Mitigating Climate Change** *Test MiG for its potential as a tool for adaptation and mitigaiton of climate change through carbon sequestration, soil moisture retention and enhanced plant diversity.*	May 2014 - April 2017
FAIF	FI02	**Vented orchard covers to protect cherries from rain and hail** *Piloting a net to protect orchards from rain and hail and transferring knowledge to growers.*	Jul 2014 - Nov 2017
FAIF	FI03	**Innovative Forage Practices** *Demonstrating innovative forage production practices to increase climate change adaptation including user manual/guide.*	Oct 2014 - May 2017
FAIF	FI04	**Evaluation of thrips damage to potatoes in a changing climate** *Evaluating yield loss due to thrips damage in relation to growing season conditions.*	Jan 2015 - June 2017
FAIF	FI05	**Economic, social & environmental benefits of riparian rehabilitation as a climate change adaptation strategy** *Project will assess efficacy of group Environmental Farm Plan process in Alderson Creek drainage.*	March 2015 - Feb 2018

Annex 4: Proposed Structure for Climate Dialogue Sessions

As part of its commitment to integrating climate change adaptation into all Ministry programs, the Ministry of Agriculture will plan a series of informal, program-focused dialogues in close cooperation with The B.C. Agriculture and Food Climate Action Initiative (CAI). Timing of these events could be approximately semi-annually, but should be flexible to complement other meeting opportunities and respond to program priorities.

Preparation
Experience with conducting 2 pilot sessions in February 2015 suggests the value of early discussion with managers and program leads in planning the workshops, particularly about:

- **Who should be invited**?
  Which regional agrologists or industry specialists do you work most closely with already? The idea is to get the core people who know the program and are already active in framing / responding to program issues. The intent is to focus on issues of program strategies and planning.
- **What are the areas of program activity most closely related to climate?**
  Who is already engaged with CAI? Who is not? How is info from CAI fed back to the program now?
- **Agenda**
  Test some potential focal areas for program implications from climate change, based on agenda materials
- **How can the session be structured to provide useful feedback to the program's own strategic planning efforts?**
  What is the program planning to do,and how can the Adaptation Dialogue support that?
- **Subject matter experts**
  Make sure the resource persons can speak to program-specific interests.

Introduction for Program Area Staff
Climate change is beginning to affect agricultural producers in B.C. and these effects are expected to accelerate. Do these changes affect your program? What issues do you see from the program side? What concerns are emerging among producers or producer groups?

We propose a 2 – 3 hour dialogue that allows program staff to explore issues of concern to them and to agricultural producers, based on their own experience, and evidence from CAI regional profiles and projects.

The expected result will be improved understanding of the program risks posed by climate change and the implications (if any) for program planning and management. Where there are significant implications for programming, this will allow program managers to plan for any adjustments necessary to ensure program effectiveness. Where there are no significant implications for programming, this exercise will provide confidence and evidence of how the Ministry has assessed the issues.

The discussion will be structured around 6 general principles and 3 guiding questions.

General Principles

1. Sessions are scheduled based on program area interest and Ministry priorities
2. Program staff bring their questions and concerns
3. External resource persons bring new knowledge about recent studies or producer practices in the sector
4. Both managers and regional staff should be involved. Regional agrologists should be invited wherever possible.
5. Content specific to program or theme
6. Process is light and low-cost

Guiding question 1: What are the implications of climate change for this program?

1. Changing climate risks – what do we see already in relation to this topic? (~30 min). External resource persons set the stage, with open discussion about interactions between climate risk and other agricultural business risks in relation to the specific topic and program focus. Particular attention paid to the producer perspective.
2. What are the Ministry's responsibilities in relation to existing programming; and / or public profile or perceived responsibility that could expose it to liability (~10 min)

Guiding question 2: What recent innovations or lessons can provide insights for the program?

3. Presentation of new knowledge or practices related to climate adaptation in agriculture sector (~30 min) e.g. CAI
4. How might these issues affect Ministry functions and programming? (~20 min)

Guiding question 3: What follow-up actions should be undertaken?

5. What strategies would be appropriate to ensure that programs continue to meet producer needs under a changing risk profile? This could include program actions, further consultation, monitoring, or detailed studies, if any action required. (~30 min)
    a. What aspects of your current programming and practices could be adjusted in light of the information discussed at this session?
    b. What questions need to be resolved before action can be taken?
6. Follow-up measures or next steps (if any required)

Potential Participants (depends on theme / location)

- Innovation and Adaptation Services Branch management
- Manager and staff of climate action team
- Program lead(s)
- Regional staff
- Regional agrologist(s) and industry specialists – relevant to theme
- CAI
- External resource person(s) (depending on topic)

Total: about 10 – 12 people

Annex 5: External Organizations Consulted

B.C. Agriculture and Food Climate Action Initiative

Emily MacNair – Manager, Adaptation Programming
Emily@BCAgClimateAction.ca

Samantha Charlton – Project Coordinator, Regional Adaptation Program
samantha@bcagclimateaction.ca

Fraser Basin Council

Steve Litke – Senior Program Manager
slitke@fraserbasin.bc.ca

Ministry of Forests, Lands and Natural Resource Operations

Kathy Hopkins – Technical Advisor, Climate Change; Competitiveness and Innovation Branch
Kathy.Hopkins@gov.bc.ca

Lyle Gawalko – Manager, Fire Management; Wildfire Management Headquarters
Lyle.Gawalko@gov.bc.ca

Manitoba Agriculture, Food and Rural Development

Matt Wiens – Landscape Stewardship Specialist; Agri-Environment Knowledge Centre
Matt.Wiens@gov.mb.ca

Annex 6: Ministry of Agriculture Program Contacts

Name	Title	Program
Grant Halm	Program Specialist Business Risk Management Branch	Production Insurance
Leslie MacDonald	Assistant Director Sector Development Branch	Agriculture Emergency Management
Brent Barclay	Resource Stewardship Agrologist Sector Development Branch	Agriculture Emergency Management
Orlando Schmidt	Regional Manager, Coast Sector Development Branch	Regional Agrologist Network
Greg Tegart	Regional Manager, Interior Sector Development Branch	Regional Agrologist Network
Greg Bartle	Land Use Planner Innovation and Adaptation Services Branch	Strengthening Farming
Dave Trotter	Agroforestry Specialist Sector Development Branch	Agroforestry
Tracy Hueppelsheuser	Entomologist Plant Health Unit Plant and Animal Health Branch	Pest Management (Plant Health)
Gayle Jesperson	Plant Pathologist and Acting Manager, Plant Health Plant and Animal Health Branch	Pest Management (Plant Health)
Geoff Hughes-Games	Manager, Resource Management Innovation and Adaptation Services Branch	Environmental Farm Plan Program Beneficial Management Practices Program
Stephanie Tam	Water Management Engineer Innovation and Adaptation Services Branch	Agriculture Water Management
Carly Haycroft	Agri-Innovation Officer – Climate Action Innovation and Adaptation Services Branch	Climate Action Team
Anna Stemberger	Climate Change Researcher Innovation and Adaptation Services Branch	Climate Action Team
Ian McLachlan	Manager – Climate Action Innovation and Adaptation Services Branch	Climate Action Team

Annex 7: B.C. Climate Change Adaptation Strategy: Core Deliverables

http://www.livesmartbc.ca/attachments/Adaptation_Strategy.pdf

Strategy 1: Build a strong foundation of knowledge

Engage climate science:

- Continue engaging with the research institutions Pacific Institute for Climate Solutions (PICS), Pacific Climate Impacts Consortium (PCIC) and other research centres to ensure they produce high quality applied science information that decision-makers need.

Continue building robust observation networks:

- The Ministries of Environment, Forests and Range, and Transportation and Infrastructure will jointly develop a long-term climate related monitoring program to optimize the value of existing data and networks in partnership with PCIC.
- Explore opportunities to gather climate change observations in other vulnerable sectors, such as health, agriculture and ecosystems.

Develop adaptation planning tools for decision-makers:

- Promote and support the development of tools that can be used by a broad range of decision-makers taking adaptation actions. Such tools could include: guides for local government, and climate change assessment methods for identifying and evaluating adaptation options.

Continue knowledge transfer and outreach activities:

- Continue supporting existing organizations that work with decision-makers to help them prepare for climate change.
- Work with PICS to develop a continuing education program on climate change impacts and adaptation for professionals (e.g. engineers) and decision-makers (e.g. local government).
- Incorporate, where appropriate, adaptation concepts and actions into provincial climate change outreach programs.

Strategy 2: Make adaptation part of Government's business

Consider adaptation in planning:

- Ministries will consider climate change impacts by incorporating adaptation in Ministry Service Plans and business planning, where relevant.
- Integrate adaptation into B.C. Government policies, legislation and regulations:
    - Ministries will consider climate change impacts and adaptation when drafting new or amending existing legislation and regulations.
- Identify approvals that are sensitive to climate by determining whether climate change impacts will be significant over the life of a decision and, where possible, incorporate consideration of climate change impacts into the approvals process.

Implement through a coordinated approach:

- Strengthen cross-government coordination to ensure that ministries share experiences, have access to the same information and work towards common goals.
- Engage and work with partners in other levels of government, the private and non-profit sectors and other jurisdictions.
- Integrate adaptation into the strategies for building B.C.'s Green Economy.

Strategy 3: Assess risks and implement priority adaptation actions in sectors

Assess risks and implement actions:

- Conduct climate change assessments for sectors known to be sensitive to climate change.
- Establish Sector Working Groups with government and stakeholder co-chairs to lead the process. The assessment will be supported by appropriate social and natural science experts from the Pacific Institute for Climate Solutions.
- Review and update, through the assessment process, existing B.C. Government policies, strategies and operational activities to ensure that they will deliver the desired objectives for their sectors in a changing climate.
- Implementation of sector assessments will be a staged process, beginning with one or two key sectors.

Partners:

The B.C. Government will work with local and federal governments, First Nations and other stakeholders, including research institutions, non-governmental organizations, and professional associations, to implement specific core deliverables.

– END OF DOCUMENT –

Page 254 to/à Page 268

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Ministry of Agriculture
2013 Carbon Neutral Action Report Overview

28 May 2014

This is the 2013 Carbon Neutral Action Report (CNAR) for the Ministry of Agriculture. This report discusses actions taken in 2013 to reduce the Ministry's greenhouse gas emissions, improve sustainability, and support adaptation by the agriculture industry. The report also discusses our plans to continue in these areas in 2014 and beyond.

1. 2013 Fleet Vehicles, Business Travel, Buildings, and Paper Consumption

The Ministry showed a reduction in fleet, travel and buildings emissions and an increase in paper consumption in 2013 and over the past three years. Emissions for 2013 and trends for the three year period 2011-2013, since Lands was shifted from the Ministry, are discussed below.

Fleet Vehicles

- Fleet emissions have decreased 12% per year over the past three years, due in part to travel restrictions and sustained efforts to carpool, walk, bike or bus to meetings.
- For most of 2013, the fleet included 50 vehicles, 16 of which are hybrids.
- The transfer of the meat hygiene inspection unit to the Ministry in 2013 required the purchase of 20 additional vehicles in late 2013. However, 2013 emissions were still down, even including the use of these 20 additional vehicles.
- While the purchase of a hybrid vehicle was considered, a suitable hybrid is not available to meet the requirements for the work of the meat inspector.

Business Travel

- Business travel emissions have been reduced almost 50% over the past three years, due in part to travel restrictions and sustained efforts to reduce travel and utilize electronic meeting tools.
- Video conferencing equipment was purchased for Victoria and Abbotsford boardrooms in 2013.

Buildings

- Buildings-related emissions, which accounted for over 80% of total emissions, were reduced by 12% or 220 tonnes CO_2e in 2013.
- At the Abbotsford Agriculture Centre, the air conditioning system was upgraded to a high efficiency system and low wattage LED lighting was installed in some parts of the building. This change was likely responsible for the reduction in emissions related to heating, cooling and lighting buildings.
- While the Abbotsford Agriculture Centre is owned by the Province, most of the Ministry's other floor space is rented. Opportunities for GHG emission reduction actions are limited in rental buildings. Efforts such as automatic light sweeps to turn off lights in the evening which were implemented in the rented building in Victoria (808 Douglas Street) have continued.

Paper Consumption

- While paper consumption emissions were less than 1% of total emissions, they have increased by 55% over the past three years.
- This increase has occurred despite continued efforts to reduce paper consumption, such as automatic double-sided printing.

The Ministry spent $48,300 to purchase carbon offsets against its 2013 emissions of 1,932 tonnes CO_2e. The offsets were purchased from the Pacific Carbon Trust for $25/tonne.

2. 2014 Carbon Neutral Action Plan

Fleet Vehicles

- No new vehicle purchases are anticipated for 2014.
- Efforts to reduce fleet vehicle emissions by carpooling, walking, biking or taking the bus to meetings will continue to be supported.

Business Travel

- Efforts to reduce travel and utilize electronic meeting tools will continue to be supported.
- Individual webcams will be purchased for staff to facilitate Live Meetings as a travel alternative.
- Additional video conference equipment may be purchased to reduce meeting travel.

Buildings

- The lease on the main Victoria building, 808 Douglas Street, expires March 31, 2017. For the office space it will occupy after that, the Ministry is considering options that will continue to reduce its carbon footprint.

Paper Consumption

- The Ministry plans to pilot E-Trim, an electronic records management software. The Ministry has been using TRIM to manage the paper files, and E-Trim will now be used to manage the electronic records. The potential carbon reduction implications are: less printing (power to printers, paper, ink), fewer filing supplies (folders, labels, boxes), less off-siting (boxes, labels would not be required), and space savings (the number of filing cabinets needed will be significantly reduced).
- The Ministry will continue to implement the electronic approvals system for correspondence, briefing notes, and other documents.

3. Climate Change Adaptation

The Ministry is taking actions to support adaptation in the Ministry and in the agriculture sector.

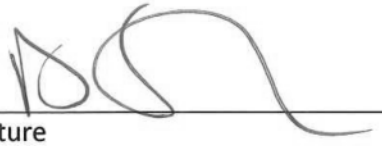
Ministry Actions

- 2013 achievements
    - A significant initiative was completed in which 14 programs were assessed to ascertain their support for climate change adaptation in the agriculture sector.
    - The assessment was led by the International Institute for Sustainable Development in partnership with the Ministry (funded by Natural Resources Canada), using the innovative Adaptive Design and Assessment Policy Tool (ADAPTool).
    - The assessment provided key findings and recommendations for going forward.

- 2014 goals
    - The Ministry will build on the ADAPTool assessments by developing an action plan for implementing the priority recommendations. Implementation of the recommendations will support the ministry in planning for climate change
    - The Ministry will encourage staff to take the new module Climate Insights 101 developed by the Pacific Institute for Climate Solutions. The new module is scheduled to be available in June 2014, and is focused on climate change adaptation.

Agriculture Sector Actions

- 2013 achievements
  - A Ministry objective is to support the efforts of industry to develop innovative products, tools and processes to reduce and mitigate greenhouse gas emissions and adapt to climate change.
  - Approximately $340,000 was provided to industry in 2013, through the Growing Forward 2 Program, to support the development and implementation of regional agricultural adaptation strategies.
- 2014 goals
  - Through the Growing Forward 2 program, the Ministry will provide a planned $1.1 million in 2014 for industry-led climate change adaptation programs at the regional and farm scales (a total of $4.3 million is planned over 2014-18).
  - The Ministry will develop a performance management plan for this programming, to allow tracking and reporting on key performance measures.
  - The Ministry will complete a project to assess the longer term economic benefits and implications of investing in climate change adaptation.



Signature Date: May 28, 2014

Name: Derek Sturko Title: Deputy Minister

Attachments

1. BC Agriculture ADAPTOOL report
2. Ministry of Agriculture GHG Emissions Data 2011-2013

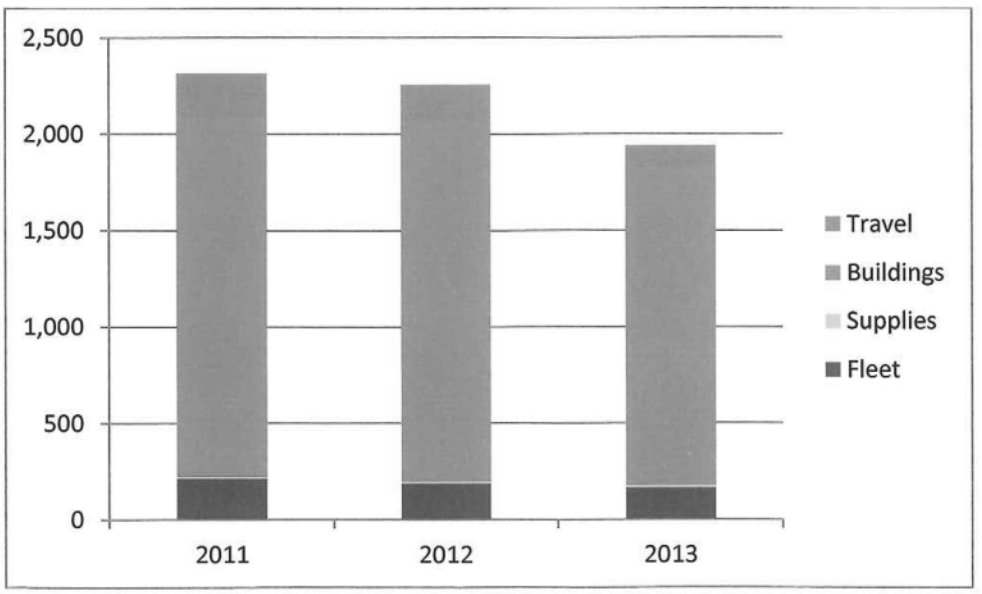
Attachments

1. **BC Agriculture ADAPTOOL report** on IISD website
   http://www.iisd.org/pdf/2014/adaptool_bc_ag.pdf

2. **Ministry of Agriculture GHG Emissions Data 2011-2013** (metric tonnes of CO_2e)

	2011	2012	2013	2013 % of Total Emissions	% Change 2011-2013	% Change 2012-2013
Fleet	215	189	166	9%	-12%	-23%
Supplies	9	12	14	<1%	19%	55%
Buildings	1,864	1,863	1,644	85%	-12%	-12%
Travel	226	191	115	6%	-40%	-49%
Total Emissions	**2,314**	**2,255**	**1,939**			
Offset Exempt	**10**	**8**	**7**			
Total for Offsets	**2,304**	**2,247**	**1,932**		-14%	-16%

Source: SMARTTool



*metric tonnes CO2 equivalent (tCO2e)

Hamdi, Rhiannon MTIC:EX

From: McLachlan, Ian P AGRI:EX
Sent: Thursday, April 16, 2015 1:48 PM
To: Minaker, Willow AGRI:EX; Pouliotte, Jennifer ENV:EX
Subject: FW: FOR REVIEW draft Ministry climate adaptation strategy (for April 24)

FYI.

From: Stephen Tyler [mailto:stephen@adaptiverm.ca]
Sent: Thursday, April 16, 2015 1:45 PM
To: McLachlan, Ian P AGRI:EX
Cc: Tyler, Kari ENV:EX; Stemberger, Anna AGRI:EX
Subject: Re: FOR REVIEW draft Ministry climate adaptation strategy (for April 24)

Hi Ian,
Thanks for this info. I think it's good that you are also in contact with FLNRO to compare your approaches, although as I pointed out they will probably have quite a different approach because of their mandate and history in this field.

Unlike FLNRO, where their responsibility for managing the resource and hence their direct actions will be clearly affected by climate change, in your case you are not directly managing an affected resource. Agricultural producers do that. MoAg's role is to support innovation and adaptation by producers. So I'm not sure the same approach would be appropriate.

As I look at the table, it seems to me all you are asking for in addition to what is already in the report (assuming the various units agree with that) is some kind of indicator or target. So I would suggest that once the report is finalized you just ask the various units to provide a copy of their workplans, with the adaptation initial actions integrated into them, along with 2 or 3 qualitative or quantitative indicators / targets for each program area. Don't ask them to complete some new kind of form, just ask for their existing workplans and a couple of indicators that relate to integration of adaptation issues from the report. Then you can build the table. To make this work, I think you need to make it easy for them.

However, this does not address the ongoing learning and integration issues, which are fairly important to the overall strategy. You don't get these by identifying actions / targets. I tried to get at these with the monitoring tool, which may need to be tweaked a bit, but is intended to encourage programs to demonstrate growth and incremental integration of emerging issues in a simple format. It requires some reflection by somebody who has been monitoring this stuff (e.g. CAI results) on an ongoing basis, but if that ongoing monitoring has been done (this is the point), the form should not take more than 20 min to complete and provides a comprehensive annual update that you can report on without having to keep bugging program units for time consuming reporting. If you plan to use the monitoring tool, you can add another box for indicators or targets for the coming period to update your table.

Cheers,

Stephen

On 2015-04-15, 6:43 PM, <Ian.McLachlan@gov.bc.ca> wrote:

Hi Stephen

See email below, distributing the draft strategy for review. Anna and I made revisions to create a more concise and engaging presentation with use of bullets, text boxes, and graphics (hope you agree!).

Getting closer to the deputy minister briefing, we are turning our minds to further concrete development of the implementation and monitoring. Anna created the attached draft table, based on the BCTS table, that shows goals, objectives, risks/opportunities addressed, actions, indicators and target, and responsibilities. We are thinking about getting program areas to do something like this to make the plan for their actions more explicit. But first we want to go through the exercise for the climate action team so we can model it for them. Do you think this table is a useful way to move further on implementation and monitoring, or do you think there are more effective ways to do so? Anna – please chime in if you have more to add.

We have given program leads until April 24 to respond with comments. We have already heard back from Stephanie Tam! I have also sent it to Emily and Samantha and CAS.

Cheers, Ian and Anna

From: McLachlan, Ian P AGRI:EX
Sent: Wednesday, April 15, 2015 3:09 PM
To: Bartle, Gregory AGRI:EX; Hughes-Games, Geoff AGRI:EX; Trotter, David B AGRI:EX; MacDonald, Leslie S AGRI:EX; Tegart, Greg AGRI:EX; Barclay, Brent S. AGRI:EX; Schmidt, Orlando AGRI:EX; Hueppelsheuser, Tracy AGRI:EX; Jesperson, Gayle AGRI:EX; Halm, Grant AGRI:EX; Tam, Stephanie AGRI:EX
Cc: Falk, Gary AGRI:EX; Pritchard, Jane AGRI:EX; Nickel, Ken AGRI:EX; Thompson, Grant AGRI:EX; Stemberger, Anna AGRI:EX; Haycroft, Carly AGRI:EX
Subject: FOR REVIEW draft Ministry climate adaptation strategy (for April 24)

Hi everyone

Attached for review is the draft Ministry of Agriculture Climate Adaptation Strategy prepared by adaptation specialist Stephen Tyler. Most of you will have had discussion with Stephen and/or his colleague Kari Hansen Tyler. As described in my email of Sept 12 (below), the strategy is a deliverable for the deputy minister that must be signed off with the Carbon Neutral Action Report in mid/late May.

Based on discussions with program areas, actions identified here are meant to align with your priorities and mostly to be feasible to initiate in the short term with current resources. Outside of this document, we can continue to have discussions about other actions that may require further resourcing and funding if opportunities arise.

A key focus of the strategy is collaborative knowledge sharing and capacity building, especially through more linkages between program staff and the work of the B.C. Agriculture and Food Climate Action Initiative (CAI). The CAI is delivering the GF2 industry-led climate adaptation programming and has many projects that will deliver relevant results over the next 1 – 3 years.
http://www.bcagclimateaction.ca/ <http://www.bcagclimateaction.ca/>

FLNRO is doing a similar exercise, in which business areas are developing plans to integrate climate action into their work. I have attached the recently released climate action plan for B.C. Timber Sales in case you are interested.

In reviewing the attached Ministry adaptation strategy:

- sections specific to your programs are clearly labelled (see exec summary Table 1, Section 3.3, and opportunity matrix Table 2 on p. 26)
- other references to your programs can be found by searching the document for the program name
- please look at the actions for your area and confirm or revise the wording
- start to think about what the next steps would be for implementing the actions

Note that the Premier announced on April 13 that B.C. will develop a new Climate Action Plan over the next few months. This will be a major interagency initiative with involvement of all sectors, including agriculture. The plan will likely include a focus on adaptation.
http://www2.news.gov.bc.ca/news_releases_2013-2017/2015PREM0022-000491.pdf
<http://www2.news.gov.bc.ca/news_releases_2013-2017/2015PREM0022-000491.pdf>

I will be in touch with each of you individually to discuss the strategy.

Our target for comments is **Friday, April 24**. This timing is required for us to meet the deadline of DM signoff in mid-May. Please respond to me and cc Anna.

Contact Anna or me anytime if you have questions or want to discuss.

Thanks, Ian

Ian McLachlan | Manager, Climate Action | (250) 356-1852
Innovation and Adaptation Services Branch – Ministry of Agriculture

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From: McLachlan, Ian P AGRI:EX
Sent: Friday, September 12, 2014 10:38 PM
To: van Dalfsen, Bert AGRI:EX; Hughes-Games, Geoff AGRI:EX; Trotter, David B AGRI:EX; MacDonald, Leslie S AGRI:EX; Barclay, Brent S. AGRI:EX; Schmidt, Orlando AGRI:EX; Hueppelsheuser, Tracy AGRI:EX; Jesperson, Gayle AGRI:EX; Halm, Grant AGRI:EX; DeBoer, Pat AGRI:EX; Tam, Stephanie AGRI:EX
Cc: Coney, David AGRI:EX; Donahue, Kayleigh AGRI:EX; 'Stephen Tyler'; 'kari@adaptiverm.ca'
Subject: NEXT STEPS implementation of BC ADAPTool report recommendations

Hi everyone

We now have the opportunity to develop the next steps to build on the ADAPTool assessment process and final report you contributed to last year.

In the attached Carbon Neutral Action Report (May 28) submitted for government reporting, DM Derek Sturko has committed that:

- *"The Ministry will build on the ADAPTool assessments by developing an action plan for implementing the priority recommendations. Implementation of the recommendations will support the ministry in planning for climate change.*

Following this, we have engaged Stephen Tyler and Kari Tyler of Adaptive Resource Management to:

- develop a strategy for implementing priority actions from the ADAPTool assessment

- get started on implementation in areas where there is interest and support already
- identify opportunities for programs to build their capacity to integrate adaptation into ongoing work

This work is being timed to provide input into strategic thinking about the funding and design of ministry programs in GF3.

Stephen or Kari will be in touch with you in the coming weeks. In advance of that discussion, it would be great if you could review the ADAPTool final report sections on your respective programs and consider action steps that could be taken to move forward with the recommendations. The focus will be on how to align those recommendations with actions you know will be beneficial for your programs.
http://www.iisd.org/pdf/2014/adaptool_bc_ag.pdf <http://www.iisd.org/pdf/2014/adaptool_bc_ag.pdf>

Please contact me if you want to discuss beforehand.

Thanks again for your engagement last year and now on implementation.

Cheers, Ian

Ian McLachlan | Manager, Climate Action | (250) 356-1852
Innovation and Adaptation Services Branch – Ministry of Agriculture

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