CLIMATE CHANGE ADAPTATION PROGRAM

Summary Report & Additional Findings

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BC AGRICULTURE & FOOD

BC Farm Practices & Climate Change Adaptation

Summary Report & Additional Findings

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with additional thanks
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Opinions expressed in this publication are not necessarily those of Agriculture and Agri-Food Canada, the BC Ministry of Agriculture and the BC Agriculture Council.

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Contents

Executive Summary

The on-farm adaptation practices project was undertaken as part of the BC Agriculture Council's Agriculture & Food Climate Action Initiative. *The main objective of the project was to develop an evaluation framework to assess the suitability of different on-farm practices to mitigate climate change and weather related production risks.*

The framework was applied in six practice evaluations and documented as part of the *Farm Practices & Climate Change Adaptation series*. The purpose of this report is to provide a more detailed description of the research approach used in the project, and to present additional findings and conclusions not included in the individual practice summary documents.

A group of farmers representing five different regions of the province were selected to participate in the study, to provide information to test and refine the evaluation framework. The framework included seven different evaluation (decision-making) criteria including: *Effectiveness, Economic Efficiency, Flexibility, Adaptability, Institutional Compatibility, Adoptability* and *Independent Benefits*. A list of 46 on-farm practices documented in participant interviews and on-farm visits was used to select six practices for detailed evaluation using the framework (see Table 3).

The process of developing the evaluation framework and evaluating farm practices in detail helped to identify:

- Potential linkages between practices and climate change related production risks;
- Differences in practice suitability to mitigate climate related production risks;
- Effectiveness, economic efficiency and adoptability as key factors in practice adoption;
- A problem of low adoptability of otherwise effective on-farm practices; and
- Limitations in the institutional and regulatory compatibility of some practices.

Additional analysis of the evaluation results, and case examples of on-farm diversification produced some additional conclusions around supporting the process of adaptation in BC Agriculture, described in the following paragraphs.

Further Evaluation

High-level evaluation of this kind helps to inform the development of more focused and effective programs to support agriculture adaptation for climate change in British Columbia. To have utility for land managers and farmers, practice evaluations must necessarily include substantially more site and farm-specific information.

Linking Adaptation Response to Future Uncertainties & Risk

There is a need to better connect practices with environmental thresholds, productivity and some assessment of the potential reduction of climate related risks. As more information comes available and work to support adaptation continues, further evaluation should be carried out at the regional and sub-regional level, to better link different farming systems with predicted climate conditions and uncertainty, e.g., more frequent extreme weather events.

Proving Effectiveness & Economics

The ranking of decision-making factors by participants served to highlight those criteria that are most important to farmers. Economics, effectiveness, and adoptability are key factors influencing decision-making about on-farm practices. Therefore, any planned adaptations for climate change must address these three criteria. There is not always sufficiently detailed economic information to support decision-making. More information on the relationships between practices and the resulting changes in environmental conditions — for example, the level soil moisture retention achieved with mulching — is needed to establish effectiveness thresholds that could be measured against predicted future conditions.

Supporting Adoptability: a Farm Systems Approach

A better understanding of farming systems, adaptive capacity and an identification of those farm characteristics that allow practice adoption, is required to help support and develop farm resilience to these risks. A classification of farm system flexibility using both strategic and a tactical orientation to manage input variability could be a useful framework for adding to this understanding in the BC context.

Many of the participants in this study employ tactical adjustments in their production practices to deal with highly variable weather conditions. Documenting full suites of practices that lead to high tactical flexibility within different farming systems would be beneficial, and may be directly transferable to other farms. In some farming systems, achieving tactical flexibility may require additional investment in machinery and infrastructure, and this points directly to the importance of financial resources in the process of adaptation. Practices with a longer time horizon and that are strategic in scope will also likely require some form of financial investment. The consideration of adaptive capacity, including financial resources, needs to be part of the farm system approach to supporting adoptability, and future adaptation.

A farm systems approach, with a farm flexibility classification should also reveal both the value of, and opportunities for, different types of on-farm diversification. Various kinds of diversification, e.g., enterprise, crop and location, produce different degrees of flexibility. Examples from this study show the availability of different resources determines the potential, and suitability of various types of diversification as an adaptation practice.

Future Efforts

Guidance to support agriculture adaptation for climate change needs to be developed in the context of the farm system, available resources, production scales, market conditions, and most importantly, it must be linked to expected climate conditions. At minimum, analysis and planning should be carried out at the regional and sub-regional level and ideally farm specific analysis would be part of any program delivery to support adaptation. Adaptation options need to be based on real farm information. The examination of location diversification among participants showed the practice can potentially have both positive and negative effects on production and income depending on the specific farm circumstances. A farm system evaluation including an assessment of all resources (see Figure 2, adaptive capacity), a flexibility classification and climate change risk assessment, combined with a practice evaluation would provide the most robust support for planned on-farm adaptation.

Introduction

THIS REPORT IS INTENDED TO SERVE AS A BACKGROUND DOCUMENT to the *Farm Practices & Climate Change Adaptation series* (see *www.bcagclimateaction.ca/adapt/farm-practices*). Its purpose is to provide a more detailed description of the research approach used in the project, and to present additional findings and conclusions not included in the individual practice summary documents for the series.

The on-farm adaptation practices project builds upon the work of the *BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment.* [1] The initial project objectives were:

- To develop a basic framework for analyzing (adaptive) agricultural practices in relation to conditions, locations and production systems in BC;
- To compile, review and assess current agricultural practices and to utilize the framework to evaluate practices for their potential suitability to strengthen farm resilience in a changing climate; and
- To identify potential areas for further research, demonstration or pilot work as well as possible barriers to implementation.

To fulfill these objectives, work was carried out in five phases:

1. A review of climate change adaptation and evaluation literature;
2. Selection of producer participants, fieldwork to document on-farm practices and face-to-face interviews with producers in five different regions of the province;
3. Analysis of interview and on-farm practice data;
4. Additional literature review on the effectiveness and economics of on-farm practices in relation to climate change impacts; and
5. Final practice evaluations and documentation.

The Scope of On-farm Practices within the Project

In order to meet the objectives, it was necessary to place limits on the project scope. For example, it was not possible to visit all regions of the province during the fieldwork stage, although most of the province's various farming systems were included in the work. There was also greater emphasis placed on practices associated with field cropping systems, in part because of the potential vulnerability of field crop production in a changing climate. Greenhouse and intensive livestock production were not considered within this project. While there are climate change related issues for these types of operations, production by-in-large takes place in controlled environments where the effectiveness and efficiency of various practices — e.g., on-going technological innovations for climate control — are much easier to measure and quantify. Other potential adaptation may involve broader economic and structural adjustments, which are not related to on-farm practices.

Irrigation practices were discussed mainly in relation to on-farm water storage and drainage and not in great detail. However, the issue of irrigation efficiency represents an entire field of on-farm adaptation that was not addressed within the scope of this project. This was in part because there are a substantial number of studies and projects, led by non-profits, government and academic researchers, that are looking at adaptation in this area. In addition, many aspects of irrigation and water-use are related to larger regional economic and institutional scales and therefore cannot be dealt with satisfactorily at the farm practice level.

On-farm Practices in Relation to Climate Change Adaptation

Adaptation options that address climate change related impacts on agriculture can be classified into four categories that are not mutually exclusive.[2] They include:

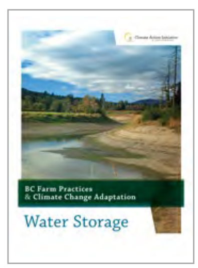
- Technological developments;
- Government programs, public infrastructure and insurance;
- Farm production practices; and
- Farm financial management.

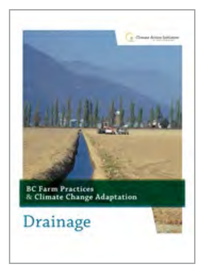
Crop insurance and income stabilization programs involve adoption and participation at the farm level, but also involve public sector adaptation and farm financial management. For this reason, crop insurance and income stabilization programs were not considered in this project. Likewise, the diversification of farm household income with off-farm employment is considered a farm financial management adaptation. While some types of enterprise diversification might also be considered as farm financial management, enterprise diversification is often linked directly to production practices and therefore was included in the study.

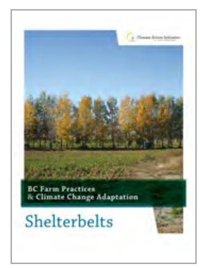
Farm production practices, primarily those focused on crop and livestock production rather than infrastructure and technology, were considered in this project. A wide range of practices was documented in the fieldwork phase (see Table 3). Six of these were examined in depth using the evaluation framework that was developed following a literature review on climate change adaptation in agriculture. Those evaluations led to the production of the *Farm Practices & Climate Change Adaptation series* and include:

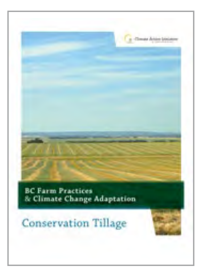
- Water Storage
- Drainage
- Shelterbelts
- Conservation Tillage
- Nutrient Management
- Management-intensive Grazing (MiG)

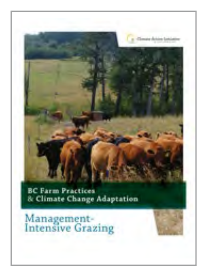
These six documents are available to download at *www.bcagclimateaction.ca/farm-practices*.











Background on Adaptation in Agriculture

What is Adaptation?

Adaptation in agriculture refers to the continual process of adjusting or coping with conditions in the production environment to realize goals. The process is influenced and stimulated by combined ecological, economic, socio-cultural and political forces,[3] and is an integral aspect of agricultural development around the world. The Intergovernmental Panel on Climate Change describes adaptation as 'changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change.'[4] 'Adaptation practices refer to actual adjustments, or changes in decision environments, which might ultimately enhance resilience or reduce vulnerability to observed or expected changes in climate.'[5] Adaptation in agricultural systems may take place at multiple spatial and temporal scales (i.e., from the farm level, to the regional, to the national and international levels; within a single growing season or over a period of years).

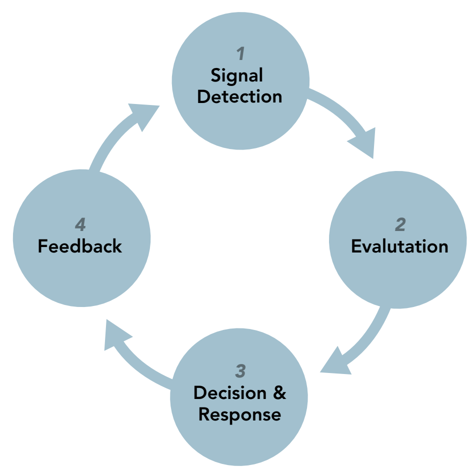


FIGURE 1 Graphical representation of the adaptation process

A Framework for the Adaptation Process

As a continuous process, adaptation can be thought of as the internally generated response of a system to ecological, economic, socio-cultural and political forces. The adaptation process for a farm, ranch, or other agricultural system can be represented by a simplified model with four stages (see Figure 1):[6]

1. Signal Detection
2. Evaluation
3. Decision & Response
4. Feedback

TABLE 1 Description of various time-scale decisions in agricultural adaptation

Decision type	Time-scale	Decision-maker or agent
Tactical	Seasonal *< 1 year*	Farmers, insurance agencies, markets, regional agricultural institutions
Strategic	Multiple years *1–5 years*	Farmers, regional agricultural institutions
Structural	Multiple decades *> 5 years*	Regional agricultural institutions, national governments, land use programs

Source: Adapted from Risbey et al. (1999)

1 – Signal Detection

Identification of the signal, or what is adapted to, is critical and should be distinguished from what is ignored by the decision maker (referred to as noise). If there is no signal detection, there can be no response or adaptation. This is significant for adaptation for climate change, because any signal that might suggest the climate is changing must be filtered from all the noise created by a series of weather events. For decision makers at the operational level, signal detection will focus on those areas or processes within familiar scales of attention. For a Peace River grain producer, the scale of attention might vary from the micro (e.g., the specific soil attributes of a particular field) to the macro-level (e.g., the price of hard red spring wheat on the world futures market).

2 – Evaluation

Once detected the signal can be interpreted by the decision maker to determine potential consequences and impacts on the farming system. Options for mitigating or adjusting to the impacts are evaluated. This might occur at the level of the individual farm operator, or a larger body such as a marketing board or a government agency.

3 – Decision & Response

Following evaluation, action is taken under the premise that there will be an observable change in system performance indicators. A response within the system is attributed to the decision, and the action to adopt or implement. Various decision-making styles have been observed in agriculture production (e.g., risk averse, satisficing) and these may influence what action is pursued and what resources, including capital and labour, are invested in the action.

4 – Feedback

Monitoring of the system is continual, so the outcome of a decision and action can be assessed to determine its effectiveness. If the adaptation is effective, it can be added to a suite of suitable adaptive options. If the adaptation is ineffective, the decision maker needs to evaluate what went wrong and why, so that further adjustments can be made.

This simplified model does a reasonable job of identifying the inherent and on-going nature of adaptation in agriculture systems. However, it does not suggest that individual behaviour is always optimized; there will be any number of decision-making and management styles and variations in the interpretation and response due to different levels of knowledge and other factors related to adaptive capacity (see section on Adaptive Capacity).

Timing

Adaptation takes place at various temporal scales and thus decision-making around actions can be tactical, strategic or structural in terms of timing. Some actions may be both tactical and strategic. A description of these terms, and the type of decision-makers typically involved is presented in Table 1. This type of classification may not apply to some real

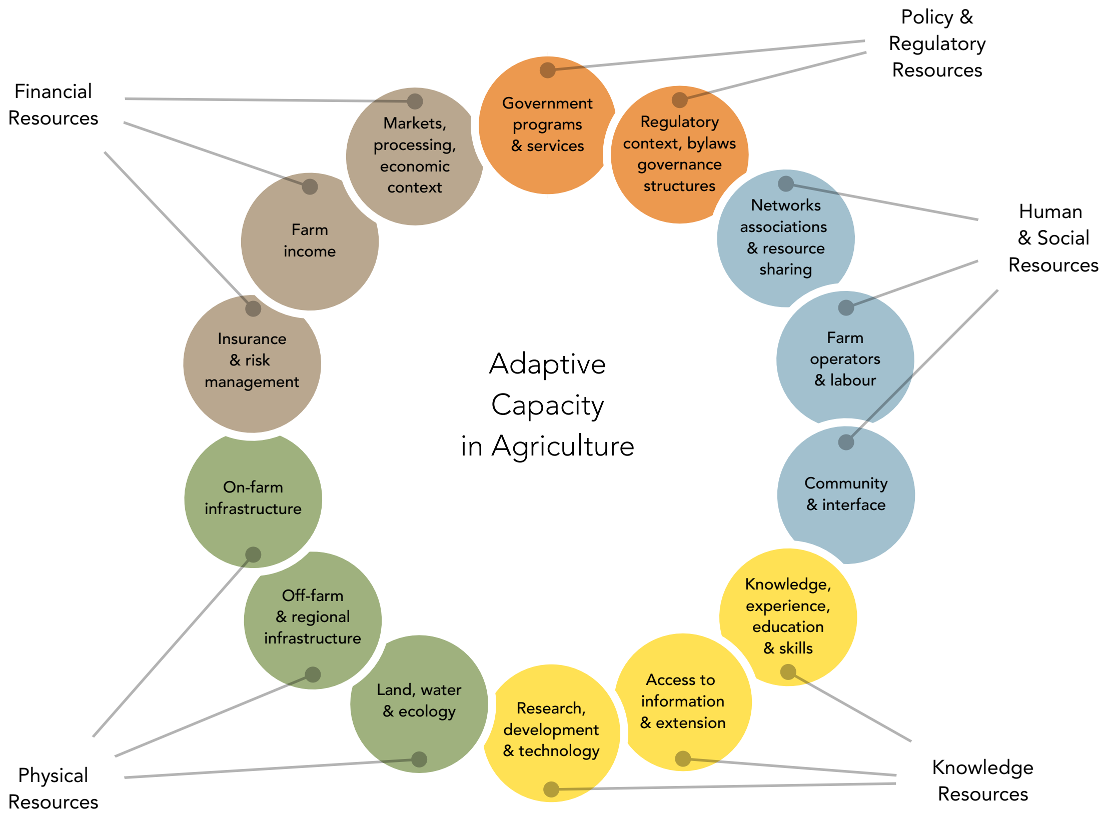


FIGURE 2 Adaptive capacity in BC Agriculture

(Source: see endnote 1)

world situations, but the decision-maker's awareness and matching of the appropriate time-scales for both actions and stimuli, is likely to improve adaptation overall. Similarly, there may be situations where governments, either at the regional, provincial or national level, develop tactical or strategic policies. Drought relief and production insurance schemes might fall under this category. Longer time frames associated with policy development, and associated spheres of decision-making authority including regulation and legislation, mean these actions are generally more structural in nature.

Additional terms have been used to describe the intent and the timing of adaptation action in direct response to climate change. Actions undertaken by governments or other institutions to address climate change related risks are often planned. This type of action is often in contrast to adjustments made by farmers that are spontaneous, or are made independent of climate change, and come about as part of ordinary adjustments made within on-going management.[7] Timing of an action directed toward climate change can also be described as proactive (anticipatory), concurrent (during), or responsive (reactive or after the fact). Responsive timing most closely follows the adaptive process outlined in the previous section. These distinctions in how adaptation action takes place are not always clearly distinguishable. For example, if a farmer responds to an extended period of drought by changing to a more resistant crop variety because of an expectation that the drought will continue in the future, the action would be considered both responsive and proactive.

Adaptive Capacity

Adaptive capacity refers to the relative ability to adapt, or the availability, state or condition of various resources needed to respond. The *BC Agriculture Climate Change Adaptation Risk and Opportunity Assessment* report provides an outline of the adaptive capacity in BC Agriculture (Figure 2). It identifies five interrelated types of resources: financial, physical, human and social, knowledge and policy and regulatory. Increased adaptive capacity suggests an optimization of resources, and a more effective and increased ability to deal with more variable conditions. [8] Thus increasing adaptive capacity is an important focus of planning for adaptation to climate change.

The availability of adaptive resources can affect all aspects of the adaptation process from signal detection to feedback. In theory at least, increased adaptive capacity also implies more effective evaluation of adaptation options in the decision and response, and feedback phases of the process. Successful adaptation — where a suite of effective adaption options can be developed — suggests a robust adaptive capacity.

Evaluation of Adaptation Options for Agriculture

The formal evaluation of adaptation options arises directly from planned and proactive responses to climate change. Evaluations are intended to help decision-makers (producers, agribusiness, governments) decide whether to pursue adaptations, and in their choice of adaptation options. [9] Evaluation goes beyond the classification of options and is intended to assess the overall merit, suitability, utility or appropriateness of potential adaptation options.

The evaluation of adaptation options is challenging for several reasons. Apart from the significant uncertainties and assumptions that must be made about future climate scenarios, both the evaluation criteria and how those criteria are assessed will vary depending on who undertakes the adaptation (scale), and who benefits from the adaptation. For example, a farm level adaptation evaluated highly by government or business may have little value from the point of view of a producer. Also, as adaptation takes place, the actions taken by decision-makers at different scales may change the economics associated with an option and make it more cost-effective for producers to adopt.

Research on adaptation in *Canadian Agriculture* have also shown that farmer decision-making responses to climatic stimuli are made interdependently with other factors in the production environment, and these are linked to perceptions of recent — especially the previous year's — experience. [10] This may suggest there is an issue with the signal detection of longer-term climatic signals, or some other aspect of the adaptation process. Adjustments in agricultural practices that have some relationship to climatic variables are likely to be part of day-to-day management, and related to other factors influencing production and overall risk management. Apportioning costs and benefits, and quantifying these in economic terms is difficult.

Some evaluations estimate costs and benefits of adaptation options using crop production models in future time-periods, applying various climate change scenarios. It is difficult to make this type of analysis dynamic, so it carries the rather implausible assumption that there will be no further adjustments to practices in the future period that could affect production. The institutional environment, which may affect both costs of production and prices, is determined in large part by historical conditions that may not hold in the future. Nonetheless, evaluation is an inherent part of the adaption process, and developing dynamic and informed aids for decision-makers should add to adaptive capacity and reduce the potential for maladaptation.

Methodology

Evaluation Framework Development: Multi-criteria Evaluation

Cost-benefit analysis can be useful for well-defined capital investments in infrastructure. However, "soft" resources like knowledge and management, key aspects of farming systems and on-farm adaptation, are less amenable to this type of analysis. Multi-criteria evaluation (MCE) is a process designed to select the most desirable alternative using more than one decision criteria. [11] It can also be useful for problem exploration and decision-making when quantitative cost-benefit information is lacking (World Bank, 2010).[12]

Various approaches are applied to MCE depending on the nature of the problem and the criteria on which different options are to be judged. A very simple and descriptive approach is to score each alternative against each of the selected criterion, and then look at these separate scores to evaluate each option. Economic efficiency can be considered, but in MCE the relative net present values of different options expressed in quantitative monetary terms, may be given a qualitative rating so it is comparable to other criteria ratings.

MCE scores for each option can also be aggregated into a single value so that decision alternatives can be compared. However, this can lead to questions about the extent to which each criterion is independent of the other and whether the scales of measurement applied to each, represent the same utility or quality.

The most commonly applied form of MCE is the weighted sum method. Here there is an attempt to standardize scoring against a desired objective, and the scores are weighted based on how the decision-maker values the criteria in relation to each other. A number of sophisticated methods have been used to help establish these relative trade-offs for decision-makers, some requiring considerable investment and knowledge. While the merits of different approaches to MCE can be debated, it is mostly accepted that the process, even when using the simplified approach, can result in a better understanding of the problem and potentially bring forward better solutions.

Given the scope of this project, it wasn't possible to develop the specific decision-making criteria with stakeholders. Instead the criteria were developed by looking at other studies in the field of adaptation for climate change. [13] However, producers did provide input on the relative importance of the selected decision making criteria in a ranking exercise (27 of 29 participants). In the end, seven criteria were selected for use in the evaluation framework. Each is defined and a qualitative rating scale has been assigned across a scale from 1 to 5, and is presented on the following page. More detail on the MCE scoring process for selected practices can be found within the *Farm Practices & Climate Change Adaptation series* (see *www.bcagclimateaction.ca*).

Effectiveness *refers to whether the adaptation option reduces the risk or vulnerability, and/or enhances opportunity to respond to the effects of climate change.*

Scale	Evaluation Criteria
1	Very ineffective
2	Moderately ineffective
3	Neutral
4	Moderately effective
5	Very effective

Economic efficiency *refers to the economic benefits relative to the economic costs that are assumed in implementing the adaptation option. A neutral rating would mean the present value of benefits equal the present value of costs associated with the option.*

1	Very inefficient
2	Moderately inefficient
3	Neutral
4	Moderately efficient
5	Very efficient

Flexibility *refers to the ability of an option to function under a wide range of climate change conditions. An option that reduces income loss under specific conditions, and has no effect under other conditions would be considered inflexible.*

1	Very inflexible
2	Moderately inflexible
3	Neutral
4	Moderately flexible
5	Very flexible

Adaptability *refers to whether a practice can be built upon to fit future conditions and allows further adaptation.*

1	Very low adaptability
2	Moderately low adaptability
3	Neutral
4	Moderately adaptable
5	Very adaptable

Institutional compatibility *refers to the compatibility of the adaptation option with existing institutional and legal structures.*

1	Very incompatible
2	Moderately incompatible
3	Neutral
4	Moderately compatible
5	Very compatible

Adoptability *refers to the ease with which farms can implement the practice under existing management practices, values and resource conditions.*

1	Very low adoptability
2	Moderately low adoptability
3	Neutral
4	Moderately adoptable
5	Very adoptable

Independent benefits *refers to the ability of a practice to produce benefits independent of climate change. A practice able to reduce income loss regardless of climate change effects would be rated high.*

1	High trade-offs
2	Moderate trade-offs
3	Neutral
4	Moderate independent benefits
5	High independent benefits

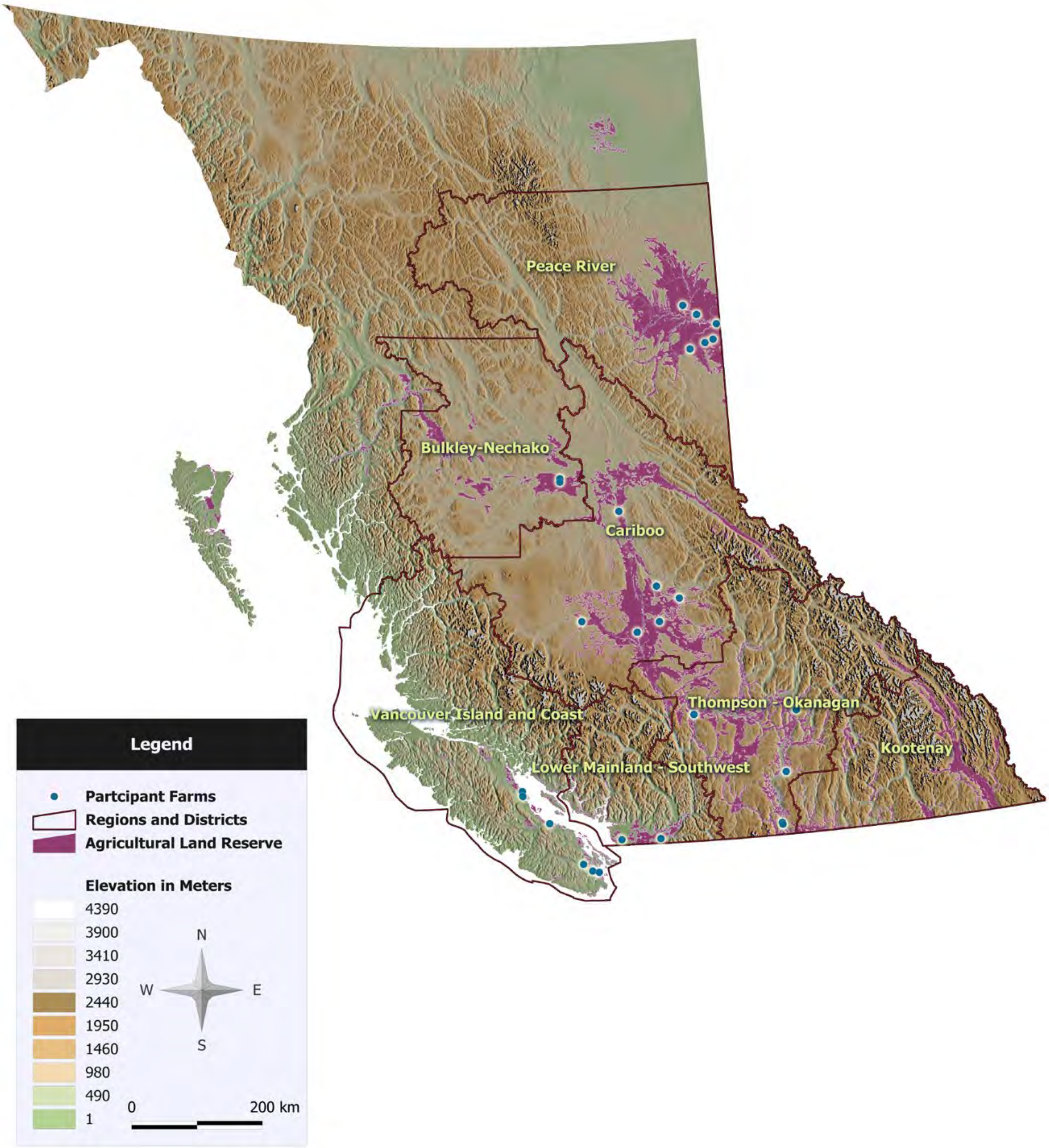


FIGURE 3 Participant Farms, Agricultural Land Reserve and elevation relief

Participant Farms

Participant farms were selected based on their adoption of one or more innovative or adaptive farm practices, some of which were identified in the *BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment*. An effort was made to balance the number of farms selected by both region and scale. Potential participants in the Bulkley-Nechako, Lower Mainland, Peace, Thompson-Okanagan and Vancouver Island regions were identified with the assistance of Ministry of Agriculture regional agrologists and specialists. The selection of participants from the Cariboo was based on professional knowledge, and focused on members of a local rancher collaborative of the Cariboo Regional Cattlemen's Association working together to promote grass-fed beef.

Farm operators were contacted either by e-mail or telephone to introduce the project and to obtain consent to participate. With one exception, interviews were completed with participants at their farm headquarters. In 75% of the cases, operators provided a tour of production areas, and/or facilities during the visit. Farm visits in the Cariboo, Bulkley-Nechako and Peace regions were conducted in mid-August 2012; visits to Vancouver Island, Lower Mainland and Thompson-Okanagan farms were made in early to mid-October. Thirty-one of 32 operators contacted, indicated a willingness to participate in the project. There was one outright refusal, and two willing participants could not be scheduled. The total participant sample included 29 farms. The location of participant farms is shown in Figure 3.

Structured Interviews

Interviews were guided by a series of predetermined questions in three main topic areas:

1. Farm ownership, management and land resources;
2. Changes in on-farm practices, and how these might be linked to climate or weather related production risks; and
3. Decision making processes and views about adaptation and risk.

The interviews, and many of the questions themselves, were open-ended to allow for the exploration of innovative practices, and to gain individual producers views on adaptation. Respondents were also were asked to consider a hypothetical decision to adopt an on-farm practice that could potentially mitigate weather or climate related production risks using the criteria in the MCE evaluation framework. They were presented with a series of questions to help define the criteria, and were asked to rank them according to what they viewed as the most important to the least important in the decision-making process.

Interviews varied in length from 1–2 hours. Some interviews were conducted with individual operators, while some included spouses and other operators. The farm resources documented included the number of operators, years in operation, incidence of off-farm employment, use of employed labour, and a listing of land resources. Owned, rented or leased, crop and pasture acres were recorded, along with any existing Crown land tenures. Crops grown and numbers of livestock were also listed. A question on succession planning was also asked.

Data Analysis

Interviews were recorded and later transcribed to enable coding and analysis. Coding is a process of marking text passages that relate to particular themes, topic areas, and responses to specific interview questions. Identification of specific on-farm practices, and how these related to adaptation, change and climate-weather related risk was one of the main goals in coding. Marked passages were then revisited, analysed and counted. Coding and analysis was carried out using TAMS Analyzer software, a qualitative research tool. [14]

Characteristics of Participants & Farms

The characteristics of the case study participants reflect some of the basic demographic trends taking place on Canadian farms. Age of participants was not asked, but the majority (23 of 29) were estimated to be 50 years or older. Among this mature group of participants there were four cases where inter-generational transfer was underway, and younger generations were active as operators. In only one of these cases was the younger generation involved in the interview. Of the remaining participants, most appeared to fall in the 40–50 year age range, with two in 30–40 year age range.

Operators, History & Employment

Just over half (15) of the farms were operated by one household, eleven were operated by two households, one was operated by three households and there were two farms each with five households involved in operation. All the of farms operated by more than two households involved commercial dairy operations, and the value of the dairy production quota and land assets were noted to be a factor in at least two of these multi-operator arrangements. A question to determine the business structure of participant farms would have clarified management arrangements for all farms, although it was apparent from questions around succession that the large-scale operations (all farm types) were operating under corporate or limited company structures. This was certainly the case for the multi-operator commercial dairies mentioned above.

The participant group as whole would be described as experienced and well established and, this fits with what might be expected, given the selection criteria. Only one operator in the entire sample would be considered a new entrant to agriculture. Many operators had multi-generational connections to the lands they were farming. Two-thirds (21 of 29) had connections to the land they were farming that ran two generations or more. Six of this sub-group had connections that were three generations, and two had connections going back four and five generations, respectively. Even among first generation farms, there was considerable experience with all operators — with the exception of the new entrant — with all having nine or more years of experience.

One final characteristic that supports the established nature of the group is the relatively low amount of off-farm employment among operator households. Roughly half of all farms (15 of 29) indicated no off-farm employment among operator households. Seven farms indicated one or two household members with part-time employment, and six farms indicated one household member with full-time employment. One of the operations with five households involved (a dairy), indicated three individuals with full time off-farm employment.

TABLE 2 Summary of participant farms by region, farm type and relative scale

Region	Farm Type	Number of Farms	Relative Size
Bulkley-Nechako	Grain, Beef Cattle, Dairy	1	Large
	Grain, Hay	1	Large
Cariboo	Beef Cattle	4	Small-Large
	Organic Beef Cattle, Sheep, Hog	1	Medium
	Beef Cattle, Vegetable, Berry	1	Medium
Lower Mainland	Vegetable, Berry	1	Large
	Vegetable, Cranberry	1	Large
Peace	Beef Cattle	2	Medium
	Grain	2	Medium-Large
	Grain, Beef Cattle	2	Large
Thompson-Okanagan	Organic Vegetable	1	Medium
	Tree Fruit	2	Large
	Tree Fruit, Beef Cattle	1	Small
	Vegetable	1	Large
Vancouver Island	Beef Cattle	1	Small-Large
	Berry	1	Medium
	Berry, Commercial Broiler	1	Small
	Berry, Specialty Dairy	1	Small
	Dairy	3	Medium
	Vegetable, Poultry	1	Small
Total		**29**	

Note: Farm type indicates principal products. Grain farms also have oilseed, and some also have pulse (pea) production.

Land Resources, Production & Labour

The availability and type of land resources managed by participants reflects the general pattern of agricultural production in the province. More extensive land use is associated with beef, hay, grain and oilseed production in the northeast and north-central interior regions. More intensive agriculture including dairy, vegetable and fruit production was found on smaller production units in the southern interior, the Lower Mainland and on Vancouver Island. There were some interesting variants among the group including a grain-oilseed, beef and commercial dairy operation in the Bulkley-Nechako, a beef cattle, vegetable and u-pick berry operation in the northern Cariboo and a tree fruit orchard and beef cattle operation in the Thompson-Okanagan. Private land (owned, rented or leased land, excluding Crown tenures and leases) managed by participants ranged from a maximum of 25,000 acres to six acres.

The regional distribution of participant farms, production and relative scale are shown in Table 2. Farm scale is a subjective rating based on the region, land capability, type of production and the relative value of that production. Farms with grain production in the Peace and Bulkley-Nechako, and considered large scale, were cropping in the range of 5,000–6,000 acres. In contrast the large-scale vegetable producers in the Thompson-Okanagan and lower mainland had in the range of 400–800 acres in crop. The scale of beef operations was established using livestock numbers, where small producers were those owning 100 head or less.

There was more crop and enterprise diversification on participant farms than expected, even though some of the farms of this type were purposely selected. It is not possible to infer much from this characteristic in the larger farm population because of the small sample size, and because it was not randomly selected.

Unfortunately, measures of farm-level diversification are not readily evident from reported statistics. The Statistics Canada Census of Agriculture uses the North American Industry Classification System (NAICS) to identify different farm types. However, it is not possible to determine from these reports whether a farm is producing another product or multiple types of products. Farms are classified to an industry when 50% or more of the estimated gross revenues correspond to that industry. For example, a farm where 55% of the estimated gross revenues come from crops and 45% come from cattle would be classified as a Crop farm. Therefore, not all farms reporting cattle are classified as Cattle farms when using farm type. The specifics of the analysis used to determine farm type, including the assumptions used to estimate gross revenue from the data collected in the census, are not made available by Statistics Canada.

Other reports using separate Statistics Canada survey data from the prairie region (including the BC Peace River) suggest agriculture production is becoming increasingly specialized, with fewer crops grown (Bradshaw et al. 2004).[15] Because diversification at the farm scale is routinely offered as a practice for managing both climatic and non-climatic production risks, more meaningful evaluation of farm-level diversification in BC agriculture would be of value in assessing adaptive capacity.

The use of employee labour varied considerably among regions, farm type and scale. Having one or more full-time employees was common among the large operations. Farms of all types and scales employed part-time seasonal labour. The large-scale fruit and vegetable growers employed substantial numbers of part-time seasonal workers (range from 35 to 150 employees). Three farms indicated use of volunteer labour, typically recruited from on-line travel-work experience websites.

On-farm Practices

A total of 46 on-farm practices were identified and coded from participant interviews. A summary of practice characteristics is provided in Table 3. Both practice systems and the technical components of these systems are included in the table. For example, the use of electric fence is commonly associated with Management-intensive Grazing (MiG), but the two practices are listed independently. The practices are also classified by farm type, and the regions they are typically associated with. MiG and conservation tillage were the mostly frequently coded practices among the participant group (by total code count).

Practice code count totals are a reflection of the farm type, the amount of time spent discussing a practice, and the number of separate instances where a practice might have been discussed or referred to in an interview. High code counts for some practices are also a result of the purposeful selection of some farms in the study, because of their adoption of a specific practice. At the same time, instances of a code do not necessarily indicate adoption of the practice. Any discussion of an individual practice by participants is also included in the code counts. These passages were also marked as being positive or negative in relation to perceptions of effectiveness and economics, and therefore these counts do not indicate the level of practice adoption among the participant group.

Table 3 also provides a brief assessment of the practices in relation to the evaluation framework criteria, and the time-scale (temporal scope) of their implementation. The time scale of a practice is considered in relation to the farmer ability to adopt and implement the practice, but structural adjustments made by government or other agencies could also impact some practices. For example, changes instituted by an irrigation authority may have long-term and structural consequences on irrigation practices at the farm level. Based on the information provided by participants, practices that are tactical in nature, and deal with the continuous variability of annual production cycles, also appear to be fairly readily adopted. Practices with longer time horizons that are strategic in scope and require capital investment, may be more challenging to implement.

Notes for Table 3, on the following pages:
Practices identified with an asterisk (*) and bold type in the first column are summarized in detail in the Farm Practices & Climate Change Adaptation series (see www.bcagclimateaction.ca). Code count is the number of times the practice was coded for all participant interviews, and rank is the position of the practice relative to other practices based on its total code count. A practice was coded and counted if it was identified and discussed by the participant, but is not a measure of adoption. This summary is a representation of the participant sample only, and not of BC farms as whole. Remaining columns in the summary, Region, Farm Type, etc., reflect broader assessment of practice application based on information provided by the participants and literature review. Total practice counts also reflect the farm type, the amount of time, or the number of times a practice was discussed in an interview. For example, Management-intensive Grazing (MiG) was the most frequently coded practice and therefore is ranked number one. This reflects the purposeful selection of some participants because of their adoption of this practice, and awareness of the practice by livestock producers who may not have adopted the practice.

TABLE 3 Summary of on-farm practices documented and coded in participant interviews (see table notes on previous page for more details)

Practice	Code Count	Rank	Description	Regions	Farm Type	Benefits (+)	Costs (-)	Related Practices	Issues related to suitability: effectiveness, adoption etc.	Time Scale (temporal scope)
*** MiG (Management-intensive Grazing)**	113	1	Optimization of plant/grazing relationship management using time-control, shortened grazing periods and increased animal density	All	Livestock, Dairy	Improve plant cover, reduce moisture loss and erosion, slow runoff, improve infiltration, increased bio-diversity	Infrastructure, labour inputs, knowledge, observation skills	Nutrient management	Effectiveness and economic efficiency variable depending on conditions (semi-arid). Adaptable to different scales. Additional independent benefits related to more intensive management, including biodiversity, nutrient cycling. Adoptability low.	Tactical / Strategic
*** Conservation tillage, no-till seeding**	88	2	Tillage disturbance minimized, most crop residue remains on surface	All	Grain, Livestock Dairy, Forage, Forage seed	Reduce moisture loss, soil erosion, improve soil properties, and organic matter	Specialized seeding and other equipment; may require herbicide application for vegetation control	Straw-residue management, nutrient management, pest management, herbicide applications	Equipment costs, knowledge requirement can limit adoption on small farms requiring sharing or cooperation. Seeding results sometimes less effective in perennial forage systems ($20k–$300k + for seeder depending on size and type).	Strategic
Enterprise diversification	70	3	Diversify farm enterprises to reduce exposure to production risks	All	All	Risk and variability spread among enterprises	Infrastructure for different enterprises, market development	All	Broad-based knowledge required, scale sensitive, less compatible with highly specialized production practices.	Strategic
Irrigation	59	4	Increase efficiency with timing, and delivery to address moisture deficiencies	All	All	Maintain production under variable precipitation, reduce stress on supplies	Infrastructure costs, management inputs	Drainage, nutrient management	Knowledge matching to crop systems, timing and maintenance; adoption sensitive to regional watershed dynamics, supply control; can create labour savings.	Tactical / Strategic
Crop variety selection	56	5	Choosing specific adapted crop variety to mitigate climate related risks	All	All	Potential for increased adaptability for all variables	Potential for lower yields, or reduced quality under normal conditions	Location diversification, nutrient management, pest management	Varieties must be available, knowledge critical. Adaptability varies with time scale: annual perennial berries tree fruits.	Tactical / Strategic

Practice	Code Count	Rank	Description	Regions	Farm Type	Benefits (+)	Costs (-)	Related Practices	Issues related to suitability: effectiveness, adoption etc.	Time Scale (temporal scope)
Crop diversification	46	6	Diversifying crop kinds, varieties and using crop substitution to minimize climate effects	All	All	Improve plant cover, reduce moisture loss and erosion, slow runoff, improve infiltration, increased bio-diversity	Reduced revenue if not adapted to farm system, equipment for special crops	Location diversification, nutrient management, pest management	Knowledge critical, adapted crops and varieties must be available, and farm/ market system adaptable. May be unsuited to highly specialized production practices. Adoption partly sensitive to social norms, and market preferences.	Tactical/ Strategic
*** Drainage**	32	7	Ditch or sub-surface tile drainage, land leveling-surface drainage	All	All	Allow excess rainfall, snowmelt to leave fields, pastures	Cost of planning installation	Irrigation, crop diversification, GPS	Effectiveness dependent on regional watershed dynamics. Environmental, fish and wildlife concerns in some areas.	Strategic
*** Shelterbelts**	28	8	Planting or retaining suitable tree, shrub, or other vegetation breaks to influence microclimate.	All	All	Temp, wind modulation, moisture retention, erosion control	Planting costs, short-term costs	Irrigation, grazing management, crop diversification, variety selection, land clearing	Adoption limited by perceptions around costs-benefits. Short-term vs. long-term analysis, however potentially effective in broad range of applications. May require shifts in other practices to make efficient.	Strategic
Crop tunnels	24	9	High hoop house, use of Remay cloth and wire hoops	All	Berries, Vegetable	Modulate temp and precipitation	Materials and labour, management inputs	Crop rotation, pest management	Effective. Economics may limit to certain crops, Labor requirement, Need to fit farm/market structure.	Tactical/ Strategic
Herbicide application	25	10	Part of conservation tillage and no-till system	All	Grain, Livestock, Dairy, Forage, Forage seed	Reduce moisture loss, soil erosion and improve soil properties, OM	Accepted with system adoption	Conservation tillage and no-till system, crop rotation, diversification, variety selection, GPS	Adoption with most conservation tillage. Not compatible with organic, other marketing models.	Tactical/ Strategic
Pest management	23	11	Integrated suite of practices to effectively manage pests	All	All	Resilience to climate induced pest problems	Expert advice, costs associated with other practices	All	High knowledge requirement, integration with farm system and all practices, biodiversity.	Tactical/ Strategic
*** Nutrient management**	22	12	Management of plant nutrients and soils to optimize plant growth under varied conditions	All	All	Improved production and quality under stressed conditions.	Expert advice, application costs, labour, machinery	All	Effectiveness and adoption depends on level of knowledge. Related to nearly all other practices limits complete integration, reducing economic benefit.	Tactical/ Strategic

Practice	Code Count	Rank	Description	Regions	Farm Type	Benefits (+)	Costs (-)	Related Practices	Issues related to suitability: effectiveness, adoption etc.	Time Scale (temporal scope)
Location diversification	21	13	Diversify production location to address environmental variation and risks	All	All	Risk and variability spread across locations	Costs of moving equipment, labour, livestock	All	Sensitive to spatial scale, additional considerations with livestock. Wildlife predator, crop damage issues. Highly adaptable with leased/rented lands.	Tactical/ Strategic
Electric fence	20	14	Technology to support other practice systems.	All			Low relative to conventional fencing		See management-intensive grazing and grain bags, bale-grazing. Adoption may be limited by cultural factors and labour availability.	Tactical
Crop frost protection	19	15	Use of wind, water or structures to reduce frost damage	Thompson-Okanagan, Kootenay, Van. Is.	Tree-fruits, Berries	Increase low temp.	Variable w/ wind machine, installation, overhead irrigation or covers	Irrigation, shelterbelts	Adequate water supply; costs associated with wind tower construction ($40,000 per tower — 10 towers for 170 acres for V.I. blueberries). Economics depend on crop grown.	Tactical/ Strategic
Crop rain protection	19	16	Netting, helicopters, blowers, pre-harvest sprays: (e.g. Rainguard, Bluestim)	Thompson-Okanagan, Kootenay	Tree-fruit Cherries	Protect cherries or eliminate droplets to prevent splitting	Structure, helicopter-blower time, application costs	Hail, shade netting, pest management, pruning, tree shape	Overlapping layers (tent technology) allows air movement ($22,000 per acre) effective. Helicopter (rate: 2min/acre plus set up $1,600/hr.). Competition for helicopter time can be constraint. Effectiveness depends on rainfall patterns, temp following precipitation. Efficacy of sprays variable, uncertain.	Tactical/ Strategic
Silage forage	18	17	Forage harvest method allows harvest in moist conditions	All	Dairy, Livestock	Allows storage quality forage	Silage equipment, machinery, labour, energy, transportation costs	Forage production, crop rotation.	Equipment and machinery dependent on farm scale, and type. Better suited to dairy and feeder operations. Often cost prohibitive in beef operations. Haylage a similar alternative.	Tactical/ Strategic
*** Water storage**	18	18	Creation of on-farm water storage for irrigation, stockwater or domestic water supply	All	All	Increase or regulate water supply, modulate effects of groundwater shortage	Professional reports, expertise and advice, risk of denied application, cost of installation	Irrigation, shelterbelts, stockwater	Effectiveness related to design and size. Adoption dependent on scale, available land area, regulatory issues and environmental concerns in some areas.	Strategic

Practice	Code Count	Rank	Description	Regions	Farm Type	Benefits (+)	Costs (-)	Related Practices	Issues related to suitability: effectiveness, adoption etc.	Time Scale (temporal scope)
Livestock breeding	18	19	Introduce breed characteristics adapted to conditions	All	Livestock, Dairy	Increased adaptability for all variables	Changes in production, changes in infrastructure	Grazing management, MiG	Adoption partly sensitive to social norms, and market preferences.	Strategic
Fertilizer application	16	20	See nutrient management							Tactical
Composting	15	21	Aspect of nutrient management related to application of composted organic materials or manures.	All	All	Plant vigor, improved production and quality under stressed conditions.	Cost of material, turning, watering, application	Pest management, nutrient management	Access to compostable material. Well adapted with integrated crop and livestock systems. Natural system may fit with marketing advantage. Co-benefits with all aspects of pest management.	Strategic
Grazing management	14	22	Plan grazing to fit conditions	All	Dairy, Livestock	Increase snow retention, water infiltration, reduce erosion	Additional labour, infrastructure, i.e., stockwater, fencing	Location diversification, nutrient management, shelterbelts,	Knowledge re: animal requirements, plant growth requirements, regrowth, watershed characteristics.	Tactical
Swath grazing	13	23	Winter feeding practice, transfer nutrients and organic matter (OM) to specific areas	Bulkley-Nechako, Peace, Cariboo, Thompson-Okanagan	Livestock	Improve site specific productivity, with organic matter, reduce moisture loss, improve moisture retention	Electric fence, labour	Nutrient management, grazing management	Scale, equipment requirements, most adaptable in grain growing areas.	Tactical
Cover crops	9	24	Planting crop to cover soil after annual harvest, of main crop. "Green Manure"	Thompson-Okanagan, Kootenay, Lower Mainland, Vancouver Island	Vegetable, Dairy	Improved soil properties, fertility, OM, water holding cap, and pest resistance, reduced erosion	Additional equipment, and seed	Nutrient management, pest management, wildlife management	Knowledge re: crop choice, short-term vs. long-term economics, labour, farm structure capacity issues. Cultural management practice benefits, effectiveness for climate risk difficult to quantify in some situations. Wildlife issues.	Tactical
Relay cropping	9	25	Inter-seeding cover or forage crop with main crop	All	Dairy, Livestock	Erosion control, improved soil properties	Additional equipment, and seed	Nutrient management, conservation tillage (no-till) wildlife management	Knowledge, benefits, effectiveness for climate risk difficult to quantify in some situations.	Tactical

Practice	Code Count	Rank	Description	Regions	Farm Type	Benefits (+)	Costs (-)	Related Practices	Issues related to suitability: effectiveness, adoption etc.	Time Scale (temporal scope)
Grass alleys	9	26	Management of grass cover in orchards and plantings	Thompson-Okanagan, Kootenay, Lower Mainland, Vancouver Island	Tree-fruits, Berries	Reduce temperature, increase snow retention, water infiltration	Maintenance costs, additional water use	Irrigation, crop cooling, mulching, pest management	Dual irrigation may be required with drip systems. Effectiveness 2° cooling differential. Provides support for harvest equipment in wet conditions. Can provide additional mulch for crop with side delivery mower.	Strategic
Gps technology	9	27	Support and monitoring technology integrated into seeding, harvest, leveling systems and "variable rate technology", field mapping and auto steer	All	Grain, Dairy, Vegetable, Berries	Efficiency to match nutrient needs to conditions, flood control	Equipment costs, professional advice		Adoption related to scale, farm-system etc.	Strategic
Grain bags	9	28	Plastic tube on-the-ground grain storage	Bulkley-Nechako, Peace	Grain	Allows harvest in higher moisture conditions	System equipment costs, potential wildlife damage, some loss, extra labour	Electric fencing	Effective portable storage for high moisture grain (20%), adaptable to rented and leased land, use in remote areas requires 3-D electric fence to protect from wildlife.	Tactical/ Strategic
Forage production (harvest)	8	29	Varied practices, adapting harvest methods, timing, managing grazing to affect plant phenology.	All	Dairy, Livestock	Harvest in drier or wetter conditions	Equipment, labour costs	Grazing Management, Silage, haylage, bags,	Knowledge, equipment for silage, haylage increase costs. Variable nutrition requirements between dairy and beef animals.	Tactical/ Strategic
Stockwater	8	30	Various technologies to use groundwater or stored water (see water storage)	All	Livestock, Dairy	Modulate effects of intermittent water supplies.		Grazing management, Management-intensive grazing	Effective, economics may limit adoption.	Tactical/ Strategic
Crop hail protection	6	31	Hail netting	Thompson-Okanagan, Kootenay	Tree-fruits	Reduce damage from hail events	Installation of netting and support structure	Shade netting, pest management	Costs associated with construction vs. crop grown ($20,000–30,000 per acre); uncertainty around future event frequency. Maybe dual purpose with shade netting	Strategic
Farm equipment modification	6	32	On-farm modification of equipment to work in extreme conditions (rice tracks, tires etc.)	All	All	To allow equipment operation in extreme (usually wet) conditions.	Time, and costs of equipment purchase, fabrication	Drainage	Tactical, not always effective in very extreme conditions. If successful can be adopted for future use.	Tactical

Practice	Code Count	Rank	Description	Regions	Farm Type	Benefits (+)	Costs (-)	Related Practices	Issues related to suitability: effectiveness, adoption etc.	Time Scale (temporal scope)
Grain drying	6	33	On-farm aeration and grain drying systems.	Bulkley-Nechako, Peace	Grain	Allows harvest in higher moisture conditions	System and energy costs, variable under changing economic conditions		Effective, adoption related to economics of scale.	Tactical/ Strategic
Plastic mulch	6	34	Plastic sheets covering soil surface; form of artificial mulch	Thompson-Okanagan, Kootenay, Lower Mainland, Vancouver Island	Berries, Vegetable	Moisture retention, weed control, increased soil temperature, extended season	Material costs, disposal issues, potential for increased soil erosion between rows	Nutrient management, Pest management, Crop rotation, Irrigation Compost	Effective, widely adopted.	Tactical
Forage establishment	5	35	Varied practices to establish or rejuvenate forage or forage seed crops	All	Dairy, Livestock, Hay, Forage seed	Conserve soil moisture, reduce winterkill	Loss of use, less production short-term	Conservation tillage-no-till seeding, Nutrient management, herbicide application, Crop rotation, Grazing management	Knowledge, variable effectiveness, options dependent on farm scale, small scale may require equipment sharing or co-op.	Tactical/ Strategic
Land clearing	5	36	Modify land clearing practice to consider retention areas for shelterbelt, land contour to prevent erosion, maintain natural drainages	All	Grain, Livestock, Dairy	Reduce moisture loss, erosion slow runoff, improve infiltration	Reduced efficiency in operations, lower total production, more fence infrastructure	Drainage, Grazing management, Nutrient management, Shelterbelts	Requires informed planning, may require shifts in scale, farm system, and diversification.	Strategic
Mulching	5	37	Returning crop residue, pruned material, or other material to soil surface	All	Tree-fruits, Berries, Vegetable	Reduce moisture loss and erosion, slow runoff, improve infiltration	Application costs, labour	Nutrient management, Pest management, Crop rotation, Irrigation Compost	Effective and economic when integrated with farm system, i.e., in orchards with grass alley clipping, pruning and chipping.	Tactical
Silvopasture	5	38	Intentional co-management of pasture for livestock and trees	All	Livestock	Modulation of micro- climates, moisture retention, erosion control	Potentially lower agriculture production	Grazing management, MiG	Requires integration, may require farm-system adjustment.	Strategic

Practice	Code Count	Rank	Description	Regions	Farm Type	Benefits (+)	Costs (-)	Related Practices	Issues related to suitability: effectiveness, adoption etc.	Time Scale (temporal scope)
Energy	5	39	Refers to on-farm bio-fuel production, and building heating systems	All	All	Energy savings	Capital costs, access to suitable technology		Economics may be inefficient under current conditions.	Strategic
Water management	5	40	Water recycling from irrigation, washing, manure or capture from farm buildings	All	All	Modulate effects of intermittent water supplies; energy savings	Infrastructure investment, expert advice	Irrigation, nutrient management	Effective under conditions of water shortage; economics may be function of water metering and/or pricing.	Tactical/ Strategic
Bale grazing	4	41	Winter feeding practice, transfer nutrients, OM to specific areas	All, except Lower Mainland, Vancouver Island	Livestock	Improve site specific productivity, with OM, reduce moisture loss, improve moisture retention	Electric fence, other fencing	Nutrient management, grazing management	Scale, equipment issues, winter rainfall problematic for outside feeding in the Lower Mainland and on Vancouver Island.	Tactical
Pruning	4	42	Bud, fruit and mature wood pruning	Thompson-Okanagan, Kootenay	Tree Fruits	To match conditions	Accepted production cost	Mulching, nutrient management, irrigation, pest management	High level of knowledge required, effectiveness variable. Severe pruning may be used to save trees under extreme drought (water restrictions).	Tactical
Crop rotation	3	43	Rotation of annual and perennial crops, forage grasses and legumes	All	Grain, Oilseed, Livestock, Dairy Vegetable, Forage seed	Improved soil properties, fertility, organic matter, water holding cap, and pest resistance.	Possible additional equipment costs	Nutrient management, pest management, conservation tillage (no-till) seeding	Knowledge re: crop choice, short term vs. long term economics, labour, farm structure capacity issues. Cultural management practice benefits, effectiveness for climate risk difficult to quantify in some situations.	Tactical
Crop pollination	2	44	No direct weather/ climate related practice noted							
Crop density	1	45	Increased density orchard planting	Thompson-Okanagan, Kootenay	Tree fruits	Optimization of tree mgmt. for conditions, reduce water use	Associated w/ replanting	Pest Management, pruning, Irrigation, grass alleys	Knowledge required. Dense orchard structure may be better suited to future covering and netting.	Strategic
Crop cooling	1	46	Shading or water-cooling	Thompson-Okanagan, Kootenay	Tree-fruits	Reduce extreme high temperatures	Overhead shading or sprinkler installation, extra water use	Irrigation, hail-rain protection nets, grass alleys	Costs limit installation of nets on certain crops; netting may serve dual purpose for rain protection and cooling in sweet cherries.	Tactical/ Strategic

Evaluation of On-farm Practices

THE SUMMARY INFORMATION in Table 3 was also used to select six practices for inclusion in the *Farm Practices & Climate Change Adaptation series*. These practices are largely strategic, ranked high in terms of their total code count, and have wide application across farm types and regions. The detailed practice evaluations were developed using the framework outlined in the methodology section and are available at *www.bcagclimateaction.ca* . A summary of the evaluation results is shown in Table 4.

The evaluation results show that all of the selected practices have considerable potential as adaptive practices to help mitigate climate change related impacts. The upper limits of the aggregate scores of all practices are comparable. Water storage and drainage however, have wide ranges in their aggregate scores, and this reflects the variability in the suitability of these practices among the various criteria. The range quite rightly captures the very site- and farm-specific nature of these practices. On the other hand, conservation tillage, MiG, Nutrient and shelterbelts show a broader application potential based on the narrow ranges of their aggregate scores.

Almost all of the practices have a neutral to positive rating for effectiveness and economic efficiency. There are situations where drainage and water storage may be less effective and efficient, and so

TABLE 4 Summary of evaluation results for six on-farm practices included in the *Farm Practices & Climate Change Adaptation series*

Evaluation Criteria	Conservation Tillage	Drainage	MiG	Nutrient Management	Shelterbelts	Water Storage
Effectiveness	3–4	1–5	4–5	3–4	4	1–4
Economic Efficiency	3–4	2–4	4	4	3–4	2–4
Flexibility	4	4	5	4	5	4
Adaptability	4–5	4	5	5	4–5	4
Institutional Compatibility	3	3	4	5	5	2–3
Adoptability	3	2–4	2	1–2	2	2–4
Independent Benefits	5	3–4	4	5	4–5	1–5
Total Scores	**25–28**	**19–28**	**28–29**	**26–28**	**27–30**	**26–28**

they also have a low value included in their ratings. The ratings for adoptability, or the ability of farmers to implement the practices with existing resources and cultural values, ranged from very low to neutral. Water storage and drainage were exceptions as the ability to adopt these practices could be moderate depending on the specific circumstances (score ranges from 2–4 respectively). This scoring reflects the historical and established nature of these farm practices in the province. However, these two practices also had the lowest scores for institutional compatibility ratings among the six practices, reflecting some of the regulatory constraints and potential conflicts with other resource uses identified in the evaluation. In contrast, MiG, nutrient management and shelterbelts are very compatible with the existing institutional and legal context. There was little to no difference in how all six practices scored on the flexibility and adaptability criteria, rating moderate to high in their ability to function under a wide range of conditions, and to be adaptable to future conditions. However, there were some minor differences in how the practices scored on independent benefits.

Criteria Ranking & Weighting

To receive farmer input on the evaluation criteria, participants were asked to consider a hypothetical decision about adopting an on-farm practice. They were presented with a series of questions to help define the criteria, and were then asked to rank the criteria according to what they viewed as the most important to the least important in their decision-making process around the practice.

The ranking exercise was completed by 27 of the 29 participants. Discussion around this question was often quite involved, and revealed the challenges of defining abstract concepts to frame an individual farmer's decision-making process. The discussion was useful in highlighting shortcomings in the approach, but also how farmers view the adoption of farm practices in general. The aggregate response of the participants was in-line with much of the discussion with farmers about weather, climate change and adaptation.

Not surprisingly, economics ranked first and effectiveness second when the ranking preferences for each criterion were added together (majority vote method). The general view of the participant farmers was, if a practice is uneconomic and ineffective it will not be adopted. A number of participants placed adoptability first in their criteria ranking, explaining that if a practice is not easily adopted it does not matter if is economic or effective. Adoptability ranked third overall, and is obviously an important decision-making criteria for farmers. Institutional and regulatory compatibility ranked last overall, and consistently placed low in individual rankings. In many instances, participants appeared to use the last place position in the ranking for institutional and regulatory compatibility to register their views on government and/or government intervention, and a perceived lack of support for agriculture overall. At the same time, there was recognition that compliance with regulatory frameworks is important and may be related to a market advantage and therefore to longer-term benefits. One large vegetable producer ranked institutional and regulatory compatibility first, because any practice introduced in his operation needs to meet GAP (good agricultural practice)

TABLE 5 Results of evaluation framework criteria ranking exercise with farmer participants and the calculated weighting based on the summed values of rankings of each criterion

Criteria	Economic	Effective	Adoptable	Adaptable	Flexible	Independent Benefits	Legal / Regulatory
Rank	1	2	3	4	5	6	7
Weight	21%	19%	17%	14%	11%	10%	7%

standards (GAP Canada — food safety for fresh fruits and vegetables).

To apply the weighted-sum method of MCE, the rank established for each criterion is converted to a percentage using the totals for all the stated preferences, with all the percentages adding to 100%. The aggregate ranking and the calculated weighted percentage for each criterion are shown in Table 5.

Options Analysis

If the weighted-sum method of MCE were used here for options analysis, scores for each criterion from the evaluation summaries would be multiplied by the relative weights determined in the ranking exercise (Table 5). The alternative with the highest aggregated weighted score would be considered the preferred option, assuming resources were limited and that only one option could be considered for implementation at any given point in time. This might have some value if the resource conditions of a single farm or a region were known, and the six practices were re-evaluated using this information. However, following through with options analysis using the higher-level evaluations presented in the *Farm Practices & Climate Change Adaptation series* would not produce a meaningful result.

Farm Systems Flexibility: an Additional Frame of Reference

As the project progressed it became apparent that a meaningful evaluation of practices to mitigate climate change impacts must consider the characteristics of the individual farm and its management to be useful at that level of decision-making. The analysis also showed that the ability of farmers to implement four out of the six practices selected for the adaptation series — which are for the most part strategic in orientation — with existing resources and cultural values ranged from very low to neutral. The ability to implement the other two practices was considered to be moderately low to moderately adoptable. Clearly challenges associated with adopting otherwise effective and economical practices is a critical, and potentially limiting, factor for future adaptation to climate change.

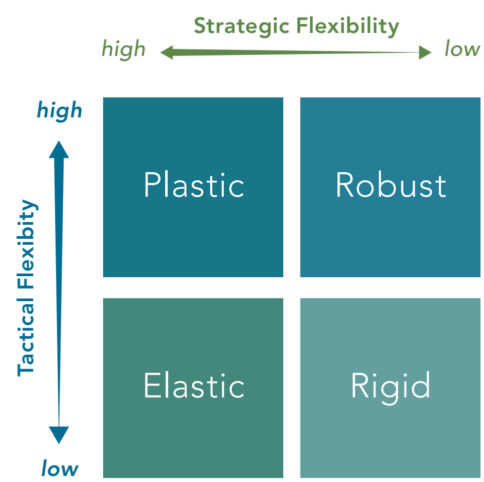


FIGURE 4 Farm system flexibility diagram

Source: Cowan et al. 2012

The farm product mix, and the market structure for those products, appears to be a determinant in the adoption of practices overall. A farm's ability to implement *both* tactical and strategic practices could also be an important factor in future adaptation. Strategic flexibility may allow adaptation to the variability expected with climate change, while tactical flexibility — having a suite of effective short-term production options — may allow an immediate response to current weather conditions. These circumstances suggest that the evaluation of farm systems and management — and farm practices — is needed to advance understanding and support agricultural adaptation for climate change.

Flexibility Classification

Some recent research conducted in Australia focuses on the structural differences among farms, and how they are able to employ tactical and/or strategic practices to manage variability in production inputs (e.g., water).[16] A classification of farms along a two-dimensional continuum of tactical and strategic flexibility was proposed in that work, and could be a useful tool for assessing current farm system flexibility (Figure 4). A farm at the low end of the strategic flexibility scale is not able to adjust its output mix without changing the farm's production strategy. For example, a mixed farm with both crops and livestock could potentially shift either to more livestock and fewer crops, or vice-versa, depending on the conditions. A farm without livestock cannot make these adjustments without changing its production model. If the farm system also had few tactical options to deal with variability in production inputs, the farm system would be considered rigid. Single crop orchards that have few ways to adjust to variations in the level of production inputs (e.g., irrigation water) might be an example of this category.

An example of tactical flexibility might be the ability to harvest forage using various methods (e.g., hay, haylage, silage) to deal with variable forage harvest conditions, while also maintaining an option to purchase some forage. Reducing water requirements, and allowing decreased production might be another. It is important acknowledge that strategic and tactical flexibility is evaluated on a relative continuum, and an individual farm could fall anywhere in the two dimensional classification shown in Figure 4 depending on the farm resources. The most flexible farm would have high strategic and tactical flexibility and would be termed 'plastic' in this classification.

More work would be required to assess the tactical and strategic flexibility of participant farms, but clearly the farm system flexibility classification may have a role to play in helping identify an appropriate suite of practices for various farm types in different regions. At the same time, it is important to distinguish that identifying existing flexibility within a farm system, is quite different than knowing how to change the farm structure to improve flexibility. The process of changing flexibility is one of adaptation, and involves adaptive capacity. Nonetheless, the classification could be helpful for developing an improved understanding of farm system flexibility, how it relates to various kinds of on-farm diversification, and what role it may play in future adaptation to climate change.

Diversification

On-farm diversification — including enterprise, crop and production location — was common among the participant group. Diversification is often suggested as a risk reducing strategy to help mitigate climate change related impacts on agriculture. Certain types of diversification allow strategic flexibility, as illustrated in the example in the previous section. Diversification practices, excluding crop variety selection, were ranked in the top 15 practice codes for all participant farms by total code count.

Enterprise Diversification & Value Chain Integration

Enterprise diversification is a strategic practice, and may be an appropriate response to a continuous or medium-term condition in the production environment. Its application is based on the natural resource endowment of a given farm. A common model for diversification, especially in marginal cropping areas where land capabilities are lower and growing seasons are relatively short, is the mixed farm that raises both annual grain crops and livestock. Adopting enterprise diversification may require the addition of infrastructure, changes in equipment for production, or start-up costs. As a strategic adaptation, enterprise diversification is unlikely to be changed on an annual basis, although some adjustment in the production contribution of each component may be possible on a shorter-term basis depending on the products. The stimulus for enterprise diversification among participants was sometimes associated with succession, or economic stress.

Value chain integration at the farm level increases the value of farm products, either through on-farm processing or marketing. There was substantial enterprise diversity and value chain integration

TABLE 6 Number of different crops grown on participant farms where crops are grown for sale by region and farm type

Region	Farm Type	Number of Farms	Number of Crops Grown
Bulkley-Nechako	Grain, hay	1	7
	Grain, beef cattle, dairy	1	5
Cariboo	Vegetable, beef cattle	1	8
Lower Mainland	Vegetable, berry	1	12
	Vegetable, cranberry	1	7
Peace	Grain, beef cattle	2	5
	Grain	1	4
	Grain	1	5
Thompson-Okanagan	Organic vegetable	1	52
	Tree fruit, beef cattle	1	2
	Tree fruit	2	2
	Tree fruit	2	1
	Vegetable	2	30
Vancouver Island	Berry, specialty dairy	1	6
	Berry, commercial broiler	1	5
	Berry	1	4
	Vegetable, poultry	1	13

Note: Excludes livestock operations and dairies where crops were grown exclusively for livestock and fed on the farm. In the diversified enterprises, mixed grass and legume crops grown for forage were counted as a single crop, corn and other grain crops were counted individually if they were used as forage or destined for sale.

among the participant group (see farm types in Table 3). Two farms had enterprise diversification that didn't involve agriculture production (electric fence equipment sales; and snow removal, land levelling) with both contributing financially to operations, and creating efficiencies for the acquisition of machinery and equipment in farm operations.

Crop Diversification & Crop Variety Selection

Crop diversification refers to the number of different crops grown by a farm operation, whereas crop variety selection refers to the decision to plant a specific genetic selection of a crop that exhibits certain traits. There is greater diversity among a group of different crops than a group of different varieties of the same crop. However, variety diversification can provide some hedge against variable weather conditions depending on the specific varietal traits. For example, early-maturing and late-maturing varieties exist for many crops. Variety selection for traits suited to particular growing conditions is an important consideration in all production situations.

Crop diversification and variety selection can be both tactical and strategic. Adding to, or changing, the combination of crops grown can be a tactical, short-term, decision in annual crop production (grains, vegetables). One participant described how they made a tactical decision to plant a faster developing, but smaller vegetable variety knowing the season was shortened by cool spring weather. Crop and variety selection becomes a strategic or medium-term decision in perennial crop production (grass and legume forage, fescue and other forage seed crops) and is an even longer-term capital investment in the case of berries and tree fruit crops.

The number of different crops grown on participant farms where crops were grown for sale is shown in Table 6. This summary excludes livestock operations and dairies where crops were grown exclusively for livestock and fed on the farm. In the diversified enterprises, mixed grass and legume crops grown for forage were counted as a single crop, corn and other grain crops were counted individually if they were used as forage or destined for sale.

Vegetable Crops

The level of crop diversity was highest among the vegetable producers, due in part to the shorter growing season of most vegetables compared to grain crops and fruit. For these vegetable growers diversity is about filling the season and finding a seasonal advantage, a market demand for a specific variety, and establishing brand recognition. However, for the organic vegetable operation in the Thompson-Okanagan, the strategy was also about how crop diversity works with annual growing conditions:

> *One of the things about having a diversity of crops like this too, it's a built in insurance system in any given year. You are going to have some crops that don't do well for one reason or another. In the same given year, other crops are going to say hey this is just what I needed, and I'm doing fine. So it kind of balances itself out we find.*

Scale is important in this case because the quantities of each crop grown are small and therefore minimal loss is associated with a poor crop or crop failure. This also fits with a production strategy that pays less attention to the individual requirements of each crop, and more to the day-to-day management of labour and other aspects of the farm.

> *We don't have time to figure out first of all what all these crops need, and in some cases, it's not worth the effort to create those special conditions for those particular crops. So we kind of treat them all the same. We are providing a certain amount of base fertility in the field, they either make it or they don't… More of our time is focused on the basic mechanics of running the farm in terms of… staffing and training people and all the marketing is a fair bit of time too. And you always have to be responsive to the market.*

There was somewhat less crop diversity at the large-scale vegetable-cranberry operation where potatoes were the major crop associated with much of the farm equipment, processing and storage infrastructure. The potato market in the province is regulated, and this likely affects decision-making around crop selection. Other crops grown including peas, beans and beets were produced through agreements with Lucerne for harvest and processing. However, more recent crop diversification has taken place with the establishment of a significant cranberry acreage, and a decision around additional acreage is being considered.

The large-scale fresh market vegetable producers were all engaged with their own field-testing of varieties, and one in particular to a remarkable degree:

> *We do a lot of tests. This year I tested over 60 peppers, and pretty big tests. Bigger than I like to do, but I found we're looking for some colored peppers…*

Location Diversification

In discussion of agriculture and adaptation, planned location diversification has been suggested as an option for minimizing production risks related to climate change. The extent to which this might be practised at the farm scale is highly variable and related to the size of the farm, the type of farm and local microclimates. BC's highly variable topography has resulted in many practices and cropping patterns evolving with production location in mind. For example, the practice of moving livestock from lower elevation spring, fall and winter grazing to higher elevation forested ranges in the summer is a traditional practice in BC.

TABLE 7 Instances of the location diversification code and resulting effects among participant farms by region and farm type

Region	Farm Type	Instances of Location Diversification			Total
		Negative	Neutral	Positive	
Bulkley-Nechako	Grain, hay			**1**	1
Cariboo	Beef cattle	7			7
Lower Mainland	Vegetable, cranberry		4		4
Peace	Beef cattle			2	2
	Grain, beef cattle	1		1	2
Thompson-Okanagan	Vegetable			3	3
Vancouver Island	Berry	1		1	2
					21

Location diversification was coded a total of 21 times among nine different participants (see Table 7, next page). There were both positive and negative examples of location diversification and the spatial scale of different production sites varied from distances of a few kilometres to over 1,000 km.

Although there were examples of both crop and livestock producers benefiting from location diversification, the negative examples were primarily associated with livestock production. Costs and stresses associated with trucking cattle and calves great distances are substantial, and dependable labour is required to ensure the management of livestock in remote and or new locations. Labour shortages and livestock loss to predators were cited as reasons for one producer to give up use of a remote livestock production location that had been successfully integrated into the grain farming and feedlot operation for years. Another producer incurred substantial trucking costs and poor weight gains on leased pasture, after being forced to leave local Crown range because of lack of forage caused by drought and wildfire. The annual use of a familiar Crown summer range area near owned or leased private land has substantial value to livestock producers. Gaining access to Crown range following drought was considered to be a positive development for one producer, even though the preference would have been to maintain operations completely on private land.

Crop production in diverse locations requires movement of machinery, and periodic inspection to monitor crops, however, these inputs are reasonably managed within existing farming operations if the distances are not significant. The use of leased and rented lands provides the opportunity to find different microclimates for crop production. A participant producing vegetables in the Thompson-Okanagan, was using owned land at lower elevation for crops needing more heat-units, and rented land higher up the valley for producing root crops. To be beneficial, location diversification needs to fit the circumstances and the resource base of the farm and its production system.

Diversification Case Example: Small-Scale Berry & Broiler

Enterprise diversification was indicated as a specific strategy for this small-scale berry and commercial broiler farm on Vancouver Island. This producer also happened to be a new entrant to agriculture, and diversification and alternative production options were part of start-up considerations.

The choice of broiler production, and a recent expansion of production quota, was related to a new entrant program initiated by the British Columbia Chicken Marketing Board to keep production on Vancouver Island. The decision to take on the quota was seen as a way to stabilize income, and reduce on-going production risks associated with u-pick berries including weather, wildlife and market volatility.

Broiler production was estimated to contribute 70% to net farm income, with berries contributing 30%. The contribution to net income from broiler production was expected to increase to 80%, with recent increase in production quota.

Considerations for adaptation & current farm system flexibility (tactical & strategic responses):

- Dependence on off-island suppliers for chicks and feed, results in chick mortality risk during winter transportation with ferry crossing and transfers, and profit sensitive to transportation costs on feed
- Limit to further livestock diversification because of broiler production restrictions — some animals aren't allowed on the farm, e.g., swine and other poultry (layers)
- Development of water storage and supply infrastructure may be needed to maintain water supply to meet requirements for cooling the broiler barn, and berry irrigation during critical dry periods — current system is near limit
- Creation of on-farm berry storage has increased marketing flexibility (opportunities)

Poultry barn in the Comox Valley.

Case Examples: Medium-Scale Organic Livestock & Organic Vegetable

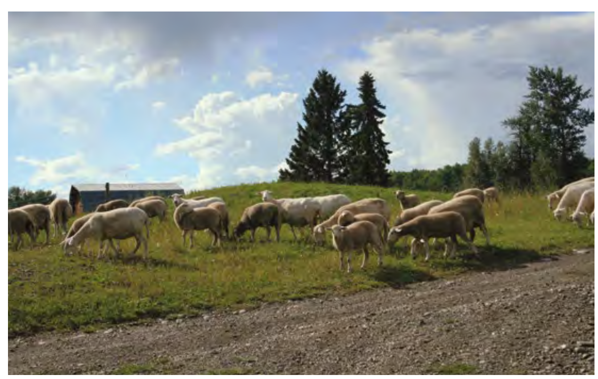
For these two organic agriculture operations, enterprise diversification was focused on complimentary and synergistic relationships between production components. Production at both farms was well suited to the local environmental conditions and natural resources — with the forage-based livestock enterprise located in the moist sub-region of east-central Cariboo, and the vegetable operation located on the Shuswap River in the Thompson-Okanagan.

For the livestock operation, the emphasis was primarily on the relationships between ecological factors, and longer-term benefits from multi-species livestock production achieved mostly through management practices. The use of pastured hogs to rejuvenate pastures for cattle grazing, is just one of many practices employed on the farm. Chemical fertilizers have not been used since 1999. Value chain integration, with direct sales from farm to retail, with organic certification and product branding associated with the holistic ecological approach, were a key part of the production strategy.

Although on-farm practices such as crop rotation, and use of green manure cover crops are an essential part of the production model, market integration was seen as a critical part of the overall success for the organic vegetable operation. Value chain and market development has included construction of on-farm processing and produce storage, and the purchase of produce from outside sources (other organic growers) to supply direct to retail markets during the winter season when the farm's own fresh produce is limited. Keeping a wide range of products available in the developed market is considered critical to maintaining the customer base, and to support the enterprise in the long-term. Customer education through a monthly newsletter was cited as a way to inform and shape consumer preferences when many products are out-of-season.

Considerations for adaptation & current farm system flexibility (tactical & strategic responses):

- Minimized use of chemical inputs in operations increases resilience, and minimizes the effects of supply disruptions, and changes in input costs
- Direct market approach of organic production and on farm storage, increases flexibility in product marketing and extends marketing windows
- Development of direct-market customer loyalty and education builds flexibility for variations in supply



Hoop houses extend the growing season on an organic vegetable farm near Salmon Arm, while multi-species grazing that includes cattle, sheep and hogs is part of the diversification on an organic forage-based livestock farm in the Cariboo.

Case Examples: Large-scale Vegetable & Tree Fruit Production
(Lower Mainland & Thompson-Okanagan)

The large scale vegetable and tree fruit producer participants also had well developed processing capacity on their farms, and were involved in various aspects of direct marketing to wholesalers and retailers. The timing of crop harvest dates with other production areas, and finding market position within the typical harvest season (i.e., first to market, early, mid, late) with fresh market crops appears to be a key factor in marketing strategies.

Development of on-farm processing capacity and export market customers is an important value chain strategy for cherry producers.

Considerations for adaptation & current farm system flexibility (tactical & strategic responses):

- Development of market relationships, useful for working out future supply adjustments
- Specialized on-farm processing capacity creates marketing flexibility
- Current product prices and profitability are insufficient to allow investment in crop protection infrastructure especially in fruit crops (e.g. hail, rain and shade nets for cherries) which may delay adaptive response to changing conditions

On-farm cherry processing facility in the Thompson-Okanagan.

Enterprise diversification among these farms is related to aspects of complimentary production that reflect resource endowments both at the farm-scale and regionally. As storable commodities, grain and hay have some marketing advantages in that the timing of sales is more flexible than fresh food products. There are also soil benefits in the rotation between hay and grain crops. Hay quality and quantity are a function of early growing season weather conditions and the suitability of the early summer harvest period (needs to be dry, with no rain). This area of the province is noted as a hay-producing region.

The grain and hay farm also has a large component of rented and leased land (highest of all participants at 84%, or 4,200 of the 5,000 acres cropped). Hay appears to be a suitable crop for rural landowners within the Agricultural Land Reserve who rent or lease their land, and this may be a factor in the make-up of this enterprise combination. The production location diversification created by having leased lands spread throughout the area, might also distribute weather related production risks that can have a negative impact on hay quality. There are also challenges related to the permanency of rental and lease arrangements, this can make future crop planning for perennial crops like alfalfa difficult.

The grain, beef cattle and dairy enterprises are complimentary in this relatively isolated region because both grain and forage can be produced and fed on the farm, eliminating freight costs on feed inputs. In years where grain quality is low because of poor weather conditions, grain can be diverted to a beef finishing operation. Production inputs and land resources can be shifted between enterprises depending on markets. Higher grain prices this year have resulted in planned shifts to increased grain production.

Adaptation Considerations that may affect farm system flexibility:

- Ability to shift resources between enterprises depending on expected conditions — e.g., strategic flexibility in farm system
- Economies of scale allow ownership of a full compliment of equipment allowing flexibility in the timing of operations — a broad range of tactical responses is created by financial investment
- Production location diversification with rented and leased land disperses crop production risks and harvest opportunities associated with micro-climates

Hay storage facilities in the Bulkley-Nechako.

Discussion & Conclusions

The evaluation of on-farm adaptation practices using a multi-criteria evaluation (MCE) framework has helped to identify:

- Potential linkages between various practices and climate change related production risks;
- Differences in practice suitability to mitigate climate related production risks;
- Effectiveness, economic efficiency and adoptability as key factors in practice adoption;
- A problem of low adoptability of otherwise effective on-farm practices; and
- Potential institutional and regulatory compatibility issues with some of the practices.

High-level evaluation of this kind helps inform the development of more focused and effective programs to support agriculture adaptation for climate change in British Columbia. To have utility for land managers and farmers, practice evaluations must necessarily include substantially more site and farm-specific information.

Linking Adaptation Response to Future Uncertainties & Risk

There is a need to better connect practices with environmental thresholds, productivity and some assessment of the potential reduction of climate related risks. As more information comes available and work to support adaptation continues, further evaluation should be carried out at the regional and sub-regional level, to better link different farming systems with predicted climate conditions and uncertainty, e.g., more frequent extreme events. Ultimately, practice evaluation efforts need to be carried out at the farm-level scale to identify appropriate adaptation options for farmers.

Proving Effectiveness & Economics

The ranking of decision-making factors by participants served to highlight those criteria that are most important to farmers. Economics, effectiveness, and adoptability are key factors influencing decision-making about on-farm practices. Therefore, any planned adaptations for climate change must address these three criteria. The detailed analysis of six on farm practices for the *Farm Practices & Climate Change Adaptation series* revealed that there isn't always sufficient economic information to support decision-making. More information on the relationships between practices and the resulting changes in environmental conditions — for example, the level soil moisture retention achieved with mulching — is needed to establish effectiveness thresholds that could be measured against predicted future conditions.

Supporting Adoptability: a Farm Systems Approach

In addition to being an important decision-making factor for participants, adoptability was also scored very low to neutral for four of the six, mainly strategic, practices assessed for the *Farm Practices & Climate Change Adaptation series*. At the same time, these same practices all show potential effectiveness for mitigating climate change related production risks. A better understanding of farming systems, adaptive capacity and an identification of those farm characteristics that allow practice adoption, is required to help support and develop farm resilience to these risks. A classification of farm system flexibility using both strategic and a tactical orientation to manage input variability could be a useful framework for adding to this understanding in the BC context.

The flexibility classification is intended to identify tactical and strategic flexibility within existing farm system structures, and could be used to examine several critical inputs. It could help identify tactical and strategic practices for different farm types, and aid in the assessment of various aspects of on-farm diversification and its role in adaptation for climate change. The classification would also likely add insight into aspects of adaptive capacity that may suggest ways to improve flexibility with some structural adjustments in farm systems. Furthermore, better understanding of tactical and strategic flexibility in farm systems, and the temporal context of practices in general, should highlight linkages between adaptive responses and the information signals that are being received by farmers.

Many of the participants in this study employ tactical adjustments in their production practices to deal with highly variable weather conditions. Documenting full suites of practices that lead to high tactical flexibility within different farming systems would be beneficial and maybe directly transferable. In some farming systems, achieving tactical flexibility may require additional investment in machinery and infrastructure, and this points directly to the importance of financial resources in the process of adaptation. Practices with a longer time horizon and that are strategic in scope will also likely require some form of financial investment. The consideration of adaptive capacity, including financial resources, needs to be part of the farm system approach to supporting adoptability, and future adaptation.

A focus on farm systems would also enable a more holistic assessment of on-farm practices, some of which are applied as practice or management systems, rather than stand-alone technical prescriptions. Inherently adaptive management systems and practices — where monitoring, evaluation and continued adjustment are integral components, i.e., nutrient management and management-intensive grazing — show promise for building resilience to climate change impacts and should be identified and supported.

Future Efforts

Guidance to support agriculture adaptation for climate change needs to be developed in the context of the farm system, available resources, production scales and market conditions, and most importantly, it must be linked to expected climate conditions. At minimum, analysis and planning should be carried out at the regional and sub-regional level and ideally farm specific analysis would be part of any program delivery to support adaptation. Practical and specific details of a farm system are critical when a practice such as location diversification is suggested as an adaptation option at the farm level. The examination of location diversification among participants showed the practice can potentially have both positive and negative effects on production and income depending on the circumstances. On the other hand, examples from this project also show positive instances of crop diversification as means to deal with seasonal weather variability. A farm system evaluation including an assessment of all resources (adaptive capacity), a flexibility classification and climate change risk assessment combined with a practice evaluation would provide the most robust support for planned on-farm adaptation.

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