Managing Climate and Weather Risks for Peace District Agriculture

(photo credit: Dave Sauchyn)

(photo credit: Garry Rapchan and Amber Havens)

Summary Report for Workshop, Grande Prairie Inn, Grande Prairie, Alberta, February 6-7, 2007

FOREWORD

It is now highly certain that climate change will have, and in some areas is already having, significant impacts on the environment and economic activities. Weather and climate are important to Canadian agriculture, a sector that has historically adapted to a multitude of changes in the broader social and physical environment. Future climate change is uncertain: it may create new opportunities for Canadian farms, but it might also exacerbate conditions already deemed problematic.

Those from the agricultural industry, policy and research communities are raising questions about how the sector can adapt and prosper under current and future climate conditions. On February 6-7, 2007, a workshop designed to address those questions and other related issues took place in Grande Prairie, Alberta. This report contains a summary of the presentations and discussion in that meeting, organized into three sections. The first provides details on the meeting itself (purpose, objectives and program). The second follows the themes of the workshop and includes summaries of the presentations and related discussion. The third offers a conclusion and comments on future directions.

The organizers are grateful to many organizations and individuals for their support in planning and holding the workshop. We appreciate contributions from the British Columbia Ministry of Environment, Agriculture and Agri-Food Canada (AAFC), Farm Credit Canada, and C-CIARN (Canadian Climate Impacts and Adaptation Research Network). Garth Mottershead and Brett Henschel in the Prairie Farm Rehabilitation Administration (PFRA) office (Dawson Creek) were very helpful with administrative tasks as was Monica Hadarits (Global Environmental Change Project, University of Guelph) and Mireille Lapensee (C-CIARN Agriculture).

Special thanks to the Peace District producers whose presentations and insights gave us all much to think about.

Ellen Wall (C-CIARN Agriculture)
Irene Hanuta (PFRA)
Alex Milton (PFRA)
Brian Haddow (PFRA)
Ben Kangasniemi (BC Ministry of Environment)
Norm Henderson (Prairie Adaptation Research Collaborative (PARC)
Robin Sidneysmith (C-CIARN BC)
Holly Dolan (AAFC, Rural Secretariat)

For questions regarding this report please contact:

Ellen Wall 519 824 4120 ext 58480
ewall@uoguelph.ca

Irene Hanuta 204-984-3694
hanutai@AGR.GC.CA

PART 1: WORKSHOP DETAILS

The workshop's title, *Managing Climate and Weather Risks for Peace District Agriculture* indicates the main purpose for the workshop, namely:

> *to provide a forum to understand and document how Peace River agricultural producers currently manage weather and climate risks so that we can learn what is needed to build their capacity for the future.*

Related to this purpose are a number of objectives:

- Provide a forum for policy and research communities to learn how producers deal with weather and climate impacts, how they approach weather forecasting issues, and how they view greenhouse gas mitigation,
- Offer an opportunity for producers to learn about climate change issues from policy and research perspectives,
- Provide opportunities for producers to learn from each other's experiences with managing weather and climate risks, and
- Document the workshop proceedings and make it widely available.

As the first objective suggests, there were three related themes in the workshop: managing risks from changing climate and weather, weather forecasting, and greenhouse gas mitigation. These topics constituted different sessions in the workshop (see Program in Appendix A).

A total of 54 people participated in the workshop, although not all were formally registered. A list of participants and short biographies of the presenters and panelists can be found in Appendix B. The overwhelming response to the workshop was positive, with attendees noting that hearing directly from producers was informative and offered good networking opportunities.

The following Table provides a summary of attendance based on relationship to the agricultural sector:

Workshop Attendance (registered), February 6-7, 2007
Grande Prairie, Alberta

Relationship to the Agricultural Sector	Number	Percentage
Policy/government agency	23	50%
Producer (and ag business)	15	33%
NGOs	2	4%
Media	2	4%
Research	4	9 %
Total	46	100%

Those representing policy and government agencies made up 50 per cent of participants. Producers were the second biggest group (33 per cent), followed by representatives of research (9 per cent); NGOs connected to agriculture (4 per cent), and media (4 per cent).

The balance of this document contains summaries of the presentations made on February 6th and 7th, 2007. First, the document lists presentations that provided background information about climate and agriculture in the Peace District, followed by presentations related to managing risks associated with climate and weather. Third is a discussion on weather forecasting ,and lastly, discussion related to greenhouse gas mitigation. Powerpoint presentations are available at: http://www.c-ciarn.uoguelph.ca/events/grandprairieworkshop.html

PART 2: PRESENTATIONS AND DISCUSSION

SETTING THE CONTEXT

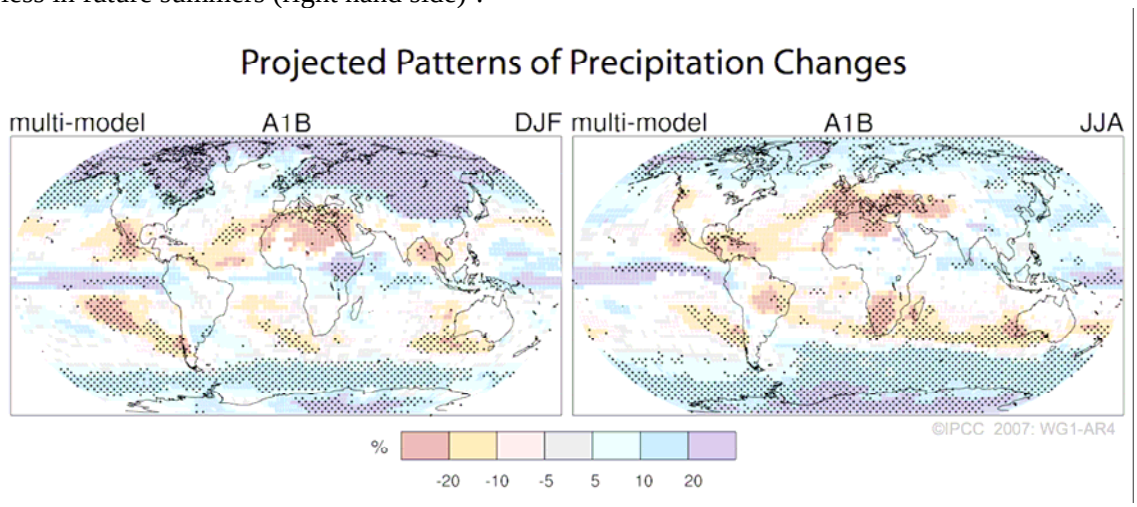
Four presentations provided background information for the main workshop topics. Bill Taylor (Environment Canada) offered a summary of climate conditions for the Peace District along with a synopsis of the main climate change challenges for the region. Amber Havens gave an overview of agriculture in the District followed by Tony Cheong and Dave Tamblyn who presented details on the surface and groundwater environment in the region. During lunch, Dave Sauchyn spoke about the history of drought in the Prairies as a framework for discussing the potential for future drought.

The Past, Present and Future Climate of the Peace District

Bill Taylor (*Environment Canada, British Columbia and Yukon*)

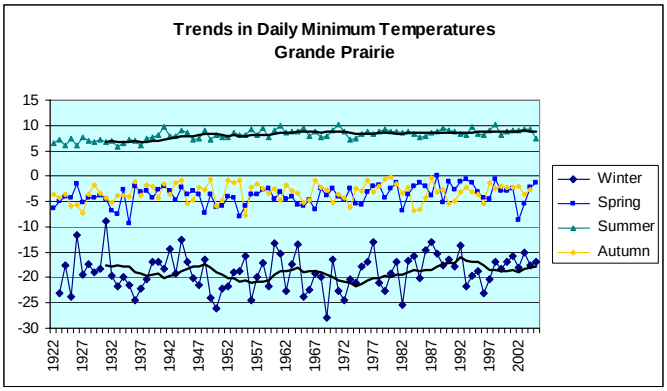
Using information on global and Canadian climate trends, Taylor highlighted the basic message from the recent IPCC (Intergovernmental Panel on Climate Change) report. Projections for average annual temperature in the Peace District by 2050 predict a warming of 3 degrees *Celsius* over temperature levels of the 1990s. Average annual temperatures in recent years suggest this warming trend is already underway.

Projecting future precipitation is a greater challenge for climate modelers due to high spatial variability and high variability in rain rates. With this caution, Taylor offered projected patterns of precipitation as shown below. The data in this map are based on multi-model averages and represent projected precipitation for 2090-2099, compared to 1980-1999. According to the projections, the Peace District may have more precipitation in future winters (left hand side), but less in future summers (right hand side)[1].

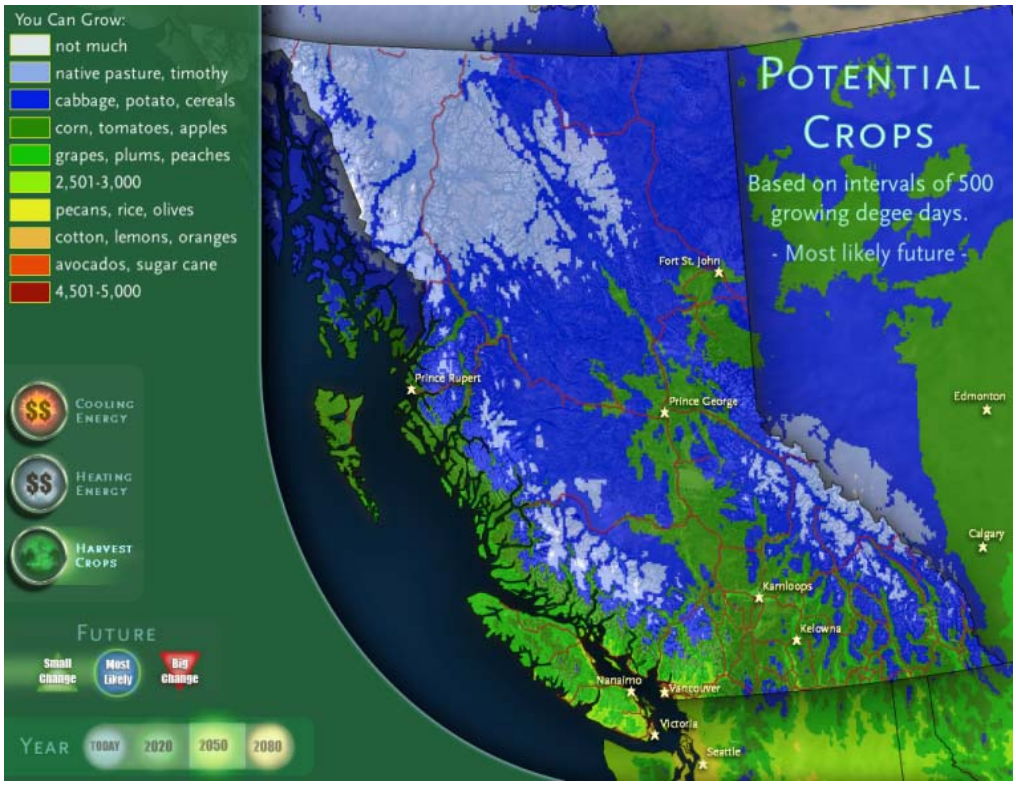


[1] Note white areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. View this map at: http://ipcc-wg1.ucar.edu/wg1/docs/WG1AR4_SPM_Approved_05Feb.pdf

Taylor also provided data showing weather patterns for Grande Prairie in more recent times. The figure to the right, for instance, shows average minimum temperatures increasing slightly in all four seasons from 1922 to 2002.



There are many implications from the trend to "less cold" conditions, especially in the winter. Warmer winters mean a greater risk that over-wintering pests will not die-off and crop diseases may become more prevalent. On the other hand, the potential to have an extended growing season that allows different crops to grow in the region could be advantageous. There is always keen interest in potential opportunities for agricultural production if climate change scenarios prove true and if all other growing conditions are suitable (e.g. adequate moisture levels). Taylor concluded his presentation with some illustrative slides[2]. The example below indicates a potential to grow corn, tomatoes and apples in the Peace region by the 2080s (using models with scenarios considered "most likely" to occur).



[2] Available at: http://www.pacificclimate.org/impacts/rbcmuseum/

Agriculture in the Peace River District – Past, Present and Future

Amber Havens (*Beef Specialist, Peace Country Beef and Forage Association*)

Havens provided an overview of crops grown by the first farmers in the region, and the challenges they faced. The typical heavy clay and grey-wooded soils posed substantial difficulties. Acidic soil meant that crop diversity was limited, but as knowledge increased and crop breeding techniques developed, adaptations have been made. Heavy clay can lead to soil baking and is still problematic, being linked to hot, dry weather conditions.

Barley was first grown at Fort Dunvegan in 1909, but wheat was the major crop, with oats being produced for livestock feed. By the 1930s, surpluses were shipped outside the region as feed/seed, legumes and grass became important crops. In the 1950s there were some changes in production as farmers grew more barley than wheat and also began planting more flax and canola. By 1965, five million acres of land were used for agriculture and the region became a major producer of Fescue seed. In addition, honey and some horticultural crops were produced but livestock numbers remained relatively low.

In general, Peace District agriculture was essentially isolated from markets and undeveloped. The winters were long and hard with most precipitation in summer months. Although the growing season was short, the longer days were some compensation.

In present times, it is clear that many aspects of agricultural production have changed little. Grass and legume seed remain major crops in the region, along with canola, wheat, barley, honey and horticultural crops. One significant change, however, is the substantial increase in cattle herds. For example, in 2001 the Alberta average herd size was 53 head, but in the Peace District for that year the average size was 192.

Several recent climate and weather challenges persist in the region, namely a lack of precipitation in some areas, which leaves soil moisture critically low. The district has perceived a general reduction in rain showers, as well as less snow during the winter.

Economically, land prices are attracting farmers from other areas into the Peace District, leading to an increase in acreage under development. As in other Canadian regions, the trend is toward larger farms with fewer farmers. The pattern of shipping raw products south for adding value and then shipping the finished product back also continues. Market isolation and transportation across the river (i.e. reliance on bridges) remain problems, as do the loss of elevators and fuel stations.

Looking to the future, Havens pointed to likely increases in cereal production, accompanied by more demand for canola and barley due for bio-fuel production. Livestock numbers will also likely increase, but the trend toward growing farm sizes will continue. Although it is cheaper to feed cattle in the Peace District than in many other Canadian regions, other costs of production,

such as transportation costs, are substantial, making the profitability of the agricultural sector an n ongoing challenge.

Following this discussion, Havens focused on climate risks, pointing out how different strategies on the part of farmers can improve environmental conditions and therefore help reduce negative impacts from weather and climate. For instance, use of bale or swath grazing by beef producers can both cut costs of production as well as produce more moisture-retaining manure, which in turn mitigates some of the aforementioned environmental challenges.

Peace District farmers are improving their capacity to handle climate change and other risks by educating themselves in numerous ways, such as attending local meetings where new and useful information is made available. They also use existing institutional resources to improve their financial and environmental management skills. According to Havens, a significant challenge is getting those producers who are falling on hard times to change their methods of production. Farmers who are experiencing financial difficulties cannot afford to experiment with their operation and venture into unknown territory. Risk-taking is much less feasible in conditions allowing no margin for error and production loss.

Future opportunities in the area include expansion of cereals and beef production. At present, Peace District land remains affordable, and historically consistent weather tends to be ideal for raising cattle. The Peace Region produces more crops and livestock than it consumes so exporting remains a strong option. However, Havens feels there could be more value added locally and more promotion of local products.

Farmers are innovative and by nature are forced to keep evolving to their surrounding conditions. According to Havens, it is of utmost importance “to get the word out there about the need to take climate risks seriously” so that farmers can anticipate and prepare for future changes.

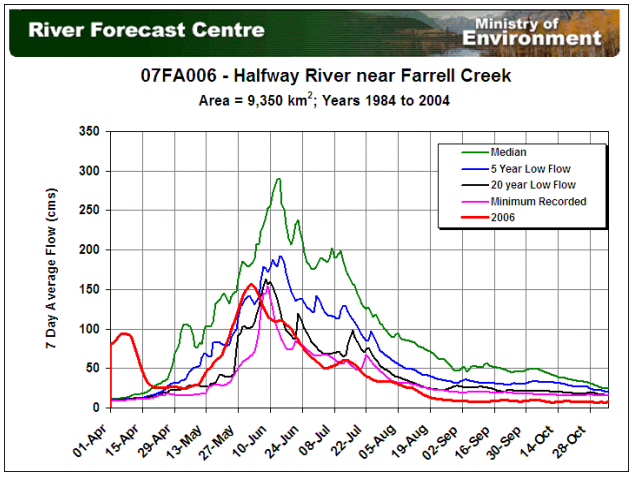
Surface Water and Groundwater Challenges in the Peace River District

Tony Cheong and Dave Tamblyn (*BC Environment, Water Stewardship*)

Cheong and Tamblyn provided information on what is available for stakeholders who rely on surface and groundwater. Such services are important and will likely become even more so under a changing climate where water resources could be more restricted.

Surface Water

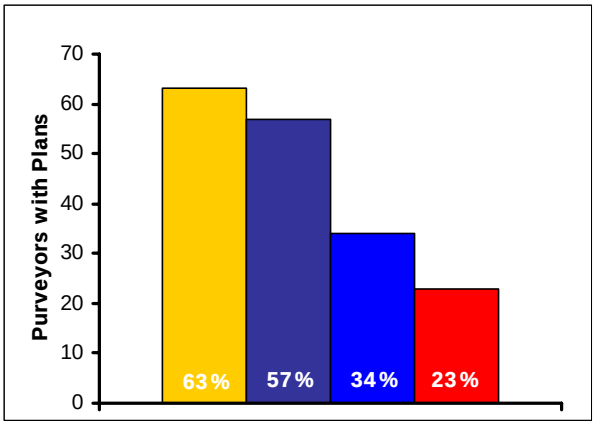
Supply users in the Peace District include agriculture; oil and gas and other industry; fish and aquatic resources; and domestic users. Governments provide monitoring and information services to those users regarding surface water conditions. For instance the graph in the figure to the right gives data on stream flow (past and present), which comes from 180 Real Time Stream Flow Stations. This comparative information could help users make decisions involving water supply.



With projections for future stress on surface water supply, it makes sense to have some kind of water use plan in place so that maximum efficiencies can be realized. One of the most effective ways to manage our demands is to first understand the capacity of our supply systems, and then to practice proactive water management with these supplies, using planning tools.

Several types of plans exist, including: a **water supply plan**—this is important as it analyzes current supplies of the system, and projects future water supplies and future demands while exploring alternative options available to develop a reliable supply of water to meet these demands. This plan should also have a technical, financial and economic cost/benefit analysis. As the Figure below indicates, water supply and conservation plans are more common than short and long-term drought plans. Ideally, all purveyors would have all four types.

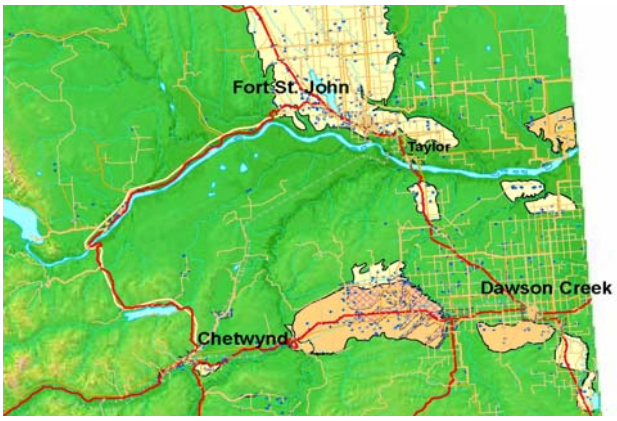
The yellow is water supply plan, lighter blue is water conservation, darker blue is short term drought plan and red is long term drought plan.



Groundwater

Noting that there has been no study of water usage for B.C. in 25 years, Tamblyn summarized the main uses as:

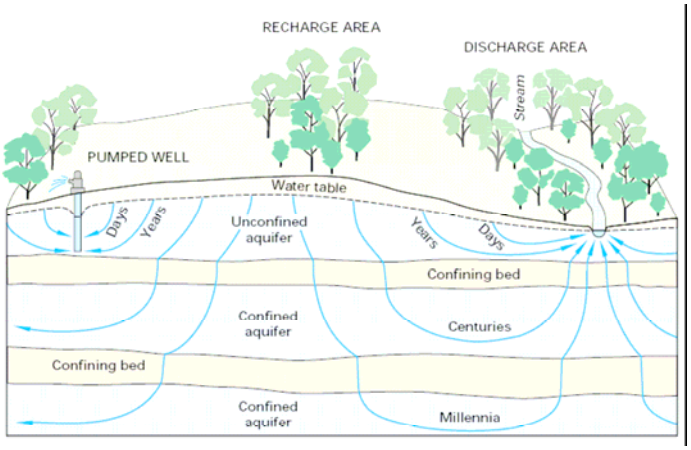
- domestic drinking water from private and community wells
- industrial-for oil and gas; mining, and agriculture
- base flow to streams-approximately half the annual discharge of streams comes from groundwater.



Groundwater provides base flow to streams so it is connected to surface water. The Peace aquifer (BC) (see Figure to right) has within it 40 aquifers (23 unconsolidated and 17 bedrock). However, groundwater resources have been delineated with detail only in small areas of the Peace Region. They are found to be generally deep, moderately productive, but with poor water quality primarily for aesthetic (taste and colour) reasons as opposed to health reasons (bacteria, parasites and the presence of unwanted elements).

Data from a provincial network of observational wells are used for drought monitoring and prediction in the Peace District (www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater). Groundwater systems (see figure below) are important for drought conditions because they are more consistent than surface water and can therefore substitute for other water sources in the short term (years). Given projections for moisture stress from future climate change, it is and will be important to ensure groundwater resources are protected and available.

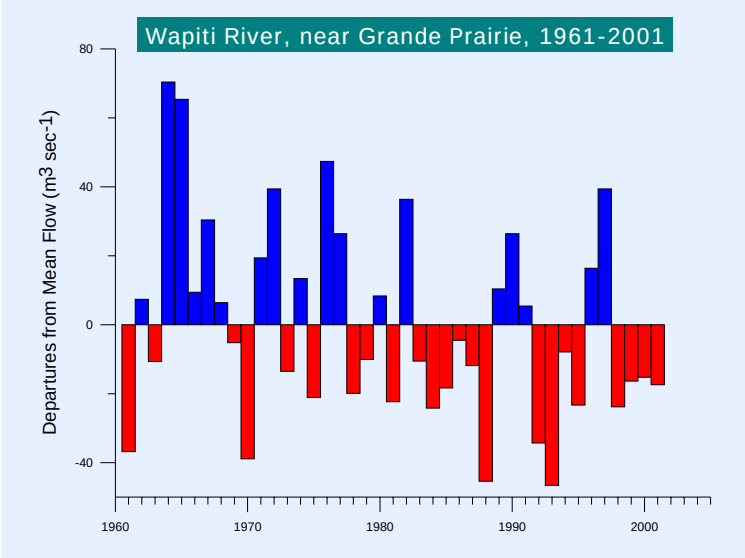
Groundwater Flow Paths and Times



Prairie Droughts: Precedents and Prospects

Dave Sauchyn, (*University of Regina and Prairie Adaptation Research Collaborative*)

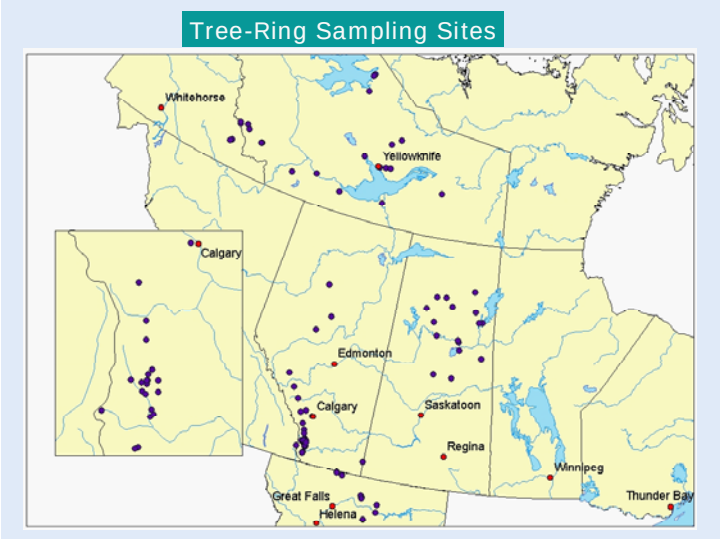
Sauchyn prefaced his comments by noting that historically, the southern part of Alberta and southwestern Saskatchewan have been the drier areas in the Prairies region so what is unusual about recent conditions is the extent of dryness further north (such as in the Peace District). For instance, as the figure to the left indicates, the Wapiti River (east of Grande Prairie) has been relatively low since the 1980s.

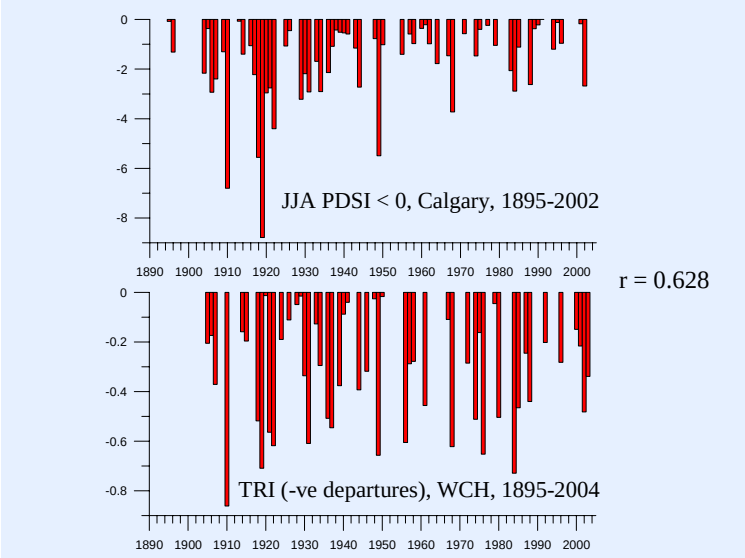


Analyzing surface and groundwater levels is one way to characterize historic precipitation and weather conditions. Another is to study tree growth. Most research however has focused on trees in the southern Prairies. To get optimum data it is best to choose trees that do not have access to springs so that only the effects of rain are evident in growth rings. Thus trees that grow on higher areas are generally used for tree ring analysis that acts as a proxy for weather.

One of the best sites for trees is in the Wildcat Hills close to Calgary. Sauchyn noted that he is very interested in getting more northern research sites such as the Peace District and encouraged workshop participants to discuss potential projects with him.

The figure to the right shows where tree-ring sampling has occurred to date.





Comparing the Palmer Drought Index with output from tree ring inferences during the 20th century reveals a strong correlation between the two, supporting the value of using tree ring analysis to identify periods of dry or wet conditions.

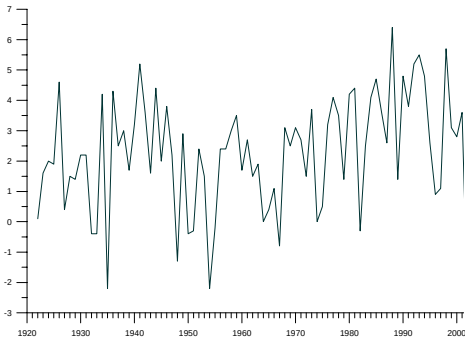
Even though the 20th century had several severe dry spells, paleo-data reconstructing conditions for several hundred years shows conditions have been even drier in the past.

Using a longer time horizon means you'll find worse weather than we have experienced recently. For instance if we examine the weather record in Calgary area (according to tree rings) from the 14th Century through to the 20th, we find several extended periods of extreme dryness throughout that time.

Examining past records is also useful for discovering trends or patterns of drought frequency. In all of Sauchyn's research sites, when you inspect the past 800 years of reconstructed precipitation, there seems to be a drought cycle occurring every 16, 32, or 64 years. Projecting this pattern to the future means we may be able to predict when a serious drought will take place and when minor ones might occur. However climate is not that consistent; sometimes the cycle is shorter, even down to 8 years (which is related to El Nino).

Looking to the future, Canadian climate models predict substantial warming across Canada. Since the 1960s temperatures have been getting warmer on average while, at the same time there is substantial variability in the extremes from year to year. The example of mean spring temperature for Grande Prairie (figure to the right) shows the tendency for gradual warming with extreme variability.

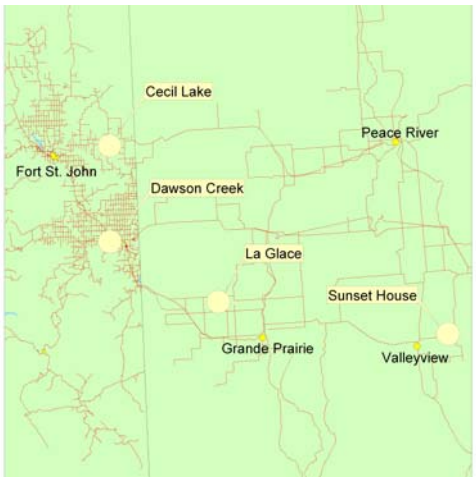
Mean Spring temp Grande Prairie 1922-2005



The take home message from Sauchyn is that even in the absence of global warming we should expect drier years. Climate change will likely worsen an already challenging situation. Models show that today, an extreme dry spell lasting 30 days occurs once every 50 years but, in future with a changing climate, this may be once every 18 years. What is challenging about future climate is not necessarily that it is getting warmer but that we can expect drought more often and of greater severity.

CLIMATE AND WEATHER RISK MANAGEMENT

Four producers from the Peace River district offered their insights on the risks and opportunities they face while managing their farm businesses in light of climate variability and changing conditions. In general they provided a positive picture, describing innovative and practical strategies that they continually modify and improve. Producers' comments reinforce the idea that managing risks associated with climate and weather is a fundamental part of their financial and environmental decision-making.



Karen Goodings (Cecil Lake B.C.)

As a member of local government and a long time producer in the Peace Region, Goodings could put many climate and weather issues into a wider perspective. For her, any discussion about climate and weather ultimately connects to water; something that has historically been in short supply in her area. When she and her family began farming in the region they had to melt snow for winter water use—if they still had to do that, there would have been major problems in recent years given the lack of snowfall.

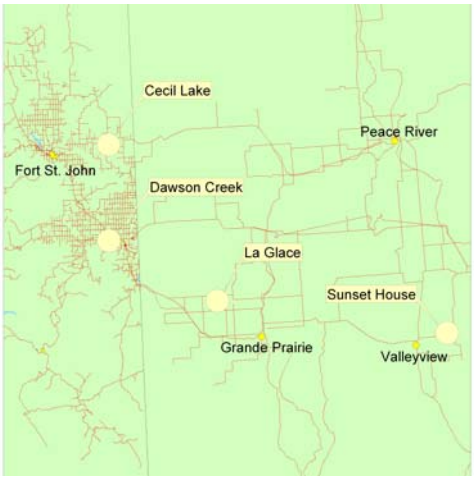
Livestock producers know the importance of sufficient, secure water supplies. To maintain a sustainable water supply, Goodings' first strategy was to have wells but they were not satisfactory and so they turned to dugouts that are filled with run-off from winter snowmelt and rainfalls. Dugouts also serve for human drinking water although water quality can be an issue if livestock also uses the same source. The need to keep cattle out of the dugouts led to installing nose pumps designed to operate on a demand basis. This adaptation resulted in cleaner water and reduced foot rot for cattle.

There are several tactics for keeping soil moisture levels as high as possible (for instance, leaving some growth on the land ends up trapping snow). Producers are aware of the strong connections between good environmental management, economic sustainability of their operations, and adaptations to climate and weather conditions.

Goodings encouraged strong institutional support for the agriculture sector, citing the work of the PFRA in educating and assisting regional producers with land and water resource management as a good example. If left to individual producers, various environmental management efforts may be inconsistent and ineffective but with a degree of government support and promotion much more can be accomplished. Environmental farm plans and community water systems are also good examples of lowering costs to individual producers while maximizing positive outcomes.

> **"I believe that if there is a government organization that has the ability and knowledge to help the ag producers through any climate change challenge, it will be PFRA"**

Peter Eggers (La Glace, AB)



Eggers, with his wife and three children, has farmed nearly 2000 acres in the Peace District for 25 years. Their farm had been primarily grain (with direct seeding and minimum till) but they are now looking more at livestock and broad based management. To Eggers, farming means constantly making changes. Looking at the weather in recent years it seemed the family would have gone broke if things did not improve. Several times, weather events ruined what appeared to be good crops: drought halved crop yields and frost reduced crop quality and quantity to some degree.

Because their farmland has had virtually no subsoil moisture in the past nine years, they decided to look at new farming methods and became involved with "Holistic Management". Eggers had practiced zero till for a long time as it improves soil moisture and helps limit damage from the tractor. But there is a drawback to zero till because of the increased chemical use.

Eggers had to change his thinking and look at where they have control and where they don't. In essence, they can control finances and what they do on the land, but can't do anything about the weather. Consequently they converted to a drought-based system and developed a financial plan to make the farm profitable in case of more severe weather events.

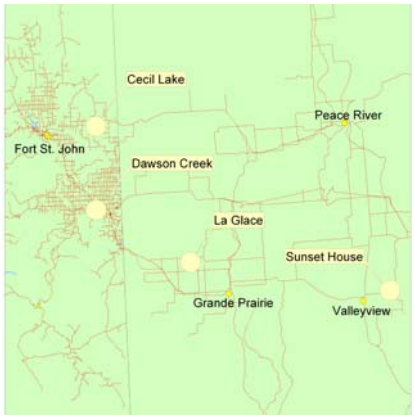
By seeding the majority of acres into grass they reduced the need to purchase inputs (for instance pesticides, fertilizer, and fuel). With grass farming, the energy "consumptive mode" is reduced as livestock (sheep for the Eggers family) keep the nutrients on the land. If Eggers had stayed with crops only, they would have lost one to two hundred thousand dollars by now because the yields would have been so much lower due to recent weather conditions.

Their drought proofing approach is also directed at mineral content of the soil, mainly by adding calcium so water absorption improves. However, it can be difficult to purchase limestone at a reasonable price so they are crushing it on the farm.

Eggers' financial plan incorporates direct marketing of sheep, reducing debt, selling off equipment, and sacrificing depreciation on equipment. Their plan appears to be working so far and combined with additional effective strategies for resource management (such as not winter feeding animals on the hillside sloped toward dugout or other areas of runoff), Eggers is optimistic about the future.

"We seem to have been empowered through the holistic management model to make decisions for ourselves."

Dave Berry (Sunset House, Alberta)



The Berry family now runs a 120 head cattle operation in the Peace District after starting out farming in southern Saskatchewan where conditions are much drier than they typically are in the north. His attitude is that there is no point in fighting with weather; you just have to learn to deal with it instead. And lately there has been much to deal with as crop losses have been significant. There is no doubt that the climate is changing because it always has, so it is best to follow the Darwinian idea that those who adapt best to change are the ones who survive.

Generally, Berry promotes the idea that producers should think for themselves and when new ideas are presented, producers must take responsibility to question applicability for their individual operations. Berry commented that many times, recommended practices are solely for the benefit of those selling the related product. A dose of common sense will help producers make good decisions.

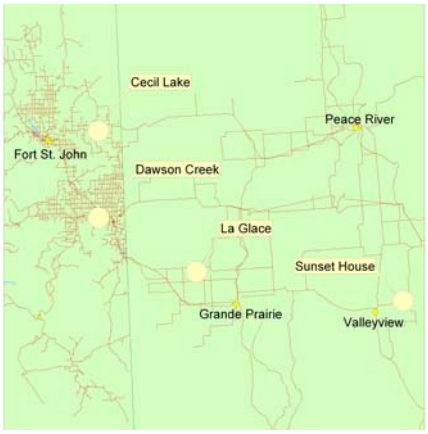
To make money as a cattle producer you have to find out how to run livestock cheaper, for instance, what if we could graze for 9, 10, 12 months of the year? That is, consider adopting extended grazing as a strategy and lessen risks from weather by using a combination of bale and swath grazing and by stockpiling forages. If a producer relies only on baled hay then his whole operation depends on a three-week window for getting in a good hay crop. If the weather is poor, there are major consequences. Better to spread the risk by having several feeding options, each one affected by different weather conditions.

Berry offers a number of suggestions to lower weather risks and help producers adapt to changing environmental conditions. First he recommends keeping cows out of the corral by feeding in the field thereby lowering production costs and improving soil quality (which drought proofs the land). Second, he affirms that producers should USE the weather not fight it. For instance, calving early can lead to many costly problems related to cold weather whereas calving in warmer temperatures makes sense because cows' nutritional requirements are lower and they can put fat back on for the winter. Third, timing the weaning for summer when the cows can be corralled and fed lower quality hay means that calves would benefit from having access to higher nutrition in fields.

In winter if there is no snow, cows can graze but they do not have to be fed every day. When there is snow, make the cows work for you by packing snow, thus saving your time and energy costs. In general Berry recommends not working on "auto-pilot" but thinking through all the angles and not letting paradigms snare your mind.

"Three rules for dealing with the weather: Number 1 have a plan; Number 2 have a back up plan; Number 3 have another back up plan"

Bill Wilson Dawson Creek, B.C.



Wilson moved up from Manitoba to the Peace Region to run a diversified operation centered on livestock production. Included in the divisions are: community herd cow/calf, custom cow/calf operation, custom feedlot, custom grazing plus a little custom haying and farming. He owns no land but rents 1400 acres from 12 landowners and seeds it to barley for silage or oats for swath grazing. As well he rents 225 acres for hay production and 11 to 15 quarters of pasture from 3 different landowners. Climate and weather have many implications in many of the choices and management decisions for the business.

Having a number of different enterprises gives Wilson many opportunities to add value on the farm, to spread risk from climate/weather and other factors, and to benefit from economies of scale. By separating the real estate dimension of agriculture (i.e. owning land) from the farming aspect (i.e. operating agricultural businesses) he is able to focus on farm business and plan more effectively.

Central to his operation is swath grazing, a practice where annual cereals (such as barley) are seeded in mid-May to early June and swathed from late August to mid-September when the crop reaches the soft to late dough stage and before killing frosts. The swaths are left in the field for the cattle to graze during the winter. There are many drought related environmental benefits from the practice as land is manured by livestock, soil biomass is increased and moisture retained. Swath grazing also has much less weather related seeding and harvest risk .

Wilson estimates he nets between 50-100 dollars/acre using this grazing style. One drawback to swath grazing (according to other producers at the workshop) is from the deer and other ungulates attracted to the feed source. Losses can be significant, especially in times of drought when natural food sources are scarce.

Wilson is also involved with True North Beef, a joint livestock marketing venture for small cow/calf producers who aim to market bulk ready calves packaged in uniform semi-load lots. Their progress has been steady even though drought in 2006 meant they were forced to cut back on production.

" I thought everything I was trying to do was economic and then I got thinking well maybe it does have something to do with weather…"

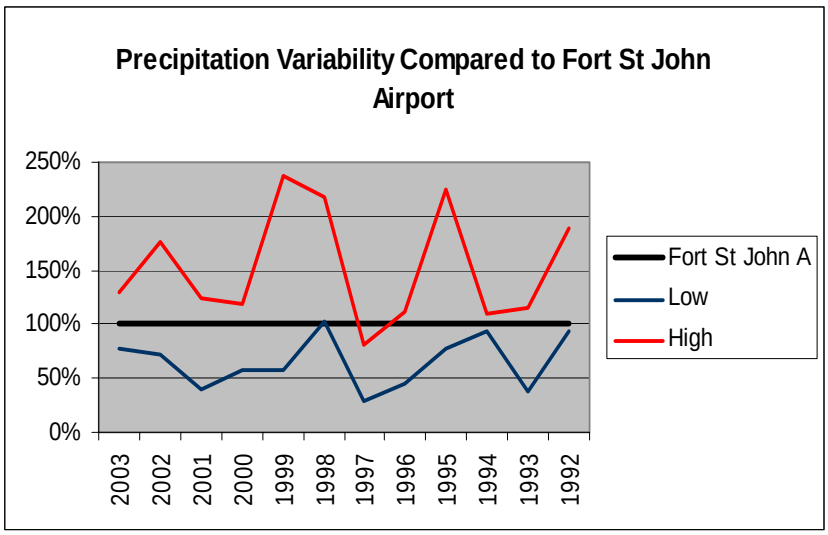
WEATHER FORECASTING

The workshop afternoon sessions began with three speakers addressing different issues related to using weather data and forecasting. Lee Bowd pointed to the benefits of using weather data for modifying farm practices; Doug Lindquist described different developments in weather forecasting; and Edmund Rath gave details about the benefits of having a weather station on the farm site.

Local Variation, Cycles and Trigger points in Weather Data

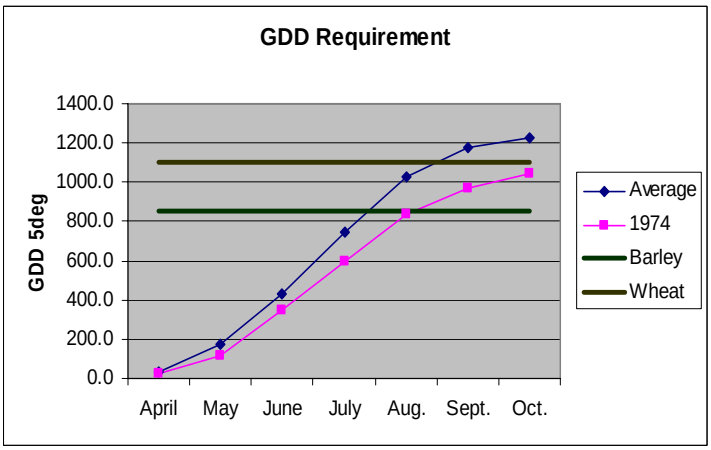
Lee Bowd, (*BC Ministry of Agriculture and Lands, Business Risk Management*)

Since 1992 Bowd has been part of a project instituted under the crop insurance branch where a number of stations in the Peace District in B.C. were established to monitor variability so that Agriculture Canada could test models. Analyzing the resulting 120 years worth of data is yielding some valuable insights. They have found significant variation in conditions recorded in Fort St, John station compared to specific farms nearby. (See Figure to the left.) This variability means producers and others have to be cautious when looking at forecasts or normal periods from any weather station; it is therefore necessary to get a sense of how much difference there is between individual farm data and the weather station. It seems that Dawson Creek data represent the area better than Fort St. John.



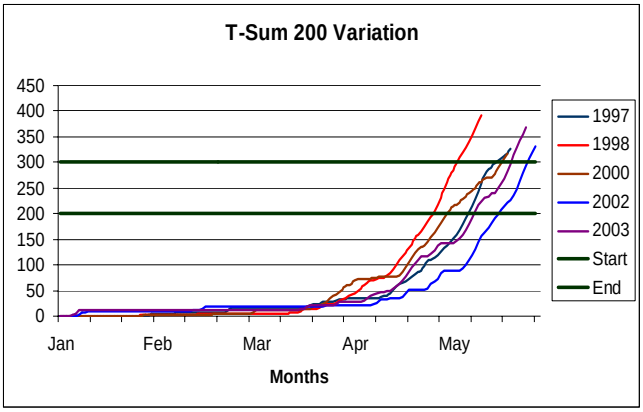
However, without adequate weather data gathering, there will always be challenges. For instance, despite anecdotal information that we had one of the worst droughts in memory in summer 2006, it cannot be shown statistically because Dawson Creek recently lost its rainfall collection capacity. There are many hurdles with weather and climate related issues for agriculture.

Data on Growing Degree Days (GDD) are plentiful and analysis indicates there is no strong relationship between GDD length and performance of individual varieties. (Discussion after Bowd's talk indicated that production variations are linked primarily to plant genetics.) An example of how weather data could be useful for farm decision-making is evident in the case of late maturity risk. Barley and wheat have to have so many heat units to produce good quality yields. In 1974, it is obvious that did not happen for wheat. (See figure at the start of next page)



Tracking data about accumulated heat units is useful for making decisions concerning crop production. By considering the situation depicted in the figure to the left, a producer would know that by the end of August the situation was not good. S/he might be better off taking the crop off then, when good conditions for harvesting are present, rather than hoping there will be enough heat later for the crop to mature. (As noted later in the summary for Edmund Rath's presentation, producers confirm this point).

Bowd then gave some examples of the kinds of services that are proving useful to growers through websites such as Farm West (http://www.farmwest.com/). Among the many features of this resource are historical and current data on evapotranspiration, corn heat units, growing degree days, and a T sum calculator [3]



Although this type of analysis is not yet available for the Peace District, it is hoped that eventually the research needed to develop a version for the area will be undertaken. As the calculations in the figure to the right indicate in any one year it looks like there is a 10-day window for applying fertilizer but it will always be a different 10-day period.

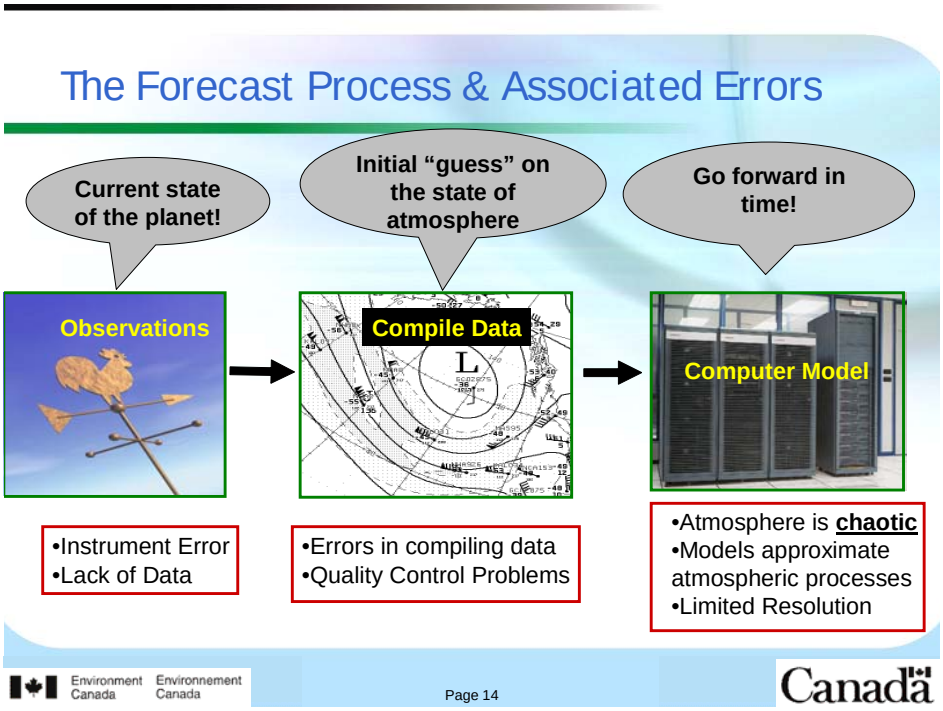
If, during the season, the farmer can track the various factors that are important for a specific crop on a specific farm, it should be helpful for deciding what to do with the crop if conditions seem to be worsening. For instance weather data could help a producer decide to swath graze or take the crop off early because it will not make grade (a farmer would know it will not make grade based on the accumulated trends for the year). Having good weather data gives a sense of comfort to farmers that some of the problems they experienced were not necessarily due to something they did wrong or had control over.

[3] T-Sum' is a method to determine when to make the first application of nitrogen fertilizer in spring. The 'T-Sum' value is the accumulated mean daily temperatures (in ° C) above zero, starting on January 1 (below-zero temperatures are ignored). For example, if the mean daily temperatures for a 5-day period were 6, 3, 0, 1, and -4°C, the 'T-Sum' total is 10. The 'T-Sum' concept assumes that rate of spring growth is related to accumulated mean temperature.

Future Forecasting: What's the Chance?
Doug Lundquist (Environment Canada)

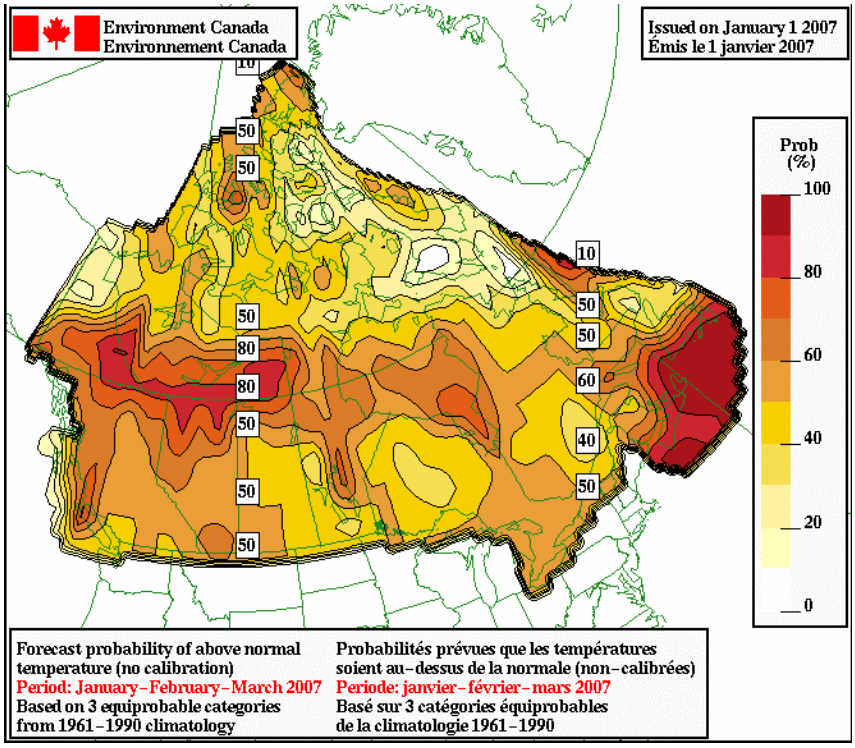
Ted O'Brien introduced Lundquist and took the opportunity to describe a new initiative from Environment Canada, namely the National Service Office for Agriculture. The office's purpose is to act as a bridge between Environment Canada and the agricultural sector (ranchers, farmers, and others) and generally improve climate and weather service delivery. As the office gets established, they want to discover users' needs and identify how to improve Environment Canada's service for agricultural sector. Ted can be reached at (306) 780 6000.

Lundquist began his presentation noting there is a major gap between the information Environment Canada has and what they provide to the public. He provided a comprehensive look at basic definitions and the history of forecasting, including a summary of the forecasting process and its associated errors (described in the figure below).



Given the inherent uncertainty involved in forecasting, newer systems such as Ensemble Prediction Systems (EPS). Twice a day, 16 "perturbed" 16-day weather forecasts are performed as well as an unperturbed 16-day control forecast. Of the 16 perturbed forecasts, 8 are performed with the global spectral model and 8 with the GEM (Generation of Weather Elements for Multiple Applications) model. The 16 models have different physics parameterizations, data assimilation cycles and sets of perturbed observations. Boundary conditions such as sea surface temperature, albedo and roughness length have been perturbed as well. The control forecast is initiated from the ensemble mean and performed with the spectral model. (For more details go to: http://www.weatheroffice.gc.ca/saisons/index_e.html#proba)

After explaining how to make probabilistic weather forecasts, Lundquist provided examples for Canadian winter weather outlooks for 2006-07.



According to this map for instance the winter outlook for the Peace District suggests a 60-70 per cent chance of above average temperatures. Given that Environment Canada recently announced that "the winter of 2006/2007 tied with the winter of 1986/1987 as the second warmest winter Canada has experienced since nationwide records began in 1948 (3.0°C above normal) based on preliminary data," this probabilistic forecast proved true.

Lundquist finished his presentation noting that in many ways, every weather forecast is probabilistic. Ensemble forecasting should be useful as a decision support tool because it indicates the range of temperature and precipitation possibilities so that various alternatives can be considered. Like anything that is in early stages there will be some growing pains as these forecasting systems are developed to their fullest potential. Constructive input will be sought from the public users, which will help that development move in the right direction.

Producer Run Weather Stations

Edmund Rath (Doe Creek Farm Ltd.)

There is no doubt that farming requires good weather data and so the Rath farm (name) decided to purchase a comprehensive weather station (including wind speed and direction, moisture gauge, and temperature) for their farm business in 1997. Accurate and detailed weather records allow the Raths to understand conditions affecting grain yield and quality.

Rath explained that their weather station is used mostly to analyze historical data and provide a context for determining trends and their associated crop conditions and yields. They do not use it for close monitoring of current conditions (which might help with determining times for spraying and other activity). In that context, Rath also noted how useful it would be to have highly accurate short-term forecasts (2-3 day weather forecasts) so that farmers could plan their farm activity more carefully. Last year was especially challenging when rain was forecasted many times but did not arrive.

Having a farm-based weather station allows the Raths to compare conditions on their farm with those for Dawson Creek (where the closest Environment Canada station is located). They have discovered that while temperature varies quite a bit between their farm and Dawson Creek, moisture does not and knowing this helps them interpret Environment Canada forecasting more effectively.

Rath and several producers in the audience noted the recent drop in humidity they experienced this past summer in the Peace. According to records, they had the lowest humidity ever recorded, which, along with a lack of rainfall, created conditions detrimental for plant growth. (Powdery mildew for example thrives in conditions when evapotranspiration is high.) If farmers can know with a high level of certainty that a crop will receive inadequate moisture to mature properly, they could harvest it earlier and thereby get more value from it rather than leaving it to turn brown and wither, while hoping for much needed rain. If these new weather conditions persist in the Peace District, it will be important to have better weather and climate data to assist with future planning.

There appeared to be some consensus among the audience that reducing the number of Environment Canada's weather stations, a lack of support for farm-based weather data gathering and questions regarding the accuracy of recent forecasts have all been challenging for the agricultural sector. There is apprehension that getting accurate and timely weather data will become more difficult as climate change brings more uncertainty and variability in growing conditions.

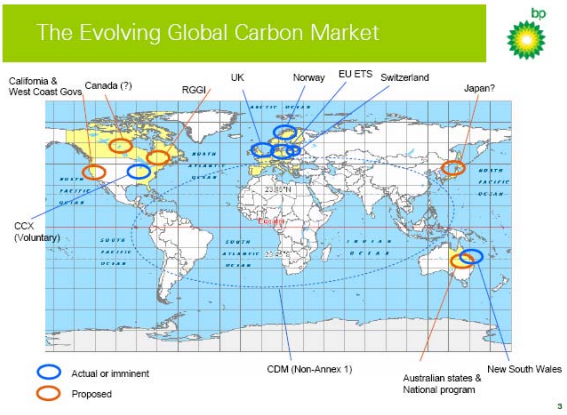
FUTURE OF GREENHOUSE GAS MITIGATION: OPPORTUNITIES FOR THE AGRICULTURAL SECTOR

Reducing greenhouse gas emissions (GHG) that contribute to climate change continues to present challenges across all Canadian regions and sectors. The workshop addressed this challenge in the agricultural sector with a final panel of producers involved in different aspects of this issue. Edgar Hammermeister discussed carbon sequestration. Nick Underwood demonstrated how closely GHG mitigation efforts are linked to strategies for improving soil health. Gary Ropchan presented experiences of establishing a system for producing biodiesel fuel from canola.

Climate Change Implications: Policy, Carbon Markets and the Farm

Edgar Hammermeister (*Soil Conservation Society of Canada*)

Farmers have to deal with many issues including the weather. Policy decisions have implications for all of us and now climate change has become a major policy issue. Based on the latest analysis, it is quite clear that there are serious problems with increased Carbon Dioxide (CO2) in the atmosphere. Signing on to Kyoto was a huge step and we are facing a huge challenge to meet our targets. One of the tools available to do so is trading carbon credits through different trading systems set up around the world (see locations on map to the right). Europe for instance traded 15 billion euros in 2006 alone: "where there is money, the hope is there will be innovation and a big push" to developing cleaner technology.



Farmers, however, are at a disadvantage to participate in emissions trading because agricultural producers are "price takers". That is, we have to take the price we are offered and cannot always pass costs along the way other sectors can. Nevertheless, there is potential for agriculture to take part in a carbon trading system given the capacity for farming practices to store and maintain carbon in the soil. Farmers need to receive $21-$23/ton to make the effort work. The topic of offsets through a carbon market is challenging and leads to numerous questions for producers who might want to get involved. For instance: How is carbon value determined? What are the penalties for losing soil carbon? Are there limitations on how you manage land? Are they (limitations) easy to work around or do they become a thorn in your side? What is carbon management liability? Should carbon be stored in perpetuity or only for the life of the contract?

Rather than considering carbon credits as a commodity to sell, it may be preferable to consider carbon sequestration an environmental service. But, whatever happens with carbon credits and the agricultural sector, several things are important to protect farmers, including:

- Ownership has to be clear; value from carbon credit should go back to farmer
- Carbon credit trading System needs to be simple and science based
- Price discovery mechanism has to be harmonized with world market.

"We (farmers) do things based on global market values...carbon is no different than oats."

GHG mitigation Opportunities in Agriculture

Nick Underwood (Alberta *Reduced Tillage Association*)

Underwood began his presentation by noting that carbon is the foundation of life so it (i.e. carbon) is not all bad news. We need to be concerned about many basics including water. The future for farmers is built on practicing good agronomy and that means paying attention to the soil. In fact, sequestering carbon in the soil makes it more productive by improving nutrient exchange. Carbon is the "bread and butter" for living organisms that generate soil health. Conditions that favour soil life also promote plant growth.

Tillage reduces soil life –this has stepped up interest in reduced tillage systems. Adopting no till and other related practices in fact create many other opportunities. Farmers can save fuel, wear and tear and depreciation on equipment. Reduced tillage will save time and using rotations improves soil life and crops. Retaining crop residue helps to prevent soil erosion.

Based on analysis completed on the organic matter in his own and a neighbour's fields, Underwood demonstrated the value of no-till for increasing microbial biomass and organic matter. The benefits from reduced tillage lead to a number of questions: What is the best way to have no-till become more popular? Should tillage be penalized beyond the already extra costs from using more energy? Should erosion events be penalized? Or, should we reward No-Till?

Underwood continued his presentation by referring to a number of related practices that will eventually lead to improved environmental conditions, including:

- Using biodiesel and producing it at the farm level.
- Establishing wind breaks and bush on farmland, to preserve moisture and biodiversity.
- Adopting better nutrient management through soil testing.

Noting that carbon credits for farmland will not work if they are too cheap, Underwood also pointed out several factors that supported Hammermeister's ideas. For instance, the value of these credits has to be fairly determined and that value should be high or it will encourage polluters (who purchase the credits) to continue polluting instead of modifying their own businesses. Landowners who get involved in the carbon credit market bear a number of risks and responsibilities when they commit to provide credits. These risks could be burdensome and need to be reduced, possibly by offering compensation to the provider.

"A farmer who depends on producing carbon credits is farming for the wrong reason."

CPCS Biodiesel Project Spirit River, Alberta

Garry Ropchan (*Central Peace Conservation Society*)

Ropchan began his presentation with a definition of ***biodiesel***, as canola oil crushed from canola seed that goes through the transesterification process to remove the glycerin. There are several issues to consider:

Sustainability – idea is to make enough biodiesel to cover what producers use on their farms.

Environmental – biodiesel is a more carbon (CO2) neutral fuel source than crude oil, and in terms of other emissions (except nitrous oxides) biodiesel is highly superior to fossil diesel.

Performance – biodiesel is a superior product compared to fossil diesel in terms of lubricity.

Ropchan informed us that currently, the US is producing 700 million gallons compared to Canada's 21 million gallons of biodiesel capacity. Demand is growing in Canada and growers are "missing the boat" as supplies are coming in from outside the country. The Central Peace Conservation Society wants to make sure Canadian growers get involved in this new industry and has supported related research and demonstrations. Ropchan's presentation showed us the details of what has been tried; what was learned and improved upon; and where things currently stand.

To run a biodiesel plant a producer needs an indoor, heated location with adequate power – the press has a 20 hp 3-phase motor, the pre-heater has 2 heater units and the reactor tank 3 heater units, in total, if all of these units are operating at capacity, you will need about 42.5 KVA. The power requirement is going to be a problem for producers who only have 15 or 25 KVA transformers. The operation will also need assorted wiring, hoses (corrosion proof!), augers, bins, bag filtering system and so forth.

After several attempts and refinements Ropchan 's demonstration project produced biodiesel that could be used in vehicles and equipment. The process also generates some by-products that have several uses. For example, cattle and sheep producers can use canola meal as a livestock ration protein supplement. They found that the animals, after some hesitation, ate it and even developed a taste for it! However, the oil content of their meal is still too high for them to consume it directly; the material should be mixed with something else first. Another by product is glycerin for soap, cosmetics, and possibly to mix back in with canola meal or used as a fuel source. Other uses might include pelletizing the meal for use in pellet burning furnaces (problems with high ash content) or maybe mixing the glycerin in with the fuel pellets if it increases the energy content and if they could be sold for more money.

PART 3 CONCLUSIONS: FUTURE DIRECTIONS

The workshop concluded with a brief summary from Carrie Spencer, C-CIARN Director. Pointing to the value such a discussion has for those developing policy, Spencer thanked all presenters for their contributions. The main goal of the workshop was to foster a better understanding among all participants about how Peace River agricultural producers manage weather and climate risks. Such insights are important for developing strategies and programs that will help to build capacity to deal with future climate and weather conditions. All producers who took part either with formal presentations or with comments and questions during the discussion indicated weather and climate factors are extremely important to their operations. They have developed multiple, innovative ways of responding to impacts from climate and weather but remain concerned that future projections for increased moisture stress in the growing season.

Weather forecasting is also of great interest to the farming community; many producers keep their own records and maintain a close watch on conditions. The government's role in providing accurate weather information and forecasts was raised a number of times throughout the workshop. Producers appreciated hearing from the government representatives (federal and provincial) who are trying to improve forecasting techniques and outcomes. Likewise, those representing government initiatives such as Environment Canada's National Service Organization for agriculture received many points to consider as they work on developing their programs.

The close link between climate and water resources was another theme that ran through the workshop. Generally speaking, environmental concerns rank very high for producers whose livelihoods depend on maintaining and improving land and water resources. The Peace District has historically enjoyed ample water and good weather conditions which have contributed in part to the success of their agriculture sector. As concerns grow over water, however, it is clear there is much that is not known, leading a general consensus that more analysis and research for water resources in the area are needed.

Producers have a vested interest in the issues related to reducing greenhouse gas emissions. The current air of uncertainty over climate change policy has not prevented many farmers and their organizations from seeking out the implications for their businesses. Biofuels and carbon credit trading are two examples that may hold several opportunities for agriculture in the Peace District. Presentations and discussion in the workshop provided a good overview and interesting details about many implications related to reducing greenhouse gas emissions.

Three main points summarize the workshop:

- Weather and climate are very important for agriculture; producers continue to integrate associated risks and opportunities into their business decision-making and have been very successful with adaptation.
- Farmers and ranchers are interested in learning about new and effective systems, technology, and management strategies, especially if they increase the level of control and certainty for their own enterprises.
- Events like this workshop where farmers and ranchers can meet with representatives from policy and research are beneficial for all involved, not only for the chance to learn first hand from practitioners, but also for the development of future partnerships to pursue interests in common.

Appendix A MANAGING CLIMATE and WEATHER RISKS FOR PEACE RIVER DISTRICT AGRICULTURE

Location: Grande Prairie Inn, 11633 Clairmont Road - Grande Prairie, Alberta
February 6-7, 2007

February 6 (18:30 – 21:00): Agricultural trade show displays. Refreshments and cash bar.
Climate and Weather in the Peace District: Past Present and Future: Bill Taylor, Environment Canada

February 7 (10:00– 17:00)

10:00 – 10:45	**Trade Show Displays and Workshop Registration** (refreshments)
10:45 to 11:00	*Workshop Introduction:* Brian Haddow, PFRA, Dawson Creek
11:00 to 11:30	*Agriculture in the Peace River District – Past, Present and Future:* Amber Havens, Peace Country Beef and Forage Association
11:30 to 12:00	*Surface Water and Groundwater Challenges in the Peace River District*: Tony Cheong and David Tamblyn, BC Environment, Water Stewardship Division
12:00 to 13:00	**Panel Discussion –** *Sustainable Livestock Management Under Weather Variability and Climate Change: Risks and Opportunities* Moderator – Brian Haddow Participants: Karen Goodings; Dave Berry; Peter Eggers; Bill Wilson
13:00 to 14:00	**LUNCH –** Dave Sauchyn, PARC: *Prairie Droughts: Precedents and Prospects*
14:00 to 14:20	*Local Variation, Cycles and Trigger Points in Weather Data*: Lee Bowd, BC Ministry of Agriculture and Lands, Product Insurance Unit, Business Risk Management
14:20 to 14:40	*Future Forecasting: What's the Chance?*: Doug Lundquist, Environment Canada
14:40 to 14:50	Edmund Rath, Producer with a Weather Station
14:50 to 15:15	**Panel Discussion** *Weather and Climate Forecasting* Moderator: Irene Hanuta, PFRA Participants: Lee Bowd; Doug Lundquist; Edmund Rath
15:15 to 15:30	**Break**
15:30 to 16:30	**Panel Discussion -** *The Future of Greenhouse Gas Mitigation: Opportunities in the Agriculture Sector* Moderator: Alex Milton, PFRA Paticipants: Edgar Hammermeister; Garry Ropchan; Nick Underwood
16:30 to 17:00	**Wrap-up Panel:** *What we Heard – Producers, policy and research panel* Moderator: Carrie Spencer, C-CIARN
17:00 PM	*Closing comments* – Brian Haddow

Appendix B: List of Registered Attendees

Name	Affiliation
Harry Archibald	Alberta Environment
Denis Belisle	AAFC/PFRA
Dave Berry	Farmer, Sunset House Alberta
Vimmy Berry	Farmer , Sunset House, Alberta
Lee Bowd	BC Ministry of Agriculture and Land
Tony Cheong	Ministry of Environment (BC)
Aston Chipanshi	AAFC/PFRA
Murray Clark	DUCKS Unlimited
Peter Eggers	Farmer, La Glace, Alberta
Jim Forbes	BC Ministry of Agriculture and Land
Curtis Galbraith	Big Country 93.1 FM Reporter
Pat Gerlinksy	AFFC/PFRA
Karen Goodings	Farmer, Cecil Lake, B. C.
Monica Hadarits	U of Guelph/C-CIARN-Agriclture
Brian Haddow	AAFC/PFRA
Trevor Hadwen	AAFC/PFRA
Phil Haight	Farmer, Peace District
Edgar Hammermeister	Farmer, Saskatchewan Soil Conservation Association
Irene Hanuta	AAFC/PFRA
Wally Happychuk	Farm Credit Canada/Grande Prairie
Amber Havens	Peace Country Beef and Forage Association
Brett Heinshel	Farmer, Peace District
Faye Hirshfield	Ministry of Environment (BC)
Ben Kangasniemi	Ministry of Environment (BC)
Darryl Kroeker	DUCKS Unlimited
Clair Langlois	BC Grain Producers Association
Doug Lundquist	Environment Canada
Alex Milton	AAFC/PFRA
Garth Mottershead	AAFC/PFRA
Bill Oakford	Farmer, Peace District
Ted O'Brien	Environment Canada, National Service Organization Ag.
Nick Parsons	Farmer and Crop Insurance Advisor
Shawn Pearson	BrettYoung
Edmund Rath	Doe Creek Farm Ltd., Peace District, B.C.
Terry Rolfe	Researcher, University of Saskatchewan
Dave Sauchyn	U of Regina/PARC
Carrie Spencer	Natural Resources Canada
Dave Tamblyn	B.C. Ministry of Environment
Bill Taylor	Environment Canada
Nick Underwood	Farmer (Reduced Tillage), Grande Prairie, Alberta
Chelton Van Geloven	Ministry of Environment (BC)
Ellen Wall	U of Guelph/C-CIARN
Bill Wilson	Farmer, True North Beef, Dawson Creek, B.C.
Alexis Young	*Daily Herald-Tribune*
Aining Zhang	Natural Resources Canada
John Zylstra	Alberta Agriculture and Food

Brief biographies for the Presenters and Panelists (in program order)

Bill Taylor is a climatologist with Environment Canada. He holds undergraduate degrees in Physics and Meteorology and enjoys delving into the climate archive looking for trends and variations in the climate and interpreting those signals within the context of global climate change. Bill was involved in a major study of climate change impacts on the Okanagan basin water supply and its potential effect on the region's agricultural sector. He was also involved in development of the Temperature Rising poster, which details potential climate change impacts on southwestern British Columbia.

Amber Havens is originally from North of Cochrane where she was raised on a mixed ranch. She graduated from Olds College, receiving an Agriculture and Agri-business diploma. Now Amber works in Fairview for the Peace Country Beef and Forage Association. She enjoys the challenges of working with the agricultural community and promoting Peace District agriculture.

David Tamblyn was originally from Ontario where he earned a civil engineering degree and specialized in ground water modeling. He came to the BC Environment, Water Stewardship Division in 2006 to start the groundwater program for the northern region of the province.

Tony Cheong is the Manager of Forecasting and Information within the Water Stewardship Division of the BC Ministry of Environment. He has a Bachelor of Science degree in physical geography from the University of Victoria and a Masters of Science from the University of BC. Tony has previously held positions in the Ministry of Forests and Range, Department of Fisheries and Oceans and the Ministry of Environment focusing on Fish-Forestry Interactions, watershed characterization and aquatic resource information management.

Karen Goodings has been on her ranch since 1970 having been born and raised in Cecil Lake. Karen plays a very active role in local government and served as Chair of the Regional district for more than 10 years. Their farm operation began as mixed but in 1982/3 they moved into total cattle production.

Dave Berry is a rancher who moved with his wife Vimmy to Sunset House outside Valleyview in 2000. He and his family own 5 quarters and rent 8 for their operation with 120 head of cattle. They are able to survive but the timing for the move has not been that great, given the recent stresses for agricultural operations.

Peter Eggers has been in the Peace District for the past 25 years farming at Debolt until 1989 and then at La Glace where he and his family currently live. In 1996, they decided to pursue "Holistic Management" as an alternative set of practices for their farm enterprise. They feel the change has been very successful and continue to modify and improve their operation each year.

Bill Wilson was born and raised on a farm in south East Saskatchewan, then moved to Manitoba where he was a manager with a large (1300 head) cow calf enterprise (Manitoba/Interlake). After working with PFRA for a spell, Bill went back to livestock production and currently manages a number of enterprises featuring renting land and contracting with several customers. Bill is also involved with a new marketing group, True North Beef.

Dave Sauchyn is a Professor of Geography at the University of Regina, where he has been a faculty member since 1983. Since July, 2000, he has been Research Coordinator for the Prairie Adaptation Research Collaborative (PARC) and since July, 2001, he has been the PARC-Manitoba Hydro Research Professor at the U of R. Dave's main research interest is in the climate of the past millennium in Canada's western interior and what past climate can tell us about the climate to expect in the near future. Among other projects, he is involved in two National Centres of Excellence, the Sustainable Forest Management Network and the Canadian Water Network.

Lee Bowd is a Product Representative for the Production Insurance Unit, Business Risk Management, BC Ministry of Agriculture and Lands in Dawson Creek, BC. His main interest is in helping agricultural producers utilize weather data to aid in timing farm operations.

Doug Lundquist graduated from the University of Alberta in 1987 with a B.Sc. specializing in Meteorology. From 1987 until 2004 Doug worked as an operational meteorologist for Environment Canada across Canada, but primarily in the West. In 2004, Doug became a Sector Development Meteorologist with a goal to work on improved delivery, understanding and use of weather forecasts and observations.

Edmund Rath has been farming in partnership with his brother since 1986. They have a grain operation (wheat, canola, oats, and fescue grass) on 6900 acres of Peace Country. Ed serves on a number of Agricultural committees and organizations in the area.

Edgar Hammermeister is a farmer, Professional Agrologist, and Crop Advisor. He is a Director with the Saskatchewan Soil Conservation Association since 2002 and now serves as its President. On the National Board, Soil Conservation Council of Canada, Edgar currently serves as its Second Vice-President. Born and raised in SE Saskatchewan, he is a graduate of the U of Sask. College of Agriculture. After working for four years in environmental agriculture research for a private, contract research farm, he returned home to the family farm. Edgar shares labour and equipment with his Dad, Harold, and youngest Brother, Jason, on a mixed farm of ~2.200 seeded acres plus pasture and hayland for 50 cows.

Garry Ropchan joined the Central Peace Conservation Society team in April 1994 and is working to help area producers adopt soil conservation practices. He was raised on a grain farm near the Grimshaw area. He graduated from Fairview College in 1986 and started grain farming that same year. Having a strong belief in that you must practice what you preach, Garry converted to zero till on his own farm back in 1992. Garry continues to focus his efforts on soil conservation, nutrient management, grass crop removal and pest control issues.

Nick Underwood came to the Peace country 36 years ago and has a Zero-Till grain farm outside of Beaverlodge, Alberta. Nick is an agronomist who has worked for the Canola Council of Canada. Currently he works with Alberta Reduced Tillage Linkages as a reduced tillage extension agronomist for the Peace Region.