Climate Adaptation Strategies

Date:
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Factsheet #1

When Needed Irrigation = Supplemental

Peace Agricultural Adaptation Strategies Working Group Members

The working group consists of representatives from Peace Agriculture Organizations, provincial and local government:

- ⇒ BC Agriculture & Food Climate Action Initiative
- ⇒ BC Branch Canadian Seed Growers Association
- ⇒ BC Grain Producers Association
- ⇒ BC Ministry of Agriculture
- ⇒ Peace Region Forage Seed Association
- ⇒ Peace River Forage Association of BC
- ⇒ Peace River Regional Cattlemen's Association
- ⇒ Peace River Regional District

Introduction:

A number of actions are identified in the *Peace Adaptation Strategies* to support agriculture to adapt to increasingly dry and drought conditions in summer, including the need to assess the potential for irrigation in the BC Peace Region. An irrigation feasibility study was completed in the autumn of 2015. The study - entitled, *Evaluation of Irrigation Potential in the BC Peace* - concluded that a small number of irrigation opportunities currently exist, and additional opportunities may exist in the future.

Supplemental Irrigation:

In the Peace Region, irrigation for field crops is likely to be planned on an as needed basis, since historically, most of the moisture necessary for growing a crop is provided through snow melt and summer rainfall. Based on long-term averages, there is a moisture deficit for Peace Region soils of approximately 40 mm to 140 mm (2 – 6 inches) varying by crop and by soil type. Although the major rainy season is in June/July, rainfall can be variable and it can come at inopportune times (and with climate change variability is expected to increase).

Supplemental irrigation is put in place anticipating that in some years irrigation will not be necessary, while in other years it will provide substantial benefits. An average moisture deficit of 87mm could be the result of a range of deficits from 29mm to 174mm.

Gun irrigation, photo courtesy of Nelson Irrigation.

Supplemental irrigation provides moisture at essential times, such as during crop germination (for even germination), tillering, seed set, or bolting stages. If a spring rain does not come until June 10 or later, crop germination could be seriously delayed in higher and drier parts of the field. A crop that germinates evenly will be better able to use the rainfall that comes later, compared to an uneven crop. About 120mm of rain or soil moisture is needed just to get the crop through the vegetative stage. Ungerminated seeds will not be able to use the later rain, except possibly to germinate late and lead to an uneven crop, which will be downgraded in quality, or may suffer from fall frosts.

Forage crops that are seeded in summer or early fall can also be affected by inadequate moisture, leading to thin stands, or non-winter ready crops which are very susceptible to winter-kill. Poor stands also lead to loss of fertilizer which is not absorbed by crops and can be lost to leaching or volatilization.

For more information:

Any questions or concerns in regards to the Irrigation report contact: the BC Grain Producers
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Published in Cooperation with
Peace Agricultural Adaptation Strategies Working Group

This and more fact sheets can be found at
www.bcgrain.com; www.peaceforageseed.ca; peaceforage.bc.ca

Precipitation 1981-2010 (Figure 1)

Place	Precip Annual (mm)	As Rain (mm)	May to Aug precip (mm)
Fort St John	445	292	220
Dawson Creek	453	307	240
Baldonnel	-	322 (1971-2000)	-
Taylor Flats	-	320 (1971-2000)	-

Wheel move , photo credit of flickr user Brad Smith

Timing of moisture

Variability of rainfall means that moisture may not always be there when it is needed. Even when a sufficient amount of precipitation has fallen, a certain amount will run-off into surface water bodies, especially after heavy rainfall events, and if the soil is already saturated. In some cases only half of the moisture that falls during a heavy rainfall event may be retained in the soil, especially in the higher parts of a field. In addition, a proportion of moisture, especially from fall rains and snow melt, may deposit in the soil at a depth beyond the rooting depth of the crop, making it unavailable to the germinating or growing crop. The extent of this problem will vary with the soil type, with sandy soils losing more moisture to depth, and clay soils having more surface runoff.

Climate Change:

Average annual rainfall and rainfall between May - August has decreased by about 5% in the last twenty years (Comparing 1981-2010 normal with 1961-1990). Over the same time period, Growing Degree Days for Dawson Creek and Fort St. John have increased by about 4%. These changes mean that the gap between moisture and sunlight is increasing and while increased sunlight and temperatures can enhance crop growth and yields, decreased moisture can have the opposite effect.

Although the changes to date are not very large, if they translate to a ten percent change in yield, then this is worth noting. Irrigation can have an impact on reducing the solar-moisture imbalance which exists regardless of change and this imbalance is likely to increase in the future.

In the Peace Region, the La Crete – Fort Vermilion area in Alberta has shown some dramatic changes for Growing Degree Days in the last ten years. Changes in moisture and Growing Degree Days have been smaller in the rest of the Peace Region. The variability in the region is worth noting as it will affect the moisture deficits at different locations as noted in *Figure 1*. However, the differences between most locations are not large, and the moisture deficits can be adjusted accordingly.

Moisture at La Crete (Figure 2)	
Growing season precip Long term normal	264 mm
Growing Season precip 2005-2015	156 mm

Moisture Deficits at La Crete 2008-2014 (Fig 3) (from Alberta Agriculture Irrigation Section)	
Wheat	avg 142 mm
Barley	avg 87 mm
Canola	avg 170 mm
Alfalfa	avg 213 mm

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Crop Moisture Deficits:

From 2005-2015 the La Crete area is shown to have significantly less precipitation during it's growing season when compared to the long term (30 year) average (*Figure 2*).

Figure 3 illustrates the average moisture deficits with different crops at La Crete, as well as the variability of average moisture deficits for different crops over a seven year period from 2008-2014, and include the stored winter moisture. These moisture deficits are higher than those that would be calculated for Dawson Creek and Fort St. John; they would be adjusted downwards by approximately 60-80 mm for Dawson Creek. They illustrate average deficits due to the variability from one year to the next.

The highest moisture deficit for alfalfa was 381mm, and adjusted downward for Dawson Creek to a possible moisture deficit of approximately 250mm, or 10 inches of moisture, in an extremely dry year. This is because alfalfa is a high water use crop when grown for forage such as hay or silage. The deficit will depend on soil type, rooting depth and age of the alfalfa stand, as well as the amount of spring run-off from particular fields, and the length and heat units of the growing season.

It is worth noting that even when the average moisture deficit is zero, there will still be moisture deficits about half of the time and there will be a moisture surplus or sufficiency the other half of the time.

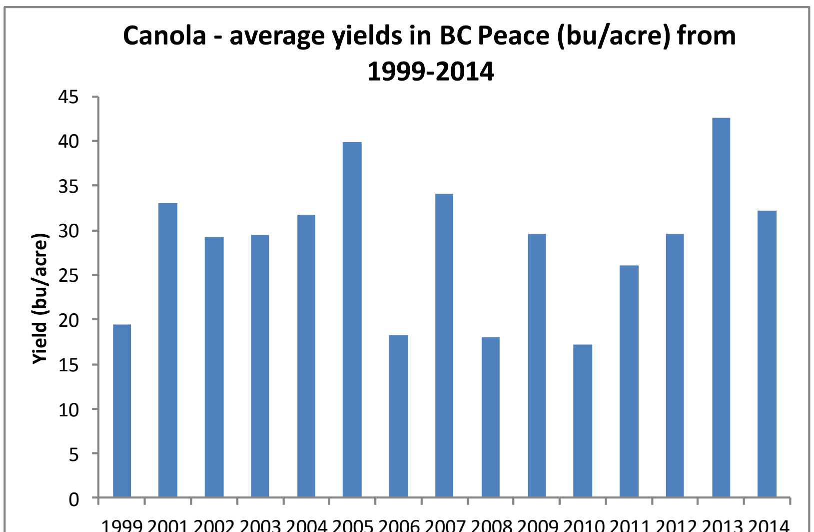

Fig 4: Source BC Ministry of Agriculture 2016


Centre Pivot, photo courtesy of Dave Reede

"Alberta research has shown that under good environmental conditions, for each 25 mm (1 inch) of water used, wheat produces 5 to 7 bushels/acre, barley produces 7 to 9 bushels/acre and canola produces 3.5 to 4 bushels/acre." (Alberta Agdex 100/561-1 - Crop Water Use and Requirements) It is important to note that once a crop has reached full potential, additional water will not increase the yield.

The recently completed study - *Evaluation of Irrigation Potential in the BC Peace* (2016) - assumes an irrigation demand of 75 mm for wheat, 200 mm for Canola, and 300mm for forage.

A moisture deficit of 100mm in Canola could result in a yield loss of about 16 bushels/acre, which could translate to $174 of gross revenue per acre. A deficit of 100mm for wheat could result in a yield loss of 24 bushels/acre, valued at approximately $165/tonne (CPSR) or $245/tonne (CWRS), or from $108 to $160/acre. In an extremely dry year, irrigation could remove a 200mm deficit and provide a benefit for canola of $350/acre.

On the other hand, the costs of irrigation must be considered, and costs are dealt with in more detail in Fact Sheet #3 (*Economics of Supplemental Irrigation*). It is important to note that average numbers will rarely apply to a particular parcel of land, and that every parcel of land, type of crop, and type of irrigation system will differ in its impact on the costs and benefits of supplemental irrigation.

The amount of supplemental irrigation required can vary depending on a number of factors, including crop type, seeding dates, crop varieties, soil type, slope direction, tillage practices (direct seeding), timing of rainfall, and irrigation efficiency. *Figure 4* illustrates how variable B.C. Peace canola yields have been over the last 14 years. This data helps to illustrate that the years in which irrigation could see a return on the farm would also be variable.

The benefits and costs of irrigation can vary depending on crop type, price of the crop, extra fertility required, distance to source of the water, cost of irrigation system, efficiency of water application, pumping elevation required, type of energy used for pumping and cost of energy.

Supplemental irrigation is most useful when it can be applied to an entire field within a relatively short period of time. This is because it is used to provide moisture at essential times to prevent the crop from reaching the wilting point, when it will suffer irreparable damage. It can also provide moisture for uniform crop germination, but the greatest benefit will be if all of the field receives moisture within two or three days, so that the crop is uniform.

With supplemental irrigation, fertilizer rates can be optimized and the risk of fertilizing for high yields and having unused wasted fertilizer sitting in the field can be reduced, resulting in economic as well as environmental benefits. Environmental benefits include the reduction of leaching and runoff of nitrogen, as well as reduction in the volatilization of nitrogen in the form of ammonia and nitrous oxides.

In order to estimate the value of supplemental irrigation on a particular field, the best yield achieved under dryland conditions on that field in the last twenty years can be used as a guide for potential yield benefits of irrigation. A starting point for evaluation for a parcel of land may be to compare average field yields to the best ever crop on that field. It may be possible to exceed that "best crop ever" through irrigation, since in a dry year it is often the case that there will be more Growing Degree Days or heat units available for crop growth.

However, a risk associated with maximizing irrigation based on soil field capacity in the Peace Region is a possibility of excessive soil moisture saturation. If the soil moisture is at field capacity just before a major rainfall event, then some damage to a growing crop may result if there is prolonged field flooding or water-logging due to heavy rains. It is important to pay attention to weather forecasts, and evaluate the relative risks of too much soil moisture in some years and at some times of the year.

Resources:

BC Ministry of Agriculture, Food and Fisheries. 2005 *BC Irrigation Management Guide*. [online] Available at: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/water/irrigation/irrigation-management-guide/577300-0_irrigmgmtguide_chapter_00_how_to_use_with_titlepage.pdf

BC Ministry of Agriculture. 2014. *BC Sprinkler Irrigation Manual*. [online] Available at: http://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/water/irrigation/sprinkler-irrigation-manual

Alberta Ministry of Agriculture & Forestry. 2017. *Crop Water Use and Requirements.* [online] Available at: https://open.alberta.ca/dataset/9a017865-5692-464d-92ac-93b5d50558db/resource/c0d20e0c-9f14-4f6d-8144-b8a6bc3452ba/download/5485851-2011-Agri-Facts-Crop-Water-Use-Requirements-Revised-100-561-1-2011-11.pdf

Alberta Ministry of Agriculture & Forestry. 2017. *Irrigation Management in Alberta*. [online] Available at: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex13628

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