Climate Adaptation Strategies

Date:
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Factsheet #2

Irrigation Site Specifics

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

For more information:

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Introduction:

In the Peace Region, opportunities for supplemental irrigation of field crops and the associated capital costs are closely linked to local conditions. After evaluating the potential crop water use deficits, yield benefits, capital costs and operating costs, a site specific feasibility study needs to be done in order to determine site suitability.


Courtesy of www.senninger.com

Before setting up an irrigation system it is recommended that a soil and landscape analysis be performed by a professional agrologist, or otherwise qualified individual, which includes all of the following factors.

- local climate (see fact sheet #1)
- soil type
- topography (land slope and aspect)
- location of water source (distance)
- elevation of water source (lift)
- water availability and quality

Soil Type:

While a wide variety of soils can handle irrigation, some soils will be limited in responding to irrigation and other soils will require more volume or frequency of water application to produce a crop due to holding capacity differences. Examples of soils with limiting conditions are described below:

- **Soils with low productive capacity** due to acidity, excessive salinity or high sodium content will not be able to respond fully to increased moisture from irrigation as crop type will be limited as well as crop yield response.
- **Soils with high sand content** will not retain moisture very well and will therefore require more moisture or more frequent moisture; there is also a higher risk of nutrient leaching which causes both environmental and production problems (note: sandy loams are good candidates for irrigation)
- **Soils with high clay content** will have a lower infiltration rate which limits the amount of water that can be added at a time; therefore, irrigation pipes must be moved frequently and/or a lower pumping rate must be used to avoid flooding, ponding and runoff of surface water.
- **Shallow soils** that have bedrock too near the surface have the potential for water logging below the surface and, as well, the shallow topsoil becomes a limiting factor for maximum crop growth potential.

While these limiting conditions do exist in some locations the Peace River area and should therefore be considered, they do not apply to the majority of

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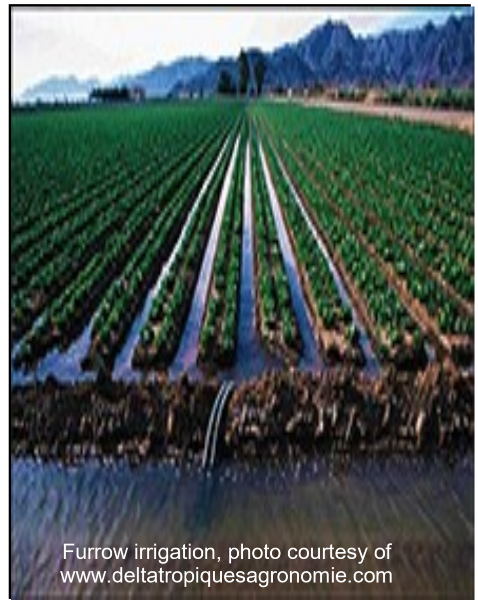
Figure1. Plant-available water and infiltration rate based on soil texture

Soil Texture	Plant Available Moisture in 1-M Root Zone (mm)	(in)	Basic Infiltration Rate When Soil is Saturated (mm/h)
Loamy Sand	112	4.4	26-60
Sandy Loam	140	5.5	25.6
Loam	180	7	6.8
Sandy Clay Loam	152	6	4.3
Silt Loam	200	8	13.2
Clay Loam	200	8	2.3
Silty Clay Loam	220	8.7	1.5
Sandy Clay	172	6.8	1.2
Silty Clay	212	8.3	1
Clay	192	7.6	0.6


Furrow irrigation, photo courtesy of www.deltatropiquesagronomie.com

Soil Type cont'd

agricultural soils in the region. In contrast to these soil limitations, any soil that has produced bumper crops under non-irrigated dryland conditions in the past may be a good candidate for supplemental irrigation. In some cases, different soil quality will simply require an adjustment of irrigation rates and methods (see Figure 1). Fewer limitations exist for sprinkler irrigation than for furrow or flood irrigation.

Soil variability within a particular field also becomes an issue with irrigation management. If a portion of a field is dramatically different than the rest with regards to soil texture (e.g. sandy loam and clay loam) then the moisture requirements will be different. Under dryland conditions this texture difference can usually be seen in the response of a crop to a drought. This means that the irrigation settings for the field may not be optimum for both soil textures, but perhaps only for the soil with the least limitations. While some irrigation systems can be adjusted for different water requirements in different parts of the field, these systems will likely be more expensive than a more basic system.

Topography

In addition to soil type, the landscape itself has an impact on irrigation rates, methods and benefits. Most landscapes in the Peace Region are not suitable for flood irrigation or for furrow irrigation, except for small horticulture fields, such as for potatoes or vegetables.

However, most fields could be suitable for wheel-move or center pivot systems, provided slopes are not too steep. Slopes up to 2% are quite suitable for wheel-moves and center-pivot systems. As slopes increase beyond that, a larger pump may be required in order to maintain pressure at the higher points in the field. A difference in pressure between the higher and lower parts of the field might be compensated for with special nozzles that adjust rates as needed, but this will add to the cost of the system.

If topography is too variable, there may be a problem for movement of systems, such as the wheels of a center pivot, through low spots in the field which will remain too wet.

North facing slopes will likely require slightly less water than south facing slopes, since the sun warms up and evaporates moisture more quickly from south facing slopes. Areas shaded by trees may also have differing levels of moisture use and losses.

Topography also affects pumping energy requirements. A 2% slope will add 50 feet, or 15 meters of elevation from one side of the field to the other. If the irrigation water enters at the low end of the field, this 15 meters of elevation must become part of the calculations for determining pump size requirements as well as line size requirements for the system.

Water Source:

Water source is essential to the success of any irrigation project. In the Peace Region, the Peace River carries more water than all other Alberta rivers combined. However, most of the land in the Peace Region is 300 meters above the level of the river, and this makes the cost of pumping river water for irrigation to the highlands very costly, and usually prohibitive. When looking at the water source for supplemental irrigation, there are a number of inter-related factors that must be considered including:

- water source relative location and elevation;
- pumping costs and logistics (pipe/pump sizes);
- water licences and public land access;
- water quality; and
- water quantity requirements.

Pumping cost considerations:

- Horizontal and vertical distances from source to irrigation site
- Size of pipe and pump used as well as pump and water line efficiencies
- Type of power used (diesel, natural gas, electric)
- Pricing contracts for power

Pumping cost example and reference point
(costs will vary with power type, pump and pipe size, energy pricing contracts)
$5/acre inch or $44/acre foot for 100 ft of lift
$25/acre foot for 16km horizontal movement

Licensing and access considerations

Water licenses are required as per the *Water Sustainability Act* and can be obtained through the relevant Ministry (FLNRO & Rural Development), in order to ensure that sufficient water is retained for environmental and wildlife purposes. In addition, prior users of the water source need to be considered. Construction of access and pipelines across public lands will require permission from the relevant government departments.

Pivot Irrigation system, courtesy of www.zimmatic.com

Quantity Example (100 mm moisture deficit)

- 100 mm of water added to 132 acres (the size of an unmodified center pivot on a 1/4 section)
- 132 acres = 53000 m^2
- 53000 m^2 x 1/10 m water = 5300 m^3 or 5.3 million liters = 5300 tonnes of water
- 5300 m3 stored on 10 acres would require a depth of 132/10 x 100 mm = 1320 mm; so almost <u>1.5 m of water on 10 acres</u> would be completely drained under such a situation, not including losses to evaporation and seepage
- note: the quantity needed at one time determines the sizes of pipes and pumps needed to provide a certain flow volume; typical flow rate requirements are 4-7 gallons per minute per acre

Water Quality and Irrigation

In most cases, surface water will be suitable (the Peace River is particularly good quality water with very low levels of salts).

Some surface water bodies may be acidic, or may contain higher levels of salts, depending on where water originates (particularly true if water originates from a spring).

Groundwater generally contains higher levels of salts, and may have slower rates of replacement, factors which may affect long term soil quality and limit withdrawal quantity (i.e. make it less suitable for sustained irrigation).

Water considered safe for irrigation has an electro-conductivity level of less than or equal to 1.0 dS/m and a sodium adsorption ratio (SAR) of less than or equal to 5 (initial soil quality should be considered).

Alberta Agriculture *Salinity and Sodicity Guidelines for Irrigation Water*

For supplemental irrigation, the quantities of water needed are much less than in parts of the country or the world where 95% of the crop water demands are met by irrigation, such as in southern California, southern Alberta, or in parts of the Okanagan. Nevertheless the potential water sources in the Peace Region should be analyzed for salt and mineral content, and in particular for sodium content. Salts and sodium can accumulate in the soil and eventually cause harmful effects on crop production levels. This is especially true if the soil is already at a marginal level for salinity or sodicity.

Forage Water Use:

In very dry conditions, and for high water use crops such as alfalfa, considerably more water could be used to irrigate 132 acres of land (than is outlined in the previous Quantity Example on page 3). Forage and grass crops can use more water because they begin to grow earlier, as much as four weeks before annual crops emerge from the ground. They can also utilize water in the fall after annual crops are mature and have stopped using moisture for growth.

Since alfalfa has a very deep rooting system, it can access water from deeper in the soil profile later in the summer. However, if the soil profile at depth is also dry, it could benefit greatly from additional water, which would increase forage volume as well as perhaps allow for an additional cut of hay. Since alfalfa produces its own nitrogen, when well inoculated, it has great potential. However, if alfalfa is grown continually under high production conditions under irrigation, and then removed from the field as hay or silage it will require more additions of other nutrients such as phosphorus, and possibly sulfur and potassium in order to sustain production.

Forages in the BC Peace region could use as much as 350 mm of water added.
Kerr Wood Leidal report *Evaluation of Irrigation Potential in the BC Peace Region*

Resources:

Alberta Ministry of Agriculture & Forestry. 2016. *Beneficial Management Practices for Irrigated Crop Production.* [online] Available at: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex9384

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

Kerr Wood Leidal Associates Ltd. 2016. *Evaluation of Irrigation Potential in the Peace Region*. [online] Available at: http://www.peaceforageseed.ca/pdf/research_updates/PC05-Evaluation-Irrigation-Potential-Peace-report.pdf

Alberta Ministry of Agriculture, Food and Rural Development. 2005. *Tall Fescue Seed Production in Western Canada*. Agdex 127/15-3. [online] Available at: http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/agdex9860

Forage Seed Production:

For forage seed crops, some of the same principles for irrigation will apply as those used for forage production. However, timing of irrigation can be critical as maximizing seed production requires different management than maximizing forage or dry matter production.

Fall Moisture:

- Essential for the tillering that will produce seed heads in the spring
- Critical to good establishment of the forage seed crop before winter prior to the seed production year

Spring/Summer Moisture:

- Essential given that forage grass such as tall fescue can use 55- 65 cm of moisture from spring to the end of July
- Additional moisture applied to crops after seed set can improve seed size, but can no longer improve the basic potential of the crop (and may also delay maturity somewhat)
- Given the nature of pollination for some forage seed crops, ideal pollination conditions should be considered and irrigation minimized or eliminated at the appropriate time in order to maximize pollinator actions (e.g. leaf-cutter bees prefer warm and dry conditions)

In some years, sufficient moisture can double the seed yield (e.g. for fescue or bromegrass) but there is no data for an average potential crop response to moisture alone.

Moisture for forage seed crops will provide the biggest benefit when applied prior to seed set, so that the vegetative growth provides the best conditions for maximum amount of viable tillers and seeds produced. This is when the forage crop has the highest water demand.

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