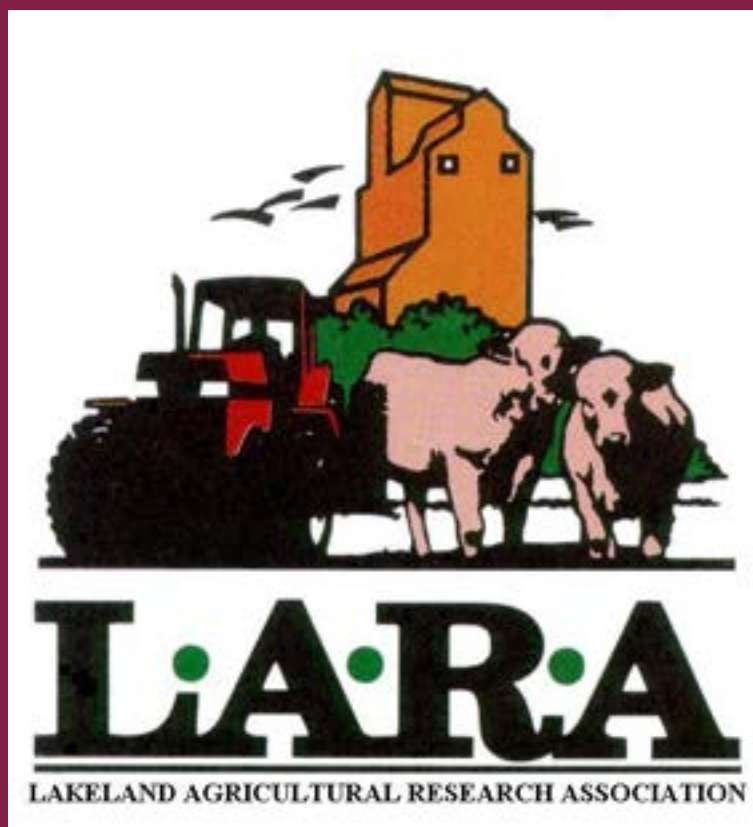




# Farming In Northeast Alberta In Extreme Heat and Dry Conditions





# About This Booklet

This booklet aims to summarize and provide agricultural producers in Northeastern Alberta with information and useful strategies to manage production challenges in extreme heat and dry conditions; and to increase whole farm resiliency.

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Many agricultural industry experts contributed to this booklet including: Sheri Strydhorst, PhD, PAg; Kevin Elmy; Barry Yaremicio, PAg; Neil Blue; Neil Whatley; Ted Nibourg; Duane McCartney; and Bill Chapman.

Thank you to all those who had a part in making this booklet a resource that agricultural producers can utilize and help increase their farm's resiliency through extreme conditions.

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# WHOLE FARM MANAGEMENT

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## Whole Farm Management

Soil health is a critical factor in the success of any farm. Building whole farm resiliency, or the ability to withstand and recover from challenges such as extreme weather events is particularly important in northern climates. In these climates, farmers face unique challenges such as shorter growing seasons, colder temperatures, and more extreme weather events, which can make it difficult to maintain soil health and productivity. One of the most effective ways to build whole farm resiliency in northern climates is through the use of cover crops. Cover crops are non-commercial crops that are grown between main cropping seasons, or within cash crops, to cover and protect the soil. They help to reduce erosion, improve soil structure, and increase organic matter in the soil, all of which are important for soil health. Cover crops also help to fix nitrogen in the soil, which is a vital nutrient for plant growth. They also feed the microbes in the soil which help to improve and increase nutrient, water and carbon cycling in the soils. In northern climates, cover crops can help to insulate the soil and protect it from extreme cold temperatures, which can help to improve soil health and increase crop productivity.

Another important practice for building soil health and resiliency in northern climates is the use of compost and other organic matter amendments. Compost is made up of organic materials such as leaves, grass clippings, and woody debris that have been broken down by microorganisms. When applied to soil, compost adds nutrients and organic matter, which can improve soil structure and fertility. Other amendments include manure, which is nutrient rich and in forms that are readily available for plants to access. It is recommended to add manure to fields when plants are actively growing, or just prior to. In northern climates, the use of compost can be particularly beneficial because it helps to insulate the soil and protect it from extreme cold temperatures.



In addition to cover crops and compost, farmers in northern climates can also use reduced tillage to improve soil health. Tillage is the process of preparing soil for planting by breaking up the soil and eliminating weeds. While tillage can be effective at preparing the soil for planting, it can also have negative impacts on soil health. It can lead to erosion, reduce organic matter, and decrease the amount of beneficial microorganisms in the soil. Reduced tillage, or the use of minimal tillage techniques, can help to reduce these negative impacts and improve soil health.

Another way to build whole farm resiliency in northern climates is through the use of diverse cropping systems. A diverse cropping system is one that includes a variety of different crops grown in the same area. This can help to improve soil health and reduce the risk of crop failure due to pests, diseases, or extreme weather events. In northern climates, a diverse cropping system can also help to extend the growing season and improve crop productivity.

Finally, building whole farm resiliency in northern climates requires a focus on water management. Water is a critical resource for any farm, and effective water management can help to improve soil health and increase crop productivity. This can include the use of dugouts, proper management of groundwater and surface water resources, improving snow capture and improved infiltration. In northern climates, it is especially important to carefully manage water resources because of the shorter growing season and the potential for extreme weather events.

In conclusion, building whole farm resiliency in northern climates requires a focus on improving soil health. This can be achieved through the use of cover crops, compost, reduced tillage, diverse cropping systems, and effective water management. By investing in soil health, farmers in northern climates can create more productive and resilient farms that are better able to withstand and recover from challenges.



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Extreme heat and dry conditions can have significant impacts on agricultural systems, including reduced crop yields and increased vulnerability to pests and diseases. To increase the resiliency of a farm to these challenges, there are several strategies that can be implemented. One way is to use Regenerative Agricultural principles. This includes farming and grazing practices to improve the health and fertility of the soil, as well as to enhance the overall resilience of agricultural systems. It does this by focusing on the following principles:

**Minimizing soil disturbance:** Regenerative agriculture practices aim to minimize soil disturbance and maintain a living root in the soil as much as possible, which helps to promote the growth of beneficial microorganisms that support soil health.

**Armour the soil and building organic matter:** Regenerative agriculture practices aim to increase the amount of organic matter in the soil, which can improve soil structure and water-holding capacity. This is often achieved through the use of cover crops, compost, and other organic matter inputs.

**Enhancing biodiversity:** Regenerative agriculture practices aim to increase the biodiversity of the farm ecosystem, including the diversity of crops and animals, as well as the diversity of beneficial microorganisms in the soil.

**Integrating animals:** In regenerative agriculture, animals are integrated into the farming system in ways that mimic natural systems and can help to improve soil health. For example, using animals to graze cover crops or to spread manure can help to build organic matter and enhance soil fertility.

**Keeping a living root as long as possible:** having a plant growing for as long as possible through the use of relay or cover cropping. This includes uses of winter annuals, perennial plants, cool season annuals. This improves water infiltration and soil aggregation to improve water management.

**Reducing synthetics and rotating crops:** Crop rotation can help prevent soil-borne diseases and pests, and can also help to improve soil structure and fertility. Reducing synthetics improves microbial function and nutrient cycling, it also improves soil aggregation.



## Seeding Considerations During a Dry Spring



Soil temperature, soil moisture, seed size and seeding depth are factors affecting seed germination. Under dry soil moisture conditions, agronomy must be properly adjusted to adapt to uncharacteristic conditions.

An embryo is a tiny, inactive plant inside of every seed. Depending on the plant type, seeds also contain either one or two cotyledons (monocot or dicot) that store reserve food to sustain embryo growth and development. The seeds of our crops begin the germination process when they encounter water in the soil, absorbing or imbibing some of this water through their seed coats. During germination, water absorption softens the seed coat and then activates enzymes within the seed, initiating embryo development. The embryo swells and enlarges, eventually sprouting or breaking through the seed coat. A small root emerges, obtaining more water from the soil, as a small shoot develops, growing through the soil surface where the first tiny leaves appear.

From a seed's initial absorption of soil water to seedling emergence at the soil surface, a seed's stored food reserve in the cotyledons depletes rapidly. Crops with larger seed size contain more food reserve in larger cotyledons, therefore can be planted deeper than crops with small seeds.

Entire seed-to-soil contact, ensuring that a seed imbibes water uniformly from all sides of the seed, is important for optimal germination. Therefore, a seed should be planted deep enough to imbibe water from above and below the seed, and from both sides. This means that large seeds must be planted deeper than small seeds. All seeds should be adequately packed to ensure complete seed-to-soil contact. Generally, under ideal soil moisture conditions, large seeded fababean can be planted up to 3" (7.5 cm) deep and small canola seed is planted at 0.5 to 1" (1.25 cm to 2.5 cm) deep. The ideal planting depth for spring cereal crops (wheat, barley and oats) is between 1.5 to 2" (3.75 to 5 cm) deep.

Soil temperature is another factor affecting seed germination. Most of our spring seeded crops are quite tolerant of lower of soil temperatures. Canola and mustard, for example, germinate when the soil temperature at seeding depth is as low as 2°C, while cereals prefer 3°C or 4°C or higher, and field pea and lentil require soil temperature of 5°C.

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# Seeding Considerations During a Dry Spring

The goal is to place seeds deep enough in soil at a satisfactory soil temperature, accessing adequate moisture for uniform water absorption, but shallow enough to ensure a seed's rapid emergence. The longer a seed sits idle in cold or dry soil, greater is its probability of acquiring a soil-borne fungal disease along with increasing the likelihood of seedling disease development like root rot.

However, dry soil conditions, such as those occurring during periods of drought on parts of the Canadian Prairies, prevent seed germination from occurring normally. The following agronomic practices can be considered under such conditions.

- Get seeds tested at a reputable lab for germination and vigour, which can especially be low when crops are grown and harvested under hot and dry climatic conditions.
- Consider applying a seed treatment to prevent seed or seedling disease when it is anticipated that seeds will spend a longer than normal period of time germinating in the soil. Crops seeded deeper and earlier into cold soils may benefit more than those planted later in May.
- Ensure good seed-to-soil contact through appropriate packing behind the seeder permitting seeds to better absorb soil moisture ensuring optimal and even seed germination.
- Select post-emergent herbicide application over pre-plant soil-incorporated herbicides that may not function correctly under dry conditions and may further dry the soil.
- Deep seeding permits improved seed contact with soil moisture, however weakens the seedling due to depleted cotyledons from additional stress required to journey upward through additional soil. Delayed emergence also makes seedlings susceptible to early season disease infection and insect predation.
- Avoid unnecessary tillage, which prevents additional soil moisture loss.



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# Seeding Considerations During a Dry Spring

- Seeding with narrow, lower disturbance seed openers such as knives ensures minimal soil moisture loss through exposed soil that would otherwise occur as a result of using wider openers like spoons or sweeps.
- As seedbed narrows through usage of a narrow opener, seed-row placed fertilizer may cause seed or root burn, especially in drier soil, resulting in reduced stands or uneven emergence. Fertilizers are salts that when placed near to the seed inhibits water contact with the seed, limiting seedling germination and emergence. While causing additional soil disturbance, banding separate from the seed-row prevents seed or root burn.
- Consideration of decreasing fertilizer rates at seeding time is an option with the possibility of applying additional fertilizer after crop establishment if adequate precipitation arrives.
- Plant cereals and pulses (pea and lentil) early to maximize capture of available soil moisture that would otherwise be used by early season weeds or evaporate with spring winds. Cereals and pulses can tolerate early spring frosts while canola is more sensitive.
- Due to small seed size and cold spring soil, canola is normally planted shallow at 0.5" to 1" (1.25cm to 2.5 cm). If this soil depth is devoid of soil moisture in early to mid-May, plant canola to a depth of 1" and wait for rainfall to germinate seeds. If dry soil conditions remain dry until late May, plant canola seeds up to 1.5" deep, increasing canola seeding rate by 10%, and pack well to ensure good seed-to-soil contact and prevent soil moisture escape.
- Use caution to reduce crop injury from herbicide residues. Herbicides applied in a field during the previous year break down slower under dry soil conditions and can therefore potentially injure a crop being rotated into the same field the subsequent spring.
- For soil water efficiency and conservation in the long-run, plant different crop types, hence different rooting systems, into the same soil yearly. Rooting depth of cereals is deep, canola is intermediate and pulses have the ability to extract water near to the soil surface. So, over time water and nutrients are extracted from various soil depths and conserved at other depths.
- Well chopped straw by the combine during harvest leaves more even straw distribution across a field which prevents moisture escaping from soil and decreases a need for additional straw management with tillage or repeated heavy harrow passes.
- Creating optimal soil organic matter through proper soil and crop management improves a soil's water holding capacity in the long-run when drought conditions may emerge.



# Nutrient Management and the Effects of Extreme Heat and Dry Conditions

Nutrient management under extreme heat and drought is guided by the Leibig's classic Law of the Minimum. Under extreme heat and drought, the main factor determining yield is water availability. However, adequate fertility helps the crop manage the impacts of heat and drought stress.

## Leibig's Law of the Minimum

Leibig's Law states that the most limiting factor, in this case heat and drought, determines yield potential. Therefore, under conditions of extreme heat and drought, further increases in fertility will not improve yield. The only way to improve yields is to provide the crop with more water and less heat stress. Unfortunately, dryland farmers cannot control these climatic factors.

## Fertilize for Realistic Yield Potential

A key principle of nutrient management is selecting the right fertilizer rate. This requires matching the nutrient supply with the crop's nutrient needs by setting a realistic yield goal given the expected growing conditions.

Selecting a realistic yield goal can be challenging since growing season precipitation is unknown. If soil moisture conditions are dry at the time of seeding, farmers may choose to reduce their nutrient applications if long-term forecasts do not suggest normal rainfall. Reduced fertilizer rates can also help to manage economic risk when conditions are dry at the time of planting.

## Adequate Base Fertility

Although growers may reduce total fertilizer applications, adequate fertility promotes root growth deeper in the soil profile allowing the crop to access water deeper in the soil. Adequate potassium (K) applications aid the plant's ability to close stomata and reduce water loss. Under dry conditions, crops tend to have a greater percent yield response to phosphorous (P) and potassium (K) fertilizer applications, compared to nitrogen (N) fertilizer.

## Top Up Fertilizer Applications

If soil conditions are dry, a grower can reduce fall or spring fertilizer applications. However, if timely rains are received after planting, reduced fertilizer applications will limit yield potential. This can be mitigated with in-crop nitrogen fertilizer applications. To maximize yield potential in cereal crops, in-crop nitrogen applications must be made before stem elongation.

## Unused Nutrients

If a lack of moisture prevents the crop from using the applied nutrients, much of the fertility will remain in the soil for next year's crop. This is because nitrogen mineralization is reduced under dry conditions and phosphorous and potassium are less mobile when placed below the soil surface.





# Nutrient Management and the Effects of Extreme Heat and Dry Conditions

## **Nutrient Placement Under Dry Conditions**

Adequate soil water is necessary for nutrient uptake. Plants absorb nutrients in areas of the soil where roots are actively growing. In times of drought, shallow fertilizer applications may be less effective, as there is less active root growth in upper levels of the soil profile.

## **Take home message**

Under conditions of heat and drought stress, water, rather than nutrients, will limit yield potential. Fertilizer rates should be based on realistic yield goals given the growing conditions. Adequate P and K fertility will help a crop mitigate heat and drought stress. Under drought conditions, nutrients should be placed deeper in the soil near areas of active root growth.





## Nutrient Management and the Effects of Extreme Heat and Dry Conditions

Nitrogen (N) applications are particularly susceptible to losses of various types during dry conditions. Urea is particularly bad, especially in the form of uncoated, surface applied product. Up to 1/3 of the nutrient has been determined to be lost in normal conditions. It is worse when it is dry and if the nitrogen fertilizer is not incorporated.

Dry conditions may also impact anhydrous ammonia retention, due to difficulty in soil resealing behind the knife applicator. Also, there needs to be some available moisture for  $\text{NH}_4^+$  (Ammonium as a liquid) to be formed from  $\text{NH}_3$  (Anhydrous ammonia gas) to prevent additional gassing off. In clay soils, where dry conditions result in more clod formations, losses increase as the air spaces in the soil are greater.

On the up side, there is less leaching of N through the soil profile when soils are dry. Excess moisture can move nitrogen down into the soil profile, and out of reach from many shallow rooted plants as they start to grow.

Phosphorous (P) is less available in dry conditions. Its mobility is reduced, but there is less reaction and nutrient tie up. It is more available as plants grow towards dry nutrient prills in the soil.

Potassium (K) has been shown to leach directly from plant residue but phosphorous requires microbial breakdown for nutrient release from organic matter (tied up in cell walls, etc.), excessively dry conditions will not facilitate that release. Moisture is also required for potassium to naturally leach from plant material.

Dry soils make soil sampling harder as penetrating into the profile to an appropriate depth is increasingly difficult as soils dry out. Hand probing soils would be tougher to get to an appropriate depth, and the sample may not be an accurate representation of phosphorous in the soil. Shallow soil samples may overestimate actual P and K in soil while underestimating N through the depth of the whole profile. These difficulties need to be taken in to consideration when sampling in particularly dry conditions.

# Physiological Signs of Extreme Conditions on Plants

Water and heat stress reduce plant growth and yield. Water stress is not uncommon in western Canada and is the main factor limiting yield.

## Management of Water Stress

More than 95% of the water taken up by plants is lost through the leaves in the form of water vapor. Plants reduce water loss by opening and closing small pores in their leaves, called stomata. When stomata are closed, water loss is minimized, but the plant is unable to take in carbon dioxide for photosynthesis. As a result, plants are constantly balancing water loss with photosynthesis and growth.

## Signs of Water Stress

In response to reduced levels of photosynthesis, plants reduce vegetative growth and grow smaller leaves. Leaves often wilt in the mid-day heat but recover later in the day when temperatures cool and solar radiation is reduced.

Under water stress, plants send a larger proportion of their photosynthates to the roots. As a result, increased root growth allows the plant to uptake water from a larger soil volume.

Under prolonged water stress, plants reduce stem elongation, abscise older leaves and senesce prematurely. Cereal plants will abort tillers and oilseeds reduce branching. These physiological changes reduce yield potential.



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# Physiological Signs of Extreme Conditions on Plants

## Timing of Water Stress

Water stress early in the season has the least impact on yield as plants can compensate by increasing the number of kernels/seeds or increasing seed weight, if growing conditions improve. If water stress occurs during stem elongation, plant height is reduced.

In Alberta, most crops have maximum water needs in July, which coincides with flowering and early grain fill. If water stress occurs at flowering, there are significant impacts on yield. Water stress at flowering often leads to kernel abortion at the tip and base of the head. If water stress occurs during seed fill and ripening, seed size is reduced resulting in decreased yield.

## Management of Heat Stress

For most cool season crops, daytime highs around 20°C are ideal. Under high heat conditions, solar energy can overheat the leaves. Plants try to avoid overheating by orienting their leaves upright or rolling their leaves. This helps the plant leaf reduce water loss and excess heating.

## Timing of Heat Stress

Flowering and reproductive stages are the most sensitive to high temperature stress. Heat and water stress at this time limits photosynthate translocation to the developing grain resulting in smaller seeds. Heat and water stress can also shorten the grain filling time resulting in earlier maturity and harvest.

## Take home message

Under water and heat stress, plants minimize water loss by closing stomata, which limits photosynthesis. The reduced photosynthesis leads to reduced yield.

Early season water stress is least damaging to yield. Water stress at flowering and grain fill has the most severe impacts on yield.

Plants respond to water and heat stress by: closing stomata, reducing photosynthesis, reducing leaf growth, rolling leaves, orienting their leaves upwards, wilting, increasing root growth, reducing plant height, aborting tillers or branches, aborting kernels, reducing seed size and maturing more rapidly.





## Cover Crops In Extreme Conditions

Water at the right time and amounts makes farming so much easier. When water is limited or in excess it causes stress on everything. Now imagine if there was a way to help manage soil moisture more efficiently, one of the ways is to use cover crops.

There are a couple options that cover crops can be used to mitigate dry conditions. If they are mismanaged, it could make the moisture shortage worse, so understanding when they use water is important. One of the issues that needs to be addressed in many soils is increasing water infiltration. This can be accomplished by increasing soil aggregation and alleviating any hardpan issues. Using cover crops with a vegetative plant growing, especially in the fall, will help create stable soil aggregates. Having tap root species in the mix will help drive plant roots through hardpan layers allowing water to infiltrate into the soil profile storing it for future use. Attempting to break up hardpans during dry conditions will prove very difficult, but having the roots in position to take advantage of any moisture to drive through the dense zone is important. With dry conditions, the soils are usually more dense due to the type of clay present in our soils, 2:1 swelling clays. When there is moisture, plant roots are able to push through many of these hardpans.

Plants in the vegetative stage can release up to 80% of the carbon they sequester as a root exudate to feed the soil biology. The soil biology will take some of this carbon to create shelter for themselves which we call soil aggregation. Late season additions of liquid carbon to the aggregates will create a waterproofing effect creating a stable aggregate. Without this stabilization the aggregates are more fragile through the freeze-thaw cycles and tend to break down more easily, making the system restart creating aggregates.

Cover crops will create soil armour. This soil armour will keep the soil cooler during the summer and allow the soil biology to continue to function, building soil until it is terminated. One of the myths of cover cropping in the fall is that it will tie up nutrients and use up water for the next year's crop. As long as the fall cover crop is in the vegetative stage the plants will play catch and release with the nutrients. The cover crop plants will rot quickly in the spring releasing any nutrients that it has captured in the fall.

# Cover Crops In Extreme Conditions

As for water, plants tend to transpire water slower than what can evaporate from the bare soil. Evaporation is a complete loss of water from the soil system and will bring up salinity to the surface. Transpiration is a by-product of photosynthesis, meaning the plant is capturing carbon from the air and releasing root exudates to build soil structure. Trials by Jimmy Emmons from Oklahoma showed that a cover crop growing in the fall did dry out the top twelve inches of the soil, but the soil column down to four feet contained more stored water than bare ground. Any moisture that fell followed the root channels down deeper in the soil to be stored instead of being wasted by running off or evaporating.

One of the keys to success in dry situations is to terminate any overwintering cover crop relatively early in the spring before it uses the shallow soil moisture. Under dry conditions having plants in the spring using water is not usually a good thing, unless it is a biennial cash crop that was seeded. Another key when planning to use a cover crop is to grow low growing, water efficient plants at relatively low seeding rate densities. Using plants that tiller out helps to cover the ground quickly which actually helps to conserve moisture. Adding in some species with tap roots and that are mycorrhizal fungi friendly will help bring up moisture and share with the other plants. Having a few of the cover crop species that grow taller would be beneficial to help slow down wind speeds at the surface. Plants such as sunflowers can create some height to the cover crop without using a lot of water.

The concern about not having enough days after harvest is usually brought up in cover cropping conversations. It does not matter if the conversation is in northern Alberta or down in Mississippi and it is true if trying to seed after harvesting spring seeded cash crops. The way around this is to utilize relay cover cropping, seeding a cover crop with the main cash crop. When the cash crop is harvested, the cover crop will continue to grow into winter. This way it does not have to be another seeding pass and is established and ready to continue to grow after harvest. Because they are seeded at low plant densities they will not take away any yield from the main crop, assuming that species used as the cover crop are synergistic like annual legumes, forbs, or biennial grasses. Having a mycorrhizal fungi friendly tap root will actually help bring up more moisture for the cash crop. If rains do start up late in the growing season, having the relay cover crop will also help harvest, using excess water during harvest and allowing machines to get on to the field.

Like many other tools we have access to, we need to use the tool correctly for it to work properly, like it was designed to. The same goes for using cover crops to help conserve soil moisture. We need to keep the soil protected from the elements so our soil biology can keep building soil aggregates and breaking up any hardpan zones. So when moisture does fall it is able to infiltrate into the soil for the plants to use. Moisture sitting on the soil surface is going to be lost to evaporation or runoff. Neither will help the extreme dry conditions. We need to help as much rain and snow infiltrate to recharge our soil profile with whatever moisture we get.



## Intercropping in the Presence of Adverse Weather Conditions



### What is it?

Intercropping is the practice of growing more than one crop at the same time in the same field. The crops can be seeded at the same time (mixed intercropping), or seeded at different times (relay cropping). There is also strip intercropping, which the different crops are grown in wider strips (such as the width of the seeder) in the same field. The purpose for intercropping is threefold. First it adds diversity to the system which in turn creates stability in the system. Second is to reduce the amount of chemicals used such as fertilizer, pesticides and fungicides as input levels, disease and pests are typically lower in an intercropping system. Third is overyielding. Overyielding is producing more than what a single crop would be expected to yield on the same land area. Protection or enhancement of the soil by making use of resources or ecological processes that would otherwise not be utilized by a single crop is also a benefit.

### Why do it?

Intercropping serves several purposes:

- Maintaining living roots in the soil for a longer period: The longer actively growing roots are maintained in the soil, the more erosion and soil compaction is potentially reduced, nutrients are retained in the rooting zone rather than leached out, and the more soil enhancing root exudates are produced.
- Providing plant diversity to enhance soil microbiome, which would add to nitrogen fixing and biodiversity opportunities.
- Creating additional yield through a situation known as overyielding, where two crops are planted at 60% of their normal seeding rate, potentially yielding 120% of a normal monocrop through advantages in nitrogen fixing, exudate production and mutual crop protection.

### What are the benefits and advantages of intercropping?

Mutual crop protection, pest impact minimization: Intercropping a crop with good standability with one that does not have that trait would enhance the standability of the overall crop. In addition, pests and diseases may be discouraged or have a lesser impact when the neighboring plant is impervious to it.

## Intercropping in the Presence of Adverse Weather Conditions

**Intercropping plant growth assistance:** As some plants grow in association with microbes, they trap nitrogen from the air, and also in association with soil microbes, they are known to exude nitrogen in a form that other plants can use in the growing season.

**Opening soil pores:** Intercropping tap rooted plants with more fibrous rooted varieties has been known to enhance water and nutrient infiltration and retention.

**Nutrient leakages from plants:** It has been shown that in the presence of other plants, and microbes, exudates of both nutrients and soil aggregate forming materials are produced by plants and expelled into the soil, enhancing soil structure and water holding capacity which can protect plants from hot, dry conditions.

**Microbial encouragement:** Different species of plants are known to grow in association with certain soil microbes. Having more than one species of plant as a crop increases the diversity which in turn will encourage a more diverse population of microbes.

**Overyielding on an existing land base:** Overyielding has the potential to yield more than a monoculture crop and may leave more nutrients and exudates in the field for subsequent years. It is calculated using the Land Equivalency Ratio (LER), which is a measure of how much land would be required to achieve the yields of the intercrop with crops grown as pure monoculture stands.

Overyielding occurs for many reasons such as intercropping creating weed suppression and lower susceptibility of insects and disease. As well as complimentary resource usage between the species of crops chosen to intercrop together.

**Maintaining living roots longer:** Certain types of intercropping (fall cereals within an annual crop) will extend the length of time living roots are active in the soil. Not only are there benefits in soil retention, but there will also be additional carbon retention and increased organic matter, enhancing the water holding capacity and drought resiliency of the soil.

### **What are the risks and difficulties?**

**Impacts of unusual weather on relative maturity:** Unusually hot and dry or cool and moist conditions can have an impact on whether plants that normally mature at a similar time actually do so in the field. Careful selection of crop varieties with similar maturities can reduce this risk.

**Difficulty in harvesting diverse crops:** We are learning that in some areas, those similar maturity dates of crops can be affected by intercropping. Also, setting a combine to harvest seeds of various sizes can be a challenge.

**Weed/pest management challenges:** Providing a “green bridge” for pest to continue thriving with similar crops being planted on a yearly basis for such conditions as cereal leaf diseases, thrips and wheat stem sawfly.



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# Common Examples of Intercropping

**Peola:** A combination of field peas and canola has benefits for both crops. As the canola bolts, and the stems mature, peas can use these as trellises, improving their standability and likely enhance yields. As peas mature, they can provide nitrogen fixed exudates to provide a later season, readily available boost of this nutrient. As a result, however, caution must be taken not to seed too long of a season canola variety, so the crop still matures in a timely fashion.

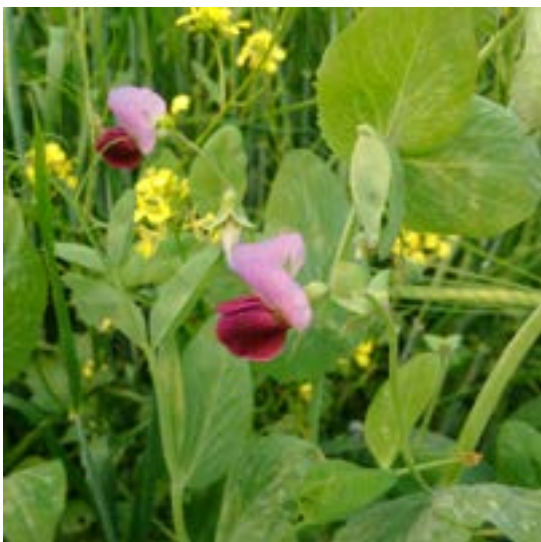
**Winter and spring cereals:** Winter and spring cereals can be seeded in combination which will have benefits in certain situations. For the combination crop/beef producer, a spring wheat crop can be harvested for grain or silage with the leafy growth of a winter cereal utilized as a late season grazing aftermath for cattle. The living roots of the winter crop will provide enhanced soil retention and the potential for a crop the subsequent year. This combination, however, does not provide a diversity of roots and microbial populations for additional soil enhancements or the potential of nutrition provision.

**Wheat/canola:** While this crop combination provides some of the pest minimization benefits of other intercropping potentials and root differentiation to improve soil quality, it does not provide benefits of nutrient and exudate sharing. Standability enhancements are likely questionable and harvesting this intercrop may provide challenges as well.

**Wheat /pulse:** This combination provides more of the benefits that pulse and broadleaf intercrops do, but standability enhancements and maturity combinations may continue to be of some concerns, and rooting differences are not that marked to cause greater improvement of the soil structure.

**Spring cereal/ pulse:** This combination can be very beneficial for silage or greenfeed. Similar to other cereal and pulse mixtures, the pulse provides added nitrogen benefits, while the cereal improves the standability if peas are used as the pulse. Adding peas can also boost crude protein of a forage by up to 5% over a cereal monoculture.

While there are some concerns, risks and challenges with intercropping in the presence of adverse weather conditions, intercropping may continue to maintain or even improve yields in the coming years.



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# Making the Most Post Growing Season

After periods of extreme heat and dry conditions, winter might be a saving grace moving into the next growing season. Trying to capture snowfall, and retain losses that can be due to erosion from winter winds, creates resilience in your system. Recovery takes time and management, as does building your system's resilience.

When harvesting after a hot, dry summer consider straight-cut harvesting. Also known as direct cutting or straight combining, which refers to the process of cutting and combining grain crops (such as wheat, canola, and barley) without the use of windrowers or swathers. Instead, the crops are directly cut and combined. By leaving the residue standing as high as possible it reduces wind erosion and increases snow capture that can provide valuable moisture the following growing season. Also leaving stubble standing, allows for the roots of the plants to decay adding organic matter into the system and provides channels in the spring to increase water infiltration, and thus soil moisture.

For pastures, consider winter bale grazing as a great way to rejuvenate pastures with the addition of organic matter and livestock waste. Consider feeding some forbs or legume seed in your mineral this spring to help bring some biodiversity and plant establishment back; feeding the microbes below the soil and increasing pasture productivity.

Keeping trees on the landscape also helps promote snow capture. They also provide valuable habitat for pollinators and beneficial insects and wildlife.



# MENTAL WELLNESS

**24** Mental Wellness

**26** Improving Mental Wellness

**27** Mental Health Stigma

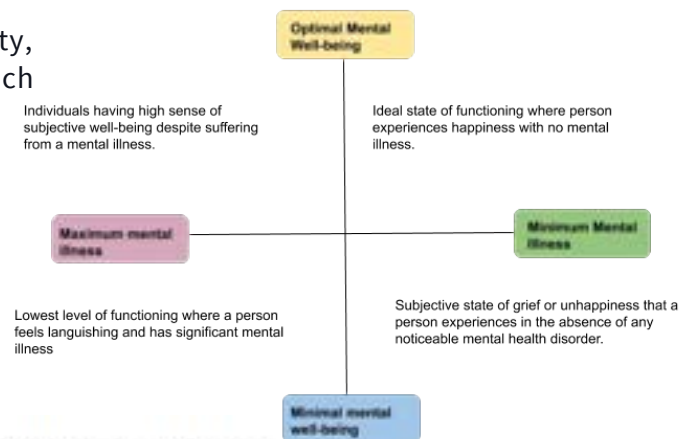


# Mental Wellness



Stress and anxiety can have a number of negative impacts on both mental and physical health. In general, chronic stress and anxiety can lead to a variety of mental health problems, such as depression, anxiety disorders, and even post-traumatic stress disorder (PTSD). These mental health problems can then lead to a range of physical health problems, such as high blood pressure, heart disease, and weakened immune systems.

When a person experiences chronic stress and anxiety, their body goes into a state of "fight or flight" in which the sympathetic nervous system is activated. This leads to a number of physiological changes in the body, including increased heart rate and blood pressure, and the release of stress hormones such as cortisol. These changes can be helpful in the short term, as they can help a person to respond to a perceived threat. However, when they persist over a longer period of time, they can lead to a number of negative health effects.



## Mental Health Continuum Model



HEALTHY	REACTING	INJURED	ILL
<ul style="list-style-type: none"> <li>• Normal mood fluctuations</li> <li>• Calm &amp; takes things in stride</li> <li>• Good sense of humour</li> <li>• Performing well</li> <li>• In control mentally</li> <li>• Normal sleep patterns</li> <li>• Few sleep difficulties</li> <li>• Physically well</li> <li>• Good energy level</li> <li>• Physically and socially active</li> <li>• No or limited alcohol use/ gambling</li> </ul>	<ul style="list-style-type: none"> <li>• Irritable / impatient</li> <li>• Nervous</li> <li>• Sadness / overwhelmed</li> <li>• Displaced sarcasm</li> <li>• Procrastination</li> <li>• Forgetfulness</li> <li>• Trouble sleeping</li> <li>• Intrusive thoughts</li> <li>• Nightmares</li> <li>• Muscle tension / headaches</li> <li>• Low energy</li> <li>• Decreased activity/socializing</li> <li>• Regular but controlled alcohol use / gambling</li> </ul>	<ul style="list-style-type: none"> <li>• Anger</li> <li>• Anxiety</li> <li>• Pervasively sad / hopeless</li> <li>• Negative attitude</li> <li>• Poor performance / workaholic</li> <li>• Poor concentration / decisions</li> <li>• Restless disturbed sleep</li> <li>• Recurrent images / nightmares</li> <li>• Increased aches and pains</li> <li>• Increased fatigue</li> <li>• Avoidance</li> <li>• Withdrawal</li> <li>• Increased alcohol use / gambling is hard to control</li> </ul>	<ul style="list-style-type: none"> <li>• Angry outbursts / aggression</li> <li>• Excessive anxiety / panic attacks</li> <li>• Depressed / suicidal thoughts</li> <li>• Over insubordination</li> <li>• Can't perform duties, control behaviour or concentrate</li> <li>• Can't fall asleep or stay asleep</li> <li>• Sleeping too much or too little</li> <li>• Physical illnesses</li> <li>• Constant fatigue</li> <li>• Not going out or answering phone</li> <li>• Alcohol or gambling addiction</li> <li>• Other addictions</li> </ul>

Mental illness is a term that refers to a wide range of mental health conditions that can affect a person's mood, thinking, and behavior. Mental illnesses can range in severity from mild to severe and can manifest in a variety of different ways, including but not limited to:

- Depression: a persistent feeling of sadness and loss of interest in activities
- Anxiety: a feeling of worry or fear that is disproportionate to the situation
- Schizophrenia: a disorder that affects a person's ability to think, feel, and behave clearly
- Bipolar disorder: a disorder characterized by extreme shifts in mood, energy, and activity levels
- Personality disorders: conditions that involve patterns of thinking and behaving that differ significantly from the expectations of an individual's culture
- Substance use disorders: conditions in which the use of substances like drugs or alcohol becomes harmful to the individual or others

Mental illnesses can be treated with a combination of therapy, medication, and lifestyle changes.

Mental illness and mental wellness exist on a continuum, and a person's mental health can change over time. Someone who is experiencing mental illness may be able to improve their mental health and achieve mental wellness with the right support and treatment. On the other hand, someone who is experiencing mental wellness can still experience periods of mental illness if they are not able to manage stress and other challenges effectively.

Mental illness refers to a range of conditions that affect a person's mood, thinking, and behavior. These conditions can range from mild to severe, and can include conditions such as depression, anxiety, bipolar disorder, and schizophrenia. Mental illness can disrupt a person's ability to function in daily life and can cause significant distress.

Mental wellness refers to a state of well-being in which an individual is able to cope with the stresses of daily life and is able to function at their best. It is a state in which a person is able to think clearly, feel calm and balanced, and engage in activities that bring meaning and fulfillment. Mental wellness is not the absence of mental illness, but rather the presence of mental health.

There are a number of signs and symptoms that can indicate that a person is experiencing mental distress. These can include:

- Changes in mood or behavior, such as feeling more anxious, sad, or irritable than usual
- Changes in sleep patterns, such as difficulty falling or staying asleep, or sleeping more than usual
- Changes in appetite or weight, such as a loss of appetite or significant weight loss or gain
- Loss of interest in activities that used to be enjoyable
- Difficulty concentrating or making decisions
- Feelings of hopelessness or helplessness
- Physical symptoms such as headaches, stomach-aches, or muscle tension



If a person is experiencing several of these symptoms, it may be a sign that they are struggling with mental health issues and could benefit from seeking help. It is important to remember that everyone is different, and what may be considered "normal" for one person may not be the same for another. It is always best to talk to a qualified mental health professional if you are concerned about yourself or someone else.

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# Improving Mental Wellness

There are many things that people can do to improve their mental wellness. Some of these include:

- Engaging in regular physical activity, as exercise has been shown to improve mood and reduce stress
- Eating a healthy, balanced diet, as good nutrition is important for overall health and well-being
- Getting plenty of sleep, as sleep is important for both physical and mental health
- Practicing relaxation techniques such as deep breathing, meditation, and yoga, which can help to calm the mind and body
- Connecting with others, as social support is important for mental health and can help to reduce feelings of loneliness and isolation
- Engaging in activities that bring meaning and fulfillment, such as hobbies, creative pursuits, or volunteering
- Seeking support from friends, family, and professionals, such as therapists or counselors, who can provide guidance and support
- Avoiding or reducing the use of substances such as alcohol and drugs, which can exacerbate mental health issues

It is important to remember that everyone is different, and what works for one person may not work for another. It may take some trial and error to find the best approach for improving mental wellness.



***A survey of over 1,100 Canadian Farmers showed that producers are facing multiple mental health complications:***

- ***57% Anxiety***
- ***45% High Stress***
- ***35% Depression***

***Alberta Mental Health Hotline: 1-877-303-2642***

***If you are in crisis, please visit your local emergency department or call 911.***

The stigma surrounding mental illness is a pervasive problem in many communities, including among farmers. Many people who experience mental illness may be reluctant to seek help due to concerns about being judged or discriminated against. This stigma can prevent people from getting the help they need, which can in turn make their mental health problems worse.

One of the reasons that the stigma of mental illness is particularly prevalent among farmers is that farming is often associated with traditional notions of strength, independence, and self-reliance. These stereotypes can make it difficult for farmers to admit that they are struggling with mental health issues, and can prevent them from seeking the help they need.

Additionally, the isolation that is often associated with farming can make it difficult for farmers to connect with others and seek support. This isolation can also exacerbate mental health problems, and can make it harder for people to recover from mental illness.

It is important to recognize the stigma surrounding mental illness and to take steps to reduce it. This can include educating people about mental health, providing support and resources for people who are experiencing mental health issues, and advocating for policies and practices that support mental health. By addressing the stigma of mental illness, we can help to create a more supportive and inclusive society in which people can seek help when they need it.

Farming can be a challenging and stressful occupation, and financial stress can be a significant contributor to mental health issues in the farming community. The financial challenges that farmers face can include fluctuating commodity prices, increasing production costs, and the potential for natural disasters or other unexpected events that can disrupt or damage crops and livestock. These challenges can lead to financial strain and stress, which can take a toll on a farmer's mental health.

In addition to the financial challenges that farmers face, the isolation and long hours that are often associated with farming can also contribute to mental health issues. The combination of financial stress and isolation can be particularly challenging for farmers, and it's important for them to have access to support and resources to help them manage these challenges.

If you're a farmer and you're experiencing financial stress or other mental health challenges, it's important to seek help. There are resources available to support farmers, including counseling services, financial assistance programs, and support groups. It's also important to take care of your physical health, as good physical health can have a positive impact on mental health.



# WATER MANAGEMENT

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Water is a vital resource for agriculture, and the quality of the water used on a farm can have a significant impact on crop growth and yield. Here are a few factors to consider when it comes to water quality for farms:

1. **Chemical composition:** The chemical composition of water can affect the growth and development of crops and livestock. For example, water that is high in salt can be detrimental to some crops, while water that is low in nutrients may not support optimal crop growth. It can also affect the efficacy when using pesticides.
2. **Pesticides and other contaminants:** Water that is contaminated with pesticides or other chemicals can be harmful to crops, livestock and the environment. It is important to monitor the water used on a farm for the presence of contaminants and to take appropriate measures to ensure the water is safe for use.
3. **pH:** The pH of water can affect the availability of certain nutrients to crops. Water that is too acidic or too alkaline can affect the ability of crops to absorb nutrients from the soil.

Water quality is extremely important for the health and well-being of livestock. Clean, fresh water is essential for animals to maintain good health and to support their growth, development and reproductive potential. Poor water quality can lead to a variety of health problems in livestock, including dehydration, diarrhea, and other illnesses. In some cases, contaminated water can even be fatal. Therefore, it is important for farmers and ranchers to regularly test the quality of the water that their animals are drinking, and to take steps to ensure that it is free from contaminants and other substances that could be harmful to the animals. This can include treating the water with chemicals to remove bacteria and other contaminants, or regularly replacing the water to prevent it from becoming stagnant. By taking these steps, farmers and ranchers can help to ensure that their animals have access to clean, fresh water, which will support their overall health and wellbeing.



# Groundwater

Groundwater is a vital source of water for many farms and communities, and drought can have a significant impact on groundwater levels. During a drought, there is less available water in the soil and in surface water sources, such as streams and lakes. As a result, people and farms may rely more heavily on groundwater as a source of water.

However, the overuse of groundwater during a drought can lead to a depletion of the groundwater supply. As the water is pumped out of the ground, the water level in the aquifer (the underground layer of rock, sand, or gravel that holds water) decreases. This can result in a drop in the water level of nearby wells, making it more difficult to access the water.

In addition, as the groundwater level drops, the water can become more concentrated with minerals and contaminants, which can affect the quality of the water. This can be particularly problematic in areas where the water supply is already limited or compromised.

Overall, it is important to carefully manage the use of groundwater during times of drought to ensure that the resource is not overused and to protect the quality of the water. This may include implementing conservation measures, such as reducing water use or using alternative sources of water, to reduce the reliance on groundwater.



Maintaining a water well is an important part of ensuring that it continues to provide clean and reliable water. Here are a few steps you can take to maintain your water well:

1. Regularly test the water quality: It is important to regularly test the water from your well to ensure that it is safe to drink and use. This can be done by taking a sample of the water to a laboratory for testing, or to your local health unit.
2. Keep the well casing and cover in good condition: The well casing and cover should be in good condition to prevent contaminants from entering the well and to keep people and animals out. Inspect the well casing and cover regularly, and repair or replace any damaged components as needed.
3. Protect the well from contamination: There are several steps you can take to protect your well from contamination, such as keeping chemicals and other potentially hazardous substances away from the well, properly disposing of wastewater, and maintaining septic systems and other waste management systems. Also ensure that runoff is directed away from your well, and that no runoff pools around your well.
4. Regularly inspect and maintain the pump: The pump is an important component of a water well, and it should be inspected and maintained regularly to ensure that it is functioning properly. This may include cleaning and lubricating the pump, as well as replacing worn or damaged parts.
5. Monitor the water level: The water level in a well can fluctuate due to a variety of factors, such as changes in groundwater levels or pump performance. It is important to monitor the water level in the well and make any necessary adjustments to ensure that it is operating at optimal levels.
6. Consider shock chlorination of your well: shock chlorination prevents bacteria from building up in your well and fouling your system.



## Poor Water Quality

Poor water quality can have a number of negative effects on livestock. Some of the most common problems that can be seen in animals that are given contaminated or poor-quality water include:

- **Dehydration:** One of the most common effects of poor water quality is dehydration, which occurs when an animal's body doesn't have enough water to function properly. This can be caused by a variety of factors, including water that is contaminated with bacteria or other substances, or water that is not available in sufficient quantities. Dehydration can cause a variety of symptoms in animals, including lethargy, weight loss, and a decrease in milk production in lactating animals.
- **Illness:** Contaminated water can also cause a variety of illnesses in livestock. This can include bacterial infections, such as salmonella or E. coli, which can cause diarrhea and other digestive problems. Contaminated water can also contain toxins and other substances that can be harmful to animals, leading to a wide range of health problems.
- **Reduced growth and development:** In addition to causing illness, poor water quality can also have a negative impact on the growth and development of livestock. This is particularly true for young animals, who are particularly vulnerable to the effects of contaminated water. Poor water quality can lead to stunted growth, reduced weight gain, and other developmental problems.
- **Reproductive problems:** Contaminated water can also cause reproductive problems in livestock. This can include reduced fertility, miscarriages, and other complications that can affect an animal's ability to reproduce.
- **Mortality:** In some cases, poor water quality can be fatal for livestock. This can occur when animals consume large amounts of contaminated water, or when they are exposed to water that is extremely toxic. In these cases, animals can die within a short period of time, often without any warning signs.

# Surface Water Bodies

Extreme heat and dry conditions can have a number of negative effects on surface water bodies, such as wetlands, lakes, creeks and streams. When the weather is extremely hot and dry, the amount of water in these bodies can decrease, leading to lower water levels; which can concentrate toxins or chemicals in the water. This can have a number of impacts on the plants and animals that live in and around the water, as well as on the water itself.

One of the most significant effects of extreme heat and dry conditions on surface water bodies is the increased risk of algal blooms. Algal blooms are large concentrations of algae that can form in water when there is an excess of nutrients, such as phosphorus and nitrogen. These blooms can cause the water to turn green or blue-green, and can produce unpleasant odors.

It can also lead to blooms of cyanobacteria. Also known as blue-green algae, cyanobacteria are a type of microorganism that can be found in freshwater environments. While some types of cyanobacteria are harmless, others produce toxins that can be harmful to animals, including livestock. When livestock consume water that is contaminated with cyanobacteria, they can be exposed to these toxins, which can have a range of negative effects on their health. The specific effects of cyanobacteria on livestock will depend on the type and amount of toxins that the animals are exposed to. In some cases, animals may experience mild symptoms, such as nausea and vomiting, after consuming contaminated water. In more severe cases, animals can develop liver damage, respiratory problems, and other health problems. In extreme cases, the consumption of cyanobacteria can be fatal for livestock.

Extreme heat and dry conditions can also lead to the increased risk of water contamination. When water levels are low, there is less water available to dilute contaminants, such as chemicals and bacteria. This can lead to higher concentrations of these substances in the water, which can be harmful to plants and animals.

In addition, extreme heat and dry conditions can also affect the quality of the water itself. When water levels are low, the water can become warmer and less oxygenated, which can be harmful to many aquatic species. This can lead to a decrease in the diversity of plants and animals that live in and around the water, and can also make the water less suitable for human use.



# Dugouts

Dugouts are a great source of water for many uses, however many encounter problems over their lifespan. Good planning, monitoring and maintenance are key to prolong the use and maintain the quality of water in your dugout. Aeration is one of the simplest things you can do to mitigate issues and maintain water quality. Inspections should be done regularly for signs of: animal entry (both domestic and wildlife); lack of aeration (stagnant water); damage to buffer areas; erosion and bank slumping; surrounding vegetation; and visible signs of water quality (turbidity, colour, smell etc.).

Dugouts properly constructed (minimum 15 feet deep, 1.5:1 slope, spoil pile either removed or leveled out and grassed, and big enough for a two year supply of water) will provide a dependable source of water. Trees around the dugout are good for snow trap, but must be setback to prevent roots from breaking through the clay liner and reduce natural aeration. Deciduous trees should be no closer than 50 meters from the bank and coniferous trees no close than 20 meters to prevent leaves and branches from the trees from falling into the water and adding organic matter to your water source. Proper siting is also crucial for runoff capture, ensuring maximum capture to sustain over dry years. Proper diagnosis of issues is essential for determining appropriate treatment method.

Problem	Causes	Treatment
Black Smelly Water	Depletion of oxygen due to algae growth, plant decay or no aeration. Damaged or improper intake pipe. Anaerobic bacteria growth.	Install or fix aeration, change diffuser at the bottom of dugout. Control weeds and algae. Physically remove decaying matter. Raise intake pipe.
Dirty Water (Turbidity)	Soil erosion, human activities, direct access by livestock, and animals such as ducks and muskrats.	Coagulation. Plant vegetation and soil erosion control. Could create a two dugout filtration system (settling pond). Prevent livestock from entering dugout with exclusion fencing and offsite watering systems.
Algae and/or Cyanobacteria	There are many types of algae; most common is green algae and blue-green algae (cyanobacteria which are toxic).	Aeration and prevention of nutrient overloading. Offsite watering systems and fencing off dugouts from livestock. Algaecides, color dyes, hydrated lime (best for blue-green algae), or registered liquid copper.
Vegetation	Some types are beneficial (providing shade, take up excess nutrients, and lowering water temperature) and other types are harmful.	Identify what species are present in your dugout to determine treatment option. Physical removal (raking, mowing); biological control (weevils, galls); colorants; registered herbicides; aeration/diffuser.
Nutrient Build Up	Over the years sludge builds up, containing precipitated chemicals, dead biological matter, and sediments. Causes algal blooms, cyanobacteria and vegetation growth.	Clean out dugout (roughly every 10 years), usually using a track hoe to remove sludge layer at the bottom and sides and remove excessive plant growth.

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# Contaminants In The Water

When water levels are low, there is less water available to dilute contaminants, such as chemicals and bacteria. This can lead to higher concentrations of these substances in the water, which can be harmful to plants and animals. This includes sulphates, total dissolved solids, sodium, and alkalinity, which can increase dramatically in periods of hot, dry weather.

Contaminants can enter surface water bodies in a variety of ways. For example, they can be introduced through agricultural runoff, which occurs when rainwater washes pesticides and other chemicals from fields into nearby rivers, lakes, and streams. Contaminants can also enter surface water through industrial discharge, when factories and other industrial facilities release chemicals into nearby water bodies. Sewage and other forms of wastewater can also contain contaminants, which can enter surface water through sewage treatment plants or through leaks and overflows.

Once contaminants are present in surface water, they can have a number of negative effects on the plants and animals that live there. For example, chemicals can be toxic to fish and other aquatic species, causing them to die or to become sick. Bacteria and other microorganisms can also be harmful, leading to disease and other health problems. Contaminants can also make the water unsuitable for human use, such as for drinking or for swimming.

Contaminants can create a multitude of health impacts on livestock and even lead to fatalities. Some of the impacts of contaminants include:

- Sulphates can lead to diarrhea (in poultry, pigs, horses and ruminants), trace mineral deficiency in calves, polio in feedlot cattle, copper deficiencies in mature cattle, and overall animal performance. In extreme cases (over 4,000 mg/L) it can result in severe health issues and mortality.
- Molybdenum can lead to a fatal copper deficiency.
- Sodium can cause diarrhea, which can lead to dehydration. Could be fatal if no other water supply is provided.
- Nitrates for cattle can result in abortions and even death. For poultry can result in depressed growth, poor performance and even death.
- Total Dissolved Solids can cause diarrhea, reduced water intake which can result in dehydration. It can result in reduced performance and long-term health.

To prevent contamination of surface water bodies, it is important to reduce the sources of contaminants, such as by using pesticides and other chemicals responsibly, and by properly treating and disposing of wastewater. It is also important to regularly monitor the water quality in these bodies, and to take steps to remove or neutralize contaminants if they are present. By taking these steps, we can help to protect the health of surface water bodies and the plants and animals that depend on them.



# Algae and Cyanobacteria

Algal blooms are large concentrations of algae that can form in water when there is an excess of nutrients, such as phosphorus and nitrogen. These blooms can cause the water to turn green or blue-green, and can produce unpleasant odors. In some cases, they can also produce toxins that can be harmful to plants, animals, and humans.

Algal blooms can occur in both fresh and saltwater environments, and can have a variety of negative effects. For example, they can reduce the amount of oxygen in the water, which can be harmful to fish and other aquatic species. They can also produce conditions in the water which release toxins and chemicals that can be harmful to people and animals if they come into contact with the water. In severe cases, algal blooms can lead to the death of fish and other aquatic species, and can make the water unsafe for human use.

There are several factors that can contribute to the formation of algal blooms. One of the most significant is the presence of excess nutrients in the water, which can come from agricultural runoff, sewage, and other sources. Warmer water temperatures can also encourage the growth of algae, as can calm, stagnant water conditions.

To prevent algal blooms, it is important to reduce the sources of excess nutrients in water bodies, such as by using fertilizers responsibly and by properly treating and disposing of sewage and preventing livestock manure from entering. It is also important to regularly monitor water quality, and to take steps to remove or neutralize algae if they are present.

Algae and cyanobacteria are both types of microorganisms that can be found in water. However, they are not the same thing, and there are some important differences between the two. One of the main differences between algae and cyanobacteria is their size and complexity. Algae are a diverse group of aquatic organisms that range in size and complexity. They are typically plant-like in appearance, and are able to photosynthesize, which means that they use sunlight to produce their own food. Algae can be found in a variety of environments, including fresh and saltwater, and can range in color from green to brown to red. Cyanobacteria are typically smaller and simpler in structure, and are often found in colonies or mats. While some types of algae are harmless, others can produce toxins that can be harmful to plants, animals, and humans.



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# Blue-Green Algae

Blue-green algae are a unique group of bacteria (cyanobacteria) that have the ability to photosynthesize. There are more than 100 species of cyanobacteria in Alberta, with many being able to out compete algae in a growing season. The word cyan (from cyanobacteria) means blue-green, but in addition to green chlorophyll, cyanobacteria contain many other accessory pigments that can influence their color and gives rise to species that appear green and blue-green but also other colors like red, purple and red-brown. The additional pigments allow them to harvest light at spectrums other phytoplankton types of growths can't use. Cyanobacteria can out-compete other types of algae such as green algae for example in turbid water as light is less available., Cyanobacteria out-compete other algae during periods of nutrient limitation as some species can fix atmospheric nitrogen. Notably, in nitrogen enriched conditions other harmless forms of algae outcompete cyanobacteria. They also have the ability to trap gasses and regulate their buoyancy, and can move throughout the water column to find optimum growing conditions. Many of Alberta's lakes are naturally nutrient rich to support cyanobacteria growth, but this can be exacerbated by extensive watershed development (industrial, urban and agricultural), and shoreline disturbance such as the removal of shoreline vegetation. Blooms are also weather dependent, so the occurrence, severity and persistence of the bloom can not be predicted . When the cyanobacteria decompose, oxygen is often depleted from the water and ammonia is produced. Also, certain strains of cyanobacteria can produce nerve and liver toxins during decomposition, which can pose a serious health risk to humans and animals.

If you suspect cyanobacterial growth in your dugout that is used for animal consumption:

- Contact an Agricultural Water Specialist or veterinarian as soon as possible to determine if your cattle need to be removed from the source so treatment can be done.
- Provide an alternate source of drinking water for your livestock or pets if cyanobacteria are in your dugout until diagnosis is determined and the problem resolved.
- Proper identification of the algae must be made, and treatment recommendations must be provided by a Water Specialist so as not to cause harm to livestock or pets. Water analysis may be required.
- Toxins may remain in the water for up to a month after the death or treatment of the algae.
- Cyanobacterial blooms may not always be apparent as they may sink down into the water column at times.
- Do not irrigate or rinse edible crops with water that is suspected to have cyanobacteria in it.
- Do not enter the water if you suspect cyanobacteria are present. They can cause skin irritation, vomiting and diarrhea.



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# The Value of Wetlands

Wetlands can provide a number of important benefits during times of drought and extreme heat. Some of the most significant benefits include:

**Water storage:** Wetlands can act as natural reservoirs, storing water during times of high rainfall and releasing it during periods of drought. This can help to maintain stable water levels in rivers and other water bodies, and can provide a valuable source of water for plants and animals during times of extreme heat and dryness.

**Cooling:** Wetlands can also provide a natural cooling effect, which can be particularly valuable during times of extreme heat. The water in wetlands is typically cooler than the air temperature, and the plants and soil in wetlands can also help to dissipate heat. This can create a more comfortable environment for plants and animals, and can help to reduce the risk of heat-related illness.

**Evapotranspiration:** Wetlands can also help to regulate the water cycle through a process known as evapotranspiration. This occurs when water is evaporated from the wetland surface, and when moisture is released by plants through their leaves. Evapotranspiration can help to cool the air and can also help to return water to the atmosphere, where it can be redistributed through rainfall. This can help to maintain stable water levels and can support the growth of plants and animals during times of drought.

**Habitat:** Wetlands are also important habitats for a variety of plants and animals. In Alberta, 80% of our wildlife require wetlands for a portion of their lifecycle requirements. During times of drought and extreme heat, these habitats can provide important resources, such as food, shelter, and breeding sites, which can help to support the survival and reproduction of these species. This can help to maintain the diversity of plants and animals in an area, and can also provide important ecosystem services, such as pest control and water purification.

Overall, wetlands can provide a number of important benefits during times of drought and extreme heat. By protecting and restoring these important ecosystems, we can help to support the health and wellbeing of plants, animals, and humans.



# Protecting Water Quality

There are several steps that farmers and ranchers can take to protect the water quality in areas where livestock are present. Some of the most effective strategies include:

**Regularly testing the water quality:** It is important to regularly test the water that your animals are drinking to ensure that it is free from contaminants and other substances that could be harmful to the animals. This can include testing for bacteria, chemicals, and other substances that could be present in the water. By regularly testing the water, you can identify any potential problems and take steps to address them.

**Providing clean, fresh water:** Ensuring that your animals have access to clean, fresh water is essential for their health and wellbeing. This can include providing offsite watering systems to your livestock and preventing livestock from directly accessing the source. If the water quality is poor consider treating the water with an appropriate method such as with chemicals to kill bacteria and other microorganisms, or using filtration systems to remove contaminants.

**Managing waste:** Properly managing the waste produced by you and your animals is also important for protecting water quality. This can include collecting and properly disposing of animal waste, such as manure and urine, to prevent it from entering nearby water bodies. It can also include using best management practices, such as rotational grazing, to minimize the amount of waste that is produced.

**Planting vegetation:** Planting vegetation, such as grasses, sedges, rushes and trees, around water sources can also help to protect water quality. These plants can help to filter pollutants out of the water, and can also provide shade and shelter for your animals. This can help to create a healthier environment for your animals, and can also help to improve the quality of the water.

By taking these steps, farmers and ranchers can help to protect the water quality in areas where livestock are present. This can support the health and wellbeing of the animals, and can also help to preserve the health of the local environment.



# Offsite Watering Systems

In dry conditions, it is especially important to manage livestock access to riparian areas in order to protect these ecosystems and ensure their long-term health. Dry conditions can lead to reduced water levels in streams and wetlands, making riparian areas more vulnerable to damage from livestock. Allowing livestock to graze in these areas during dry conditions can lead to overgrazing and erosion, which can further reduce water levels and harm aquatic life.

To minimize the negative impacts of livestock on riparian areas during dry conditions, it is important to implement appropriate grazing management practices. This may include fencing off sensitive areas, using rotational grazing practices, and providing alternative sources of water for livestock through offsite watering systems. It may also be necessary to implement other measures, such as restoration projects, to repair the damage caused by previous grazing practices.

It is also important to carefully monitor the condition of riparian areas during dry conditions and take steps to protect them as needed. This may include providing additional water through offsite watering systems or implementing other measures to help maintain the health of the ecosystem.

Offsite watering systems can be a crucial tool for livestock farmers in times of drought to maintain riparian health and improve water quality. Several different types of offsite watering systems exist.

Pipeline systems consist of a network of pipes that deliver water from a central source, such as a well or a dugout, to watering troughs or tanks at various locations on the farm. These systems are particularly useful for large farms with a lot of animals, as they allow the farmer to provide water to all of their livestock at once.

Gravity flow systems rely on the natural slope of the land to deliver water to troughs or tanks. These systems are relatively simple to set up and maintain, and they can be a good option for farmers who don't have access to electricity or who want to minimize their operational costs.





Solar pumps use solar panels to power a pump that delivers water from a well or other source to troughs or tanks. These systems are environmentally friendly and can be a good option for farmers who don't have access to electricity or who want to reduce their energy consumption.

Tanker trucks are vehicles that carry water to the farm and can be used to fill up troughs or tanks. These systems are flexible and can be used to provide water to livestock in remote or hard-to-reach areas.

In times of drought, offsite watering systems can be a vital tool for farmers who need to ensure that their livestock have access to clean, fresh water. These systems allow farmers to provide their animals with the hydration they need to stay healthy and productive, even when natural water sources are scarce or unavailable.



# ANNUAL CROP MANAGEMENT

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## Seeding Considerations During a Dry Spring



Annual cropping in the presence of dry conditions can be quite challenging. Seeding depth, timing, and prep work are all issues that may be impacted by adversity in the field. The following are some considerations when considering spring seeding during a dry cycle:

**Seeding into moisture.** While it is necessary to have some moisture for crops to germinate and grow, chasing moisture through the soil profile may result in patchy germination; depending on the crop, soil type, soil temperature, rotation, field work and other considerations. While cereals can emerge from as much as a four-inch depth, seeding to soil moisture small seeds such as canola may have reduced emergence from a depth less than half that. So, while it makes sense to seed cereals deeper to ensure good germination moisture, most small seeds need to be seeded shallower to ensure the seedlings have the energy to emerge, even if that means a temporary stranding in dry soil zones.

Early seeding usually takes advantage of whatever early season moisture there is, spreading out the timing of seeding may take advantage of variable moisture occurring throughout the growing season and possibly may even maximize a return in the event of dry conditions.

It is known that while working fields in advance of seeding could help to warm the soil and combat weeds, moisture loss is also prevalent from various passes of field work. Warmer soil temperatures generally ensure a more rapid emergence. The benefit of any field pass must be weighed against the reduction in soil moisture, especially in the presence of dry conditions. Good packing after seeding would minimize moisture loss, some soil types would form a crust as a result of normally adequate packing. Tight rotations might expose the germinating plants to more seedling disease pressure. All of these considerations must be reviewed in order to ensure maximum crop emergence and growth.

All of these aspects of spring work must be considered when seeding depth, timing and spring work are intertwined to ensure the best crop return in the face of dry conditions. Minimizing risk by critically analyzing all aspects of the seeding season and adapting accordingly should assist in decision making in the spring.

For more details check out the Whole Farm Management Section on seeding in dry conditions.

# 4R Nutrient Management in the Presence of Dry Conditions

In dry conditions, it is particularly important to manage nutrients wisely. A current standard in fertilizer applications, which is known as 4R nutrient management, is certainly a favorable means of managing these essential crop ingredients. This stands for the right source, right rate, right time and right place of nutrient application. Under dry conditions, proper nutrition application is particularly important. The following aspects of 4R nutrient management need to be taken into consideration:

## Right Source

If anhydrous ammonia is used, risks increase during dry conditions. Some moisture is required to have anhydrous bind in the soil, so seeking moisture during application is a requirement but is also more difficult when the soil is dry. Packing is the next concern in this regard. Soils need to be sealed back to ensure as much of the nutrient stays in the soil, so additional packing may be required in dry soils. Urea and coated urea could be used in dry conditions, especially if other considerations are taken into account. Coating urea with nitrogen loss reducing products would also be beneficial in reducing losses in dry conditions.

## Right Rate

Having some knowledge of the amount of N required for the subsequent crop would be necessary in dry conditions to prevent nutrient loss. If soil testing is not an option, calculated figures can be estimated based on past available N, estimated nitrogen use, and potential residue release. Actual soil testing would, however, whether it be as a benchmark sample or a field scale situation would be the best alternative. Even better would be specific soil testing that would determine the correct amount of nutrient per soil area or zone for optimum crop production.

## Right Time

If fall applications are required, it would be best to apply N after soil cools in the fall to prevent losses, but before soils freeze to maximize uptake of nutrients. Spring applications, as close to seeding as possible, are generally better to reduce nitrogen losses.

## Right Place

It is known that any surface application of nitrogen leads to additional losses, so subsurface banding or injections is always better than a surface application, regardless of the source or timing, especially in dry conditions. If broadcasting must be conducted, incorporation as soon as possible must follow. Application of some nutrients with the seed, as required, without causing any seedling damage, also promotes efficient use of nutrients while minimizing losses in dry conditions.



# Disease Management for Crops Under Drought and Heat Stress

Under extreme dry conditions, disease is one of the easiest production challenges for farmers to manage.

## Disease Triangle

Going back to the foundational concept of the disease triangle, the three main elements (host, pathogen and environment) are all necessary for disease development. For disease to damage a crop, and therefore reduce yield, under drought and heat stress, growers need to assess the following elements of the disease triangle:

- The pathogen - abundance and virulence:
  - Is there a lot of disease present?
  - How capable is the pathogen of causing disease?
- The host plant/crop - susceptibility to disease:
  - Is the variety being grown genetically susceptible or resistant to the disease in question?
- The environment – suitability for disease development:
  - Is it too hot or too dry for the pathogen to survive, grow and spread?



When one element is missing, such as an environment suitable for disease development, disease will not establish.

## Ideal Environmental Conditions for Disease Development

Fungal diseases are the dominant pathogens faced by western Canadian growers. To negatively impact crop growth and reduce yields, fungal diseases require abundant and prolonged moisture conditions. This includes rain, dew, and high humidity. These conditions increase fungal spore release, germination and movement.

## Poor Environmental Conditions for Disease Development

Under conditions of heat and drought stress, the absence of moisture prevents fungal disease survival, growth and movement. When fungal diseases are not able to multiply, germinate or move, drought manages disease for growers. Research from Alberta found no wheat yield response to fungicide applications when: growing season precipitation was low (121–214 mm); there was reduced May and June precipitation (85% of the long-term average); and there was lower relative humidity (57.7%–63.7%).

## Considerations for Fungicide Use

When growers are considering fungicide applications under heat and drought stress conditions, they need to consider the following:

- Fungicide applications do not increase yield; they protect yield potential. Therefore, if the crop's yield potential is low, fungicide application will not increase yield. For example, a canola crop with a 10 bu/ac yield potential or a wheat crop with a 40 bu/ac yield potential, are very unlikely to see economic returns from a fungicide application.
- Every unnecessary fungicide application is selecting for disease resistance. Although the disease may not appear on the upper canopy, the fungi are at the soil level or in the lower canopy. These fungi likely receive a non-lethal dose of fungicide which leads to fungicide resistance over time.

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# Disease Management for Crops Under Drought and Heat Stress

## Take home message

Under conditions of heat and drought stress, crops have limited yield potential and fungal pathogens are not able to multiply, germinate or move. It is therefore prudent for growers to carefully assess the need for fungicide applications under heat and drought conditions as they are unlikely to be beneficial from a sustainability, economic, productivity or resistance management perspective.



## Management of Residual Herbicide Carryover During Dry Years

Most herbicides applied to crops will decompose and disappear within a few weeks without causing crop restrictions the following year. However, a residual herbicide is a herbicide type that persists in the soil, staying active and providing longer-lasting weed control. The term 'residual', applied to this type of herbicide, has longer lasting activity in the soil, including re-cropping restrictions.

Upon application, a residual herbicide is dispersed in the top layer of the soil creating a barrier layer where germinating weed seeds absorb the herbicide as they begin to grow. Residual herbicides control weeds by absorbing the herbicide into the root, shoot or seed of the emerging weed. Susceptible weeds typically die before or as they emerge from the soil, depending on the herbicide active ingredient applied. Residual herbicides can achieve weed control over several weeks, months, or even years depending on soil type, rate of application, the active ingredient and weather conditions.

Consult the “Crop Protection Guide” (The Blue Book) for re-cropping restrictions pertaining to each herbicide label, which are based on long-term average rainfall after the herbicide was applied. This guide informs which crops should not be planted one and two years after a specific herbicide is applied.

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# Management of Residual Herbicide Carryover During Dry Years

However, if precipitation conditions during the growing season are dry, residual herbicide carryover may occur and be extended longer than the label information, and these restrictions may need to be adjusted.

While residual herbicides require spring moisture for activation to function as weed control, rainfall during the time from June through August, when soil temperatures are also warm, is the most favourable timeline and condition to decompose or break down residual herbicides. So, summers with at least in-season rainfall of 4" (100 mm) from June 1 to August 31 are required to decrease risk of residual herbicide carryover. Higher rainfall reduces this risk more. The possibility of unexpected residual herbicide carryover to the next year occurs if there is less than 3" (76 mm) of rainfall during the summer timeline. This increases herbicide injury risk to the more sensitive crops discussed in the Crop Protection Guide.

Residual herbicides break down naturally in the soil mainly through the processes of microbial activity and chemical decomposition. Microbial degradation is carried out by the action of soil microorganisms, like bacteria, algae and fungi, that live in the soil and decompose herbicides into small molecules utilizing them as sources of energy and food. The activity of these soil microorganisms is dependent on water availability, soil temperature and soil pH. Soil microbial activity occurs more under conditions of greater moisture and in warmer soils (up to 30°C) and decreases under conditions of less moisture and in cooler soils (below 10°C). Soil containing larger amounts of organic matter hold more water and therefore promote microorganism activity. Heavier textured soils like clay, as opposed to sand, enhance herbicide residue breakdown because they have greater water holding capacity. Microorganism growth is impeded by pH extremes.

The other main method of residual herbicide breakdown is via chemical decomposition. This occurs through complex chemical reactions in the soil that are influenced by soil moisture as water divides the larger molecules into smaller, less active pieces. Chemical decomposition of residual herbicides increases with warmer soil temperatures and decomposition speed is affected by soil pH. Risk of residual herbicide carryover rises with pH levels outside of the neutral soil pH range of 6.5 to 7.5. While moisture is a factor for occurrence of chemical decomposition, the amount is less than that required for microbial activity.

Therefore, a dry year, especially from June 1 to August 31, prevents residual herbicide breakdown and can change cropping plans. Growers who have had two or more successive dry years and repeatedly applied various residual herbicides will have additional negative effects on rotational crops, which is referred to as herbicide stacking. Small amounts of residual herbicides can build up over several dry years to cause unexpected crop damage.

While careful observation of residual herbicide labels in the Crop Protection Guide are important as we seek crop options for succeeding years, we need more assistance after a severely dry summer. For additional guidance, growers need to consult with the manufacturer of residual herbicides that have been used. Company representatives give guidance on which crops are most tolerant of a residual herbicide and which crops are more sensitive.



# Management of Residual Herbicide Carryover During Dry Years

The appearance of injury symptoms on crops from herbicide residues in the soil are often preceded by a soaking rainfall, which releases the herbicide from soil particles and moves it into the rooting zone where it is taken up by the crop roots. Weed scientist, Eric Johnson, says that a high-risk condition for herbicide carryover is when a grower applies a herbicide at the onset of a crop year, experiences a very dry July and August during that year, a dry month of May during the following spring, and then a heavy rainfall in June when the crop is emerging.

Good record keeping on behalf of the grower is important. Record keeping includes crop rotations, crop yields, inputs including herbicides used, etc. A grower and herbicide representative will want to observe precipitation accumulation during the growing season that the residual herbicide has been applied as this is the most predictable guide of potential risk of herbicide carryover. The Alberta provincial government has many weather stations spread widely across the province that collect accurate rainfall data. However, given the localized nature of precipitation events, including “showers”, a producer’s personal farm precipitation field records are the most important for determining individual field risk and estimation of particular risk of carryover injury from the herbicide used.

Many herbicides have not been adequately tested for carryover risks under the extreme conditions of precipitation deficit that have been experienced across the Prairie region in the early 2020s. However, it is known that some herbicides like the Group 2 Imidazoline (IMIs) family are at higher risk for herbicide carryover. IMI herbicides are frequently used with pulse crop production and with CLEARFIELD tolerant crops.

Given that crop rotation is the most important agronomic practice to prevent crop damage due to herbicide carryover, crops with lower risk should be considered. When carryover is caused by IMI herbicides, re-cropping to several pulse crops can be considered. This includes field peas and lentils. However, use caution because growing these pulse crops closely in rotation can worsen some pulse diseases like root rots (aphanomyces is common in both pea and lentil) and make soil erosion and weed management problematic. While not as tolerant as some pulses, a cereal crop like spring wheat is relatively tolerant to IMI carryover but barley, durum, and oat are less tolerant. Canola and mustard are very sensitive to IMI carryover.

Other than complete rotation away from crops sensitive to herbicide carryover, the only way growers can prevent damage is by tweaking agronomy management techniques. However, none of these tools will totally eliminate risk and may end up being costly.



Although some herbicide chemical residues can be detected via soil samples tested at a lab, the process is expensive and relatively unreliable. Soil tests help to assess herbicide carryover risk by providing various soil properties that affect herbicide residue breakdown like soil texture, soil organic matter and pH. However, varying soil properties at different locations across a field cannot be accurately represented in a laboratory situation. Laboratory analysis of soil may not be available for specific herbicides and may not detect those applied at very low rates.

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# Management of Residual Herbicide Carryover During Dry Years

A bioassay is the use of a living organism to test for the presence of, or the amount of, a substance that is present in a sample. The organism used is sensitive to the compound for which the test is conducted. To test for herbicide carryover, in-field strips indicate a crop's ability to grow in a field where carryover is believed to exist. Field soil can be evaluated by being brought into a greenhouse or grown in pots. Unfortunately, variability across a field may be under-represented.

Instead of inhibiting seed germination, most residual herbicides act on seedlings after they've begun to germinate. In fact, herbicide carryover injuries are most likely to reveal themselves after a rainfall event that allows an active ingredient to be washed into the root zone. Therefore, increasing seeding rates to achieve higher than optimal plant population targets is not recommended when dealing with herbicide carryover. While it continues to be important to target plant populations optimal for specific crops, boosting stand densities will not increase the crop's tolerance to herbicide residues and may be a costly way to end up with a higher number of herbicide injured plants across the field.

Cold soils can be extra stressful to germinating crops, so early seeding may be harmful to crops coping with herbicide carryover. Seeding in warmer soils is less stressful, encourages faster germination or pop-up effect of the crop and provides a longer period of time for residual herbicides to break down and prevent damage to germinating crop seedlings.



# Pests to Consider in Dry Conditions

Scouting for pests is something to be done all season long. You can also check out the pest forecasting tools and maps that are available online. The question that many producers face is when to utilize control methods? Active scouting, and pest counts are the largest decision making factor, but it needs to be weighed against crop prices, expected yields, price of chemical and the cost to other beneficial insects. For every pest there are over 1,500 beneficial insects.

Understanding what are the economic thresholds that consider the above-mentioned factors is critical. Grasshoppers can cause significant damage to crops by feeding on plant leaves, stems, and seeds. They are particularly problematic during dry conditions, as they are attracted to plants that are under stress. Typically, the current economic threshold is 8 to 12 grasshoppers per square metre for cereal crops. The number for canola is 7 to 10 per square metre. You can count your grasshoppers with tools like metre sticks or by using a sweep net available at some farm supply stores or fertilizer and chemical dealerships. If you need help consult with your local dealership or applicator.

Grasshopper growth stages are measured in instars and are classified by species in central and northern Alberta the main problems are Two stripe, Migratory and Packard's on pasture, but a newer species, the Brunner's is cyclical every 2 years. You need to start checking in mid to late May or early June as soil temperature influence the rate of germination. Grasshoppers can grow through an instar every 4 to 6 days.

For the first 25 to 30 days, grasshoppers are in the 1 to 4 instar stages, wings start to develop at 3rd instar and they can fly at the adult stage or 5th instar. You may be able to tank mix your insecticide with later sprayed field herbicide applications. Check the label or Crop Protection Guide (current Blue Book). When grasshoppers start to fly between fields, you lower the efficacy of the insecticide as you are trying to hit a moving target. Spray early, aim for the 2 to 4 instars stage to get better control since you are trying to eliminate a moving target. If you are using a contact insecticide, spray when air temperatures are below 25 degrees Celsius. The new contact insecticides are safer to apply but don't have the residual control of older organo- chloride or organo- phosphide products. Multiple applications may be required if you have a serious infestation.

In central and Northern Alberta most grasshoppers hatch from the egg beds on field margins, ditches, pastures and sandy loam undisturbed grassy areas where the previous year eggs were laid in pods. The most efficient way to estimate your economic threshold is to use a sweep net. You need to do 2 complete sweeps of 180 degrees as you take 2 steps to measure a square metre or just over a square yard. If you start sweeping early, it is easier to capture the 2 to 4 instar hoppers than adults that can fly to neighboring fields. Populations do vary in fields so take sweeps walking through the fields, do at least 10 to 20 spots throughout the field to get a more accurate count.

There are a few natural predators that damage egg pods. Scarab beetles eat the eggs, as well as blister beetles. Wet conditions can cause fungal damage, and egg mortality. Flocks of birds such as seagulls, will help control adult grasshoppers in some fields.





# Pest Considerations

## **Flea Beetles**

The newer neonic seed treatments in canola have had their share of mixed results on flea beetle control, as dry conditions at springtime delay the uptake of water-based products. To activate the seed treatment you need to seed canola  $\frac{3}{4}$ " to 1" deep in a firm moist seedbed at a preferred rate of 3.5 lbs per acre. This is to achieve a plant stand of 10 to 14 plants per foot. Make sure you check your drills and calibrate your rates. If you try and seed at a lower rate of 2 lbs per acre with a disc drill or pre-disc your fields to get rid of trash you are losing at least  $\frac{1}{2}$  inch of moisture per tillage pass. This will reduce the uptake of the seed treatment and risk more flea beetle damage.

The economic threshold for leaf damage is 25 % of the leaf surface of the cotyledons are chewed and under very dry conditions there is stem chewing as well. Tight canola rotations also increase the risk of more flea beetle damage. There are two types the back and yellow stripe flea beetle and adult populations over winter in the field margins and emerge as adults. Adult flea beetles feed on the newly emerged canola plants and lay eggs by the stems and re-appear just before maturity to feed again on pods before overwintering. Take the time to scout your fields and check for hot spots as the adult beetles can fly in from neighboring fields and will feed on your field within a few days. The easiest way is to use a sweep net to check for beetles.

**Lygus** is one insect that a lot of producers have, but don't check for it, at the bolting to flowering stage. In the spring, adults emerge from field margins and are extremely mobile with the ability to fly. They feed on the sap of plants by using their piercing-sucking mouthparts to extract the sap from plant tissues. This can cause damage to the plants, leading to reduced growth and yield. Damage from this insect is detected by missing flowers on the pedicel or stem that holds the flower and then pod on the stem. A developing canola plant can have between 50 to 75 pods on the main stem and side branches depending on variety and growing conditions so if you lose 10 to 20 florets on a plant from adults sucking the plant sap out of a developing floret you are reducing yields. You can use a sweep net to check your field and start at the edge of the fields next to pastures as the new canola plants attract the adults. They can be difficult to control, as they can easily move from one crop to another and reproduce quickly. Anything close to 6 to 8 adults per sweep at flowering is the economic threshold to spray. Control measures for Lygus include the use of pesticides, as well as cultural practices such as crop rotation and the use of physical barriers (e.g., row covers) to prevent the insects from accessing the plants.

# Pest Considerations



Other insects to check for are **Cutworms**, if you see crows or seagulls out in your canola field or cereal field go and dig up a few plants and look for chewing damage and/or missing stems. Check early in the morning as the developing worms are active before temperatures rise. **Aphids** are small, sap-sucking insects that can damage crops by feeding on plant tissues. They are particularly attracted to plants under stress, such as those experiencing extreme heat or drought.

**Thrips** are small, slender insects that feed on a wide range of plants. They can cause damage by feeding on plant tissues, which can lead to reduced growth and yield. Thrips are also known to transmit viral diseases, which can further damage crops. **Spider mites** are small, eight-legged arthropods that feed on the sap of plants. They can cause damage by sucking the sap from plant tissues, which can lead to reduced growth and yield. Spider mites are particularly problematic during hot, dry conditions, as they thrive in these conditions.

## Strategies to Manage Pests

Crop scouting throughout the season would ensure early awareness of increasing pest populations which may rapidly reach action thresholds, causing economic damage.

Crop rotation is even more critical during hot dry conditions. Ensuring any spore load or bank of insects at a stage that would impact a crop is minimized is even more critical when the pest has some form of a competitive advantage. So, maximizing the interval between similar crops is also an important consideration. Particularly if one is considering intercropping, one might need to look for different species or varieties that are resistant to prevalent pests.

Encouragement of bug predators: Keeping fence line refugia for ladybird beetle populations may help keep pest populations down. Spraying the most specific insecticides and only using these control agents when absolutely necessary will also help maintain pest predator species and lessen the risk of harmful insect outbreaks.

Maintaining healthy soils encourages soil predators that can consume pests such as grasshopper eggs.

Intercropping two or more species of crop can reduce risk and total damage to crops from a specific pest. Having strips of resistant crops alternating with susceptible ones can reduce pest contact on the host and reduce the pest's overall impact, maintain yield and crop quality.

Crop timing: While seeding as early as the soil temperature permits is often the most favorable timing for most crops, in the presence of dry or variable conditions one possible strategy to maximize return is to seed throughout the season if the farm has enough fields to permit this. Early seeding should likely be able to take advantage of whatever spring moisture exists, while later seeding may benefit from any moisture events that may occur later in the season, while the yield of the early seeded crops may already be set.

Minimizing disturbance of the soil and minimizing equipment passes would also help to retain moisture and maximize returns in the presence of dry conditions.

# Impacts of Heat and Drought on Grain Quality

Cereals, canola and pulse crops are cool season crops that are intolerant to extreme daytime heat and prefer cooler night time temperatures during the growing season. Cool season crops perform best at daytime temperatures of between 20 and 25 °C. Although some of the crop types we grow are more tolerant to dry weather than others, in general they do not thrive in dry weather – they require adequate precipitation during the growing season to achieve average or higher than average grain yields.

During the early development stages of seedlings of cereals (wheat, barley, oats) and our major pulse crops (pea, lentil, fababeans), their growing points are below the soil surface. These buried growing points allow us to plant these crops early, during the end of April to the beginning of May. These crop seedlings will regrow if one or two early spring severe frosts occur. This interesting plant physiology pays dividends most years in July. Given long-term average weather patterns of generally receiving high air temperatures near the beginning of July, early planting of cereals and pulses allows their growth stages to generally be past the major flowering period prior to the onset of high July heat. This is beneficial because high heat can abort the flowers of these crops, reducing yield.

Canola, on the other hand, has a different seedling physiology. The growing point on canola seedlings is above ground, between its two cotyledons. This leaves newly emerged canola seedlings vulnerable to early spring frosts, so canola should not be planted as early as cereals and pulses. So, while planting canola in late April is usually too early, it's important to plant as early in May as is possible, considering various climatic zones in Alberta. Canola experts say it's fine to plant canola into soil that is 5°C when a warming trend is forecasted. Canola can germinate at a soil temperature of 2°C, however, seeding into soils that are too cool adds significant stress to seedlings, extend the germination period, and reduce seedling survival. Nonetheless, establishing a canola crop as early as possible is more likely to avoid major yield damaging heat stress during the critical bud to mid flower stages in summer.

When July daytime air temperatures rise to 28°C to 30°C or higher at the flowering stage of canola, yield loss generally occurs. While flower production is not affected, high heat seriously affects flower fertility resulting in misshapen empty pods or missing pods. Yield can be more seriously affected when hot days of 28-30°C coincide with nights as warm as 16°C and higher. A more critical situation occurs because warm nights do not allow a recovery period for the canola plant, so more and more flowers are aborted, developing more blanks or empty and missing pods along a canola plant's stem.

When precipitation is lacking, crops undergo additional stress. As mentioned, our crops are cool season crops, performing best at daytime temperatures of between 20 and 25 °C. Air temperatures above this cause plant stress. As such, our crops are referred to as C3 plants because of their photosynthesis carbon fixation pathway. Crops like corn and some of our weeds like kochia and Russian thistle are C4 plants containing a photosynthesis pathway allowing them to thrive under higher air temperatures and drought. However, our C3 crops suffer under dry conditions or drought stress, causing improper plant development. As our crops mature further, lack of subsoil moisture exacerbates these problems.



## Impacts of Heat and Drought on Grain Quality

Improper plant development mostly leads to plant stunting, yield reduction and smaller seeds. Crops rely on water for plant nutrient uptake from the soil and to transport nutrients through the plant. When water supply decreases under drought conditions, overall crop growth becomes stunted. Lack of water results in slower growth and shortened internodes or areas between stem nodes. Photosynthesis mechanisms in C3 crops are negatively affected by a drought which also leads to plant growth reduction and subsequent decreased amount of seed yield and smaller seeds. Under excessive drought conditions, a plant's survival mode kicks in and the stunted plants prematurely enter into the reproductive stage to try to produce at least a minimal number of seeds so the plant is at least able to reproduce itself. Small and shriveled grain seed should be tested for germination, vigour, thousand kernel weight (TKW) prior to re-planting.

With pulse crops, root nodulation and nitrogen fixation systems can be negatively affected by drought. Resilience of pulses to dry conditions lessens as rooting patterns are affected. Reproductive stages (flowering, pod development, and seed set) are more impacted by moisture stress than vegetative stages. Chickpea, with a long tap root, is unique and can access water at a lower soil depth, however, reproductive stages continue to be adversely affected. With field pea production, a thin seed coat tends to develop with drought, making it vulnerable to cracking during harvest. A cracked seed coat lowers seed quality, germination and seed vigour, so a seed test is crucial prior to re-planting the seed.

Areas of the Prairies that receive drier weather over successive years leads to increased levels of residual nitrogen in fields. This nitrogen tends to stay within reach of the roots of our crops because it doesn't leach downward in the soil through precipitation infiltration. So, the risk of high protein in harvested barley seeds increases when we grow barley for malt during dry spells. Maltsters prefer lower protein barley and plump kernels, both of which are affected due to high temperatures and moisture stress during grain filling.

# Crop Contracts - Short of Product?

Contracting can be a useful way for farmers to market crop production and has become generally necessary to arrange delivery to a commercial buyer. A crop sale contract is a legal business agreement between a seller and buyer. Signatories to a contract should read it carefully, consider all the “what ifs?” and clear up any uncertainties prior to signing. A producer may decide to have it first interpreted by a third party, such as a lawyer, before signing it.

A crop purchase contract usually specifies price, quantity, quality or grade, the delivery location and date, and sometimes the transportation method. Grain companies are in the business of buying and selling crops, so when they sign a contract to purchase crop from a producer, at some point they will have a contract to sell that amount of crop and grade to a domestic or foreign buyer. For that reason, when a producer is unable to fulfill the volume or quality of a contract, the grain company needs to either find a replacement source for that crop in shortfall or face default penalties on the contract with their buyer.

In most years, a good time to consider contracting crop to lock in price and delivery opportunity is during the growing season when prices often rally, at least temporarily, in response to weather concerns. Usually, incrementally committing up to 25 per cent of expected production prior to harvest is a safe practice, but sometimes a crop production shortfall may still arise. Weather events or conditions in some years may prevent enough crop of the contracted grade to be produced, resulting in a shortfall to fulfill the terms of the contract. In that case, the producer who signed the contract may be liable for damages.

If a producer realizes that it will not be possible to fill the terms of the contract, they should advise the crop buyer of that situation sooner rather than later. The buyer may have obligations in place for processing and selling that crop contracted by the producer, so the buyer also faces a potential loss. If the buyer can easily replace the crop contracted with the producer at the same or lower price as the contracted amount, there may be minimal damages to a shortfall on the contract. However, if the crop price has risen from the time that the contract was signed, the producer may have to pay the price difference between the contracted price and “replacement” cost for the volume of crop in shortfall.

In some circumstances, a buyer may be able and willing to roll the crop contract to a subsequent production year, subject to a price adjustment. However, that may not be feasible in a year when current year prices are high relative to available prices of the following crop year.



## Crop Contracts - Short of Product?

Crop buyers want to maintain good relationships with producers. The most important considerations of being in a crop shortfall position are early communication of the pending difficulty in fulfilling the contract, followed by honest, open and civil communication. Farm or field inspections by a buyer representative may be necessary. Some buyers may suggest, after being advised by the producer of a potential shortfall, to wait until after harvest to deal with the contract. That is understandable but, if possible, a price for settlement may best be negotiated early rather than wait until after harvest. That is especially so if the expected crop shortfall is due to a widespread weather event, such as a multi-region drought.

Participants in Crop Insurance through Alberta's Agriculture Financial Services Corporation may be eligible for a payout in the case of crop production below their coverage level. In addition, Alberta's Variable Price Benefit of that program may provide some additional relief if there is a crop insurance claim.

If there is a contract buyout charge, that will be an allowable expense for income tax purposes. A buyout cost (excluding penalties and interest) will also be an allowable expense under the AgriStability Program, so there may be some financial relief following a contract buyout for AgriStability participants.



# ANNUAL AND PERENNIAL FORAGE MANAGEMENT

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## Winter Cereals for Spring Grazing

During dry conditions and extreme heat, winter feed sources are often limited, and pastures can become overgrazed in the fall as producers search for ways of extending available feed sources. Winter cereals such as winter wheat, winter triticale, and fall rye can be good alternative forage for early spring grazing when winter feed sources are running out. There are two timing options for seeding winter cereals.

Winter cereals seeded in fall have been shown to provide an early-season grazing opportunity for livestock. These winter cereals can take advantage of the spring snow melt to grow, which might not be available later in the spring when seeding would occur. This could allow for delayed turnout into stressed perennial pastures, thus providing more recovery time for those forages. A second option is to seed winter cereals in the spring, which prevents most of the plants from entering a reproductive stage. Therefore, these winter cereals remain vegetative, maintaining their quality and yield from summer to fall. Winter cereals are typically seeded in the spring when the soil temperature reaches 10°C. However, work done at LARA has shown winter cereals can be successfully seeded at 2°C, which provides earlier grazing and additional grazing opportunities throughout the grazing season.

Fall and spring seeding of winter cereals allows for a potential increase in grazing days and can reduce the need for additional bought feed or pasture rental during extremely dry periods. This is a planning tool that should be considered when facing dry conditions to not only cut costs but also allow for the recovery of perennial pastures.





## Seeding Forages Under Impending Dry Conditions

To seed forages or not to seed, will be the question to answer in the future if these dry weather conditions in western Canada continue. Seeds produce very strong suction forces for imbibing water due to solutes, but they needed liquid water, not vapour, which can only flow by capillarity action. Thus, the need for continuous fine channels in the soil. That is the main reason why we need a very firm seedbed, not loose soil. But if there is no water, then forage seeds will not germinate!

You need to control competition from weeds for grasses even more than with alfalfa. There are large differences in vigor between species. Timothy seedlings establish faster than some of the larger seeded wheatgrasses and wild ryes. However, the larger seeds generally can be seeded deeper. Seeds should not be broadcast, as shallow drilling will provide better soil to seed contact and less chance of relocation due to runoff, or seed being eaten by rodents or birds. Packing after seeding, especially if the soil is loose, can help a lot. Look for the windows of wet weather for timing of seeding. Water moves upward in frozen soils because it is colder at the surface, so moisture content near the surface is higher after winter than before and this might help with seed germination. Seeding grass into dry soil is not recommended unless you know that rain is forecasted soon after. This is why more research is required for persistent forage varieties.



One of the risks with dormant seeding is that germination often takes place in April, which is usually a very dry month for precipitation in our climate. Seeds germinate using snow melt, but then many seedlings will dry out before we start getting significant rains in June. In the spring, the early runoff moisture is the key, but it is often unpredictable and insufficient, and there is a fair bit of risk involved.



There is no point in seeding when it is dry and hot unless you can guarantee rain. If you seed in late fall, you are gambling that there will be enough winter snow plus spring rains for establishment. If you wait until spring, you should know if the snow melt will provide good soil moisture. But you may have to wait until the surface is dry enough to carry your seeding equipment, by which time surface moisture will be lost. When conditions are dry, forage establishment is a gamble at any time, but seeding in late fall just before the snow flies might be the best bet. Check the long-range forecast, for expected rain and snow over winter, before late fall seeding. If the expectation is dry, then it is best to wait. Also, if you get a light cover of weeds or purposefully planted cover crop species, they will help shade any seedlings from the intense sun as well despite using water the forage seedlings need. They usually provide more benefits, than detriments to have other species growing. Shade may be more valuable than limited water, as well as they provide nutrients and food for microbes for carbon, water and nutrient cycling.

One issue sometimes seen with late fall seeding is the freeze-thaw cycles over the winter. Grass seeds with a hard seed coat work well to late fall seed, others not so much. These included needle and thread, green needle grass, and western porcupine grass. It is recommended to increase water availability the year before seeding by leaving stubble higher to capture snow and limiting competition for seedlings by implementing weed control. The precipitation patterns are changing with moisture coming in a more concentrated manner in June and July with little during rest of growing season. It is extremely important to use certified seed so you are guaranteed viable seed without contaminants. If seeding in spring, seed early to take advantage of spring moisture, or seed before a rainstorm. Early fall seeding may work if you get moisture in the fall; seedlings should have adequate root reserves going into winter. For grass, they should be at 4-6 leaf stage before a killing frost. Anymore and you risk fungal diseases if you get snow cover. Dormant seeding in the early winter will work for species with a hard seed coat like Alfalfa, Cicer and wheatgrasses. Seed must be placed after soil temperatures drop below 0 degrees Celsius.

When to seed forages is always a tough question. Small seeded forages have to be seeded shallow, so rain is necessary to get them going. In much of Northeastern Alberta, a lot of the precipitation falls between mid-May and mid-July. April and August/September have less rainfall, so spring seedings in May or June are usually the least risky. Whether this rainfall pattern will change in the future, one does not know.

# Pasture Rejuvenation During Periods of Dry Conditions

Successful rejuvenation of pastures and hay stands depends on rainfall. If it doesn't rain, forage rejuvenation won't work. Producers need to decide why they need to rejuvenate and to what extent they need to renovate the pasture. Various options are available.

Breaking and reseeding of hay lands and pasture is the traditional method of rejuvenation. However, it is very costly and often requires special seeding and land breaking equipment. If breaking and reseeding is the chosen rejuvenation method, annual cropping for a year or two before reseeding a perennial forage crop will result in better establishment of the forage stand. The cropping system tends to reduce the viability of forage and weed seeds in the soil. Alternatively, perennial forage can be directly seeded or sod seeded into old forage stands. Treatment with glyphosate to suppress the existing stand before seeding allows new forage seedlings to establish. Seeding directly into untreated sod produces mixed results.

Fertilizing is another method of pasture and hay land rejuvenation, but can be costly in today's fertilizer market. Many pastures and hay lands are considered "sod bound" which means that Kentucky Bluegrass is the dominant low-producing species in the stand. Research has found most "sod-bound" pastures could be brought back to a productive state by deferring grazing until late fall. The existing smooth brome and alfalfa plants have the opportunity to grow all summer, set seed and these seeds in time revitalize the forage stand.

Dormant seeding can be done to capitalize on spring moisture. Some success has been had with dormant seeding orchard grass in the late fall and early spring, usually in combination with alfalfa under moist conditions. The orchard grass was aggressive in establishment and if allowed to go to seed and by having a grazing strategy that allowed the seed to mature and drop, they were able to increase the number of plants in the forage stand.

Brush regrowth and encroachment of weeds such as Canada Thistle can be a major obstacle to good pasture and hay land production. Cattle will graze the emerging aspen or shrubs suckers in the spring when the regrowth had been mowed or treated with herbicides the previous year. These areas should not be grazed a second time that year to allow the grasses and shrubs to regrow. The area needs to be heavily grazed in June and early July to 60-70% use of the forage and woody suckers at high stocking rates for a short duration of a few days. Aspen suckers are most nutritious and palatable in early spring but by August and September, the woody stems become too hard for the cattle to consume. In following years this grazing technique can be repeated to eventually control the brush regrowth.

Studies have shown that Canada Thistle can be controlled using high-intensity low-frequency rotational grazing for two to three years. Cattle graze the young thistle shoots as part of the forage supply keeping the thistles at the early growth stage where the rosettes were most palatable and nutritious. The use of Grazon or Lontrel herbicides also reduces the presence of Canada Thistle when sprayed at the bud or early flower stage. When pastures were rotationally grazed, and herbicide plus fertilizer was used to increase forage production, producers were able to control Canada Thistle. It is not recommended that this intensive heavy grazing treatment be applied at the same time each year because it will reduce the forage production resulting in more weeds.



# Grazing Management during Dry Conditions

There will always be periods of extremely dry conditions, we just don't know when. Thus, a drought management strategy must be part of all grazing plans. What happened in the past with previous grazings will greatly affect how a perennial pasture will act during extreme heat and dry conditions. Under moderate grazing, plants will develop deep roots, while heavy grazing develops shallow roots. The more roots you have, the more moisture that can be collected, and the more forage will be produced.

The amount of plant litter left on the soil is critical in holding moisture in the soil and maintaining a proper soil temperature by reducing evaporation during hot weather. If pasture litter is not maintained, then the plants become more dependent on the frequency of rain during the growing season, forage yields will become less predictable and carrying capacity will be reduced. The key point is perennial pastures are there to provide stable forage production from year to year and without it, cattle grazing numbers are in jeopardy.

Managed grazing, instead of letting the cattle graze the whole pasture, will help during a drought. It is essential to provide the longest rest period possible for the plants to recover after the initial grazing. When cattle graze the whole pasture during extreme weather patterns, they will consume most of the plant's leaves which reduces the plant's ability to collect sunlight, resulting in fewer plant root reserves. All plants need a rest period to provide adequate regrowth. Plants should be at the three-leaf stage or more before being re-grazed.

The main management decision during a drought is how to provide sufficient forage for the grazing animals. Stocking rates can be reduced by removing cull and older animals from the pasture, or by early weaning the calves. Growing an annual cereal pasture, such as oats, if moisture is adequate can provide ample grazing for the herd but if it doesn't rain then the annual pasture will not grow. It is best to abuse your annual pastures and protect your perennial forage stands.

The Beef Cattle Research Council has very detailed information on how to manage dry conditions on your grazing lands. They stress having adequate litter residues to protect your forages. Consider combining different groups of grazing animals to encourage the grazing of less desirable plants through higher stock densities. Graze pastures with species that can handle dry conditions and increased grazing pressures. It is important to provide extended rest periods for pastures when possible. Consider using one paddock as a sacrifice pasture where cattle remain for a longer period than normal to provide other paddocks a longer rest period for plants to rejuvenate, or even survive extended heat and dry periods. The following year this sacrificed pasture should undergo a method of pasture rejuvenation, or be allowed to rest until the end of the grazing season before being utilized once again. It may be necessary to reduce grazing animal numbers to reduce stress perennial pastures will be productive in the years following extreme dry conditions. Contemplate providing creep feed for calves, and grazing salvaged crops can also help.

# Poisonous Plants in Silage, Hay or on Pasture

There are many plants that are poisonous to animals. These plants can cause photosensitivity, abortions, birth defects, contact irritants, or have mycotoxins present that reduce animal performance or cause a quick death.

When forage is plentiful, animals avoid these plants on pasture because they may taste bad, have physical barriers such as barbs to discourage consumption, or are in areas where cattle typically do not graze. But when desired forage on pasture is limited due to dry conditions or extreme heat, grazing cattle become desperate for dry matter and are more willing to consume poisonous plants. With dry conditions, feed carry over may be limited, and hay is often made in ditches, edges of dry sloughs and from areas that are not accessible in wetter years. These areas may contain poisonous plants (weeds) that could be present in silage or hay that was made. Some of these plants are still poisonous in hay or silage.

Some of the most common plants that cause problems are:

Seaside Arrowgrass and Marsh Arrowgrass are found in salt marshes and saline soil around sloughs. These plants contain hydrogen cyanide (triglochinin) in the stems and leaves which causes poisoning. Death is caused by respiratory failure. Consumption of 7.7 pounds of fresh arrowgrass can kill an 1100 pound animal within 30 to 60 minutes. Hydrogen cyanide does not dissipate with time and maintains its' toxicity in stored hay or silage.

**Saskatoon and Chokecherry** plants are also cyanide-generating plants. The buds, leaves, flowers and twigs are poisonous on both plants; however, the cyanide potential is much greater in Chokecherry than in Saskatoon. The leaves on Saskatoon plants are quite palatable to cattle. For Saskatoon, 6.6 pounds of fresh leaves or 2.6 pounds of fresh twigs can kill an 1100 lb animal. Chokecherry is somewhat unpalatable but may be browsed when palatable forage is scarce. At the bud stage, 3.3 pounds of chokecherry leaves can kill an 1100 lb animal.



**Death Camas** is a plant that starts growing early in the spring. It can grow throughout the pasture, especially in draws and depressions. All parts of the plant are poisonous. The highest concentrations of steroid alkaloids (Zygacine) occur in the vegetative to bud stage. Ingestion of 0.2 kg of fresh material can kill a 50 kg sheep. Death is caused by cardiovascular failure. The toxins persist in cut hay.



**Water Hemlock** is considered the most poisonous plant found in low areas. The highest concentration of the toxin (Cicutoxin) is contained in the root and lower parts of the stem. The brown liquid found throughout the plant is also poisonous. When the plant is consumed, the root is often pulled out of the wet soil and is ingested. The cicutoxin acts on the central nervous system, causing convulsions, heart failure and death. Death can occur within 30 minutes of consumption. The toxin can also kill humans. Do not attempt to remove these plants without full protective equipment. Even when the plant is fully mature, the toxins remain in the plant and are a problem in hay.



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There are three types of **Larkspurs** that are a concern. Tall larkspur, Low larkspur and Plains Larkspur. Tall larkspur is found at higher elevations and the other two larkspurs in lower elevations. These plants start to grow early the growing season, mainly in areas where there is good moisture. There are many different alkaloids produced in the plant which cause muscular paralysis which leads to respiratory failure, bloat and often death. The concentration of alkaloids doesn't decline with maturity and may even increase in the flowers and pods. The alkaloids are present in mature plants that may be in hay or silage.



**Vetches** are plants that cattle like to eat. If it is in hay or silage, cattle can selectively eat these first. **Milk Vetch is safe for animals to consume at any stage of growth.** **Mature Hairy Vetch** with developed seed are toxic. The seeds contain miserotxin, or 3-nitropropionic acid (a glycoside) depending on species. Toxicity is caused by lung problems and inability to breathe which slows metabolism. Nitrate/ nitrite toxicity can also occur.

**Leafy Spurge** is a contact irritant. They do not create metabolic problems but rather the toxin (phorbol esters) that creates skin rashes, gastric inflammation and severe irritation that does not rely on sunlight for activation (not photosensitivity). One example; is a rash that forms around the mouth when spurge is consumed. At the same time, the ingested spurge causes irritation and inflammation in the mouth, and digestive tract. The esters remain in the plant even if it is mature and remains in hay or silage.



**Tall Buttercup** is also a contact irritant. A glycoside (ranunculin) and an enzyme produce an irritant oil when ingested plant material is digested and cell contents are released in the rumen. When activated, the combination causes irritation of the digestive system, abdominal pain and diarrhea. Fortunately, during harvest either for hay or silage the cellular tissue is damaged releasing the enzyme that combines with the glycoside resulting in most of the ranunculin to be released and is generally not a problem in stored feed.



**Kochia** is a weed that is often used for winter forage. It is a plant that can accumulate nitrate and cause nitrate poisoning. The secondary problem with kochia is that there can be high amounts of oxalates present. Oxalates bind calcium that is in the ration. This causes a calcium : phosphorus imbalance which reduces metabolic efficiency. If feeding kochia, limit the inclusion to 20 – 25% of the total dry matter intake to reduce the risk. Also, increase the amount of calcium in the ration to offset the tie up by the oxalates.

There are many more environmental conditions that cause animals distress or cause death. High nitrates in annual cereal crops caused by hail or a light frost can become toxic. Excessive sulfur consumption can cause polio. This is a cumulative effect of both sulfur in the feed and in water. This illustrates that toxins can be present in many forms not only in weeds.



Some of the information in this document was found in the publication authored by Majak, Brooke, and Ogivie. It is worth the time to review.

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# Making Hay in Extreme Heat and Dry Conditions

Extreme heat and dry conditions can make haying a challenge. There are several factors to consider before the hay is cut until after it is baled and in the field.

First, do the economics make sense to be cutting the hay at all? If yield is low, it might not pay to cut the hay at all by the time fuel and equipment costs are factored in. Buying hay might be a better option but this will depend on the price and availability of hay for sale. Instead, lightly grazing the hay crop might be a better economic option, especially if pasture has run out it is necessary to provide hay.

During periods of extreme heat and drought timing of cutting is important to consider. If the forecast looks dry and hay is in bloom or heading, then it is not worth it to wait for rain to increase yields. Once alfalfa is past 25% bloom, alfalfa yields will not increase with rain and quality will be negatively affected. As the plants reach maturity, crude protein and energy levels will begin to decline. To maximize quality, hay should be cut when alfalfa is at 10% bloom.

While it might be tempting to cut hay low to the ground to maximize yield, this can lead to big issues down the road during extreme heat and dry conditions. Leaving a stubble height of 4 inches above the ground will give the plant a chance to survive and regrow. Carbohydrates are stored in the bottom 3-4 inches of the plant depending on the species and cutting too low will leave no energy reserves for the plant. Leaving a proper stubble height encourages good rooting depth, and ample leaf area so plants can access lower water tables and ample sunshine. Furthermore, soil moisture can be conserved by providing some ground cover through proper stubble heights, which is important during dry conditions and extreme heat.

When it is hot and dry, surface moisture is removed quickly, but hay might not be cured. It is important to make sure hay is cured before baling to prevent spoilage. Even in hot weather, moisture can be difficult to remove from stems. Hay is not cured and ready to bale until moisture is removed from the stems and they have become brittle. While moisture probes are popular to use to see if hay is dry, they only measure surface moisture. Therefore, it is best to use the microwave moisture test or the “twist test” on a few stems of the plants.

During extreme heat and dry conditions, leaves and stems can be very brittle, leaving fines behind the baler. These parts of legumes are the highest quality components of the plants. If leaf loss is significant and there are high amounts of legumes in the stand, then baling from midnight to 8 AM can reduce leaf loss.

After baling, leave bales in the field until bale temperatures have moderated and the sweat is complete. Stacking hay in hot conditions reduces airflow between the bales, trapping heat and making it possible for bales to heat. If bales reach an internal temperature of 40 degrees Celsius, damage will occur to the proteins, making them unavailable to animals. If bales reach an internal temperature of 70 degrees Celsius, spontaneous combustion is possible.

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# Forage Quality and Nitrates



Survival is the long-term objective of plants; therefore plants strive to produce a viable seed head so the species will have new seedlings. While in normal years plants will follow a balanced pattern for development and quality, extremely dry conditions produce different results. During dry conditions, the plant will mature much more quickly with the goal of producing some sort of viable seeds before it runs out of resources. This results in decreased yields, increased fibre and protein decreasing at faster rates than normal. Once a plant has headed out, nutrient resources are put into developing a viable seed rather than the leaves or roots.

During dry conditions, it is important to harvest forages based on maturity, rather than calendar date. Quality of annual and perennial grass species declines rapidly because, under dry conditions, maturity can occur 2 to 3 weeks sooner than normal. With this, protein and total digestible nutrient (TDN) content will drop 1 to 1.5% and 3 to 4%, respectively every week.

Timing is critical when making silage or greenfeed when plants are stressed from extreme heat or dry conditions. It is better to cut earlier rather than wait for several reasons. First, there is generally no yield increase because the bottom leaves dry and drop from the plant. Therefore, the weight gained by the seed head is offset by leaf losses. Second, once plants mature, fibre levels increase rapidly. If neutral detergent fibre (NDF) levels exceed 60% of the total ration, digestibility is decreased, and animals cannot consume as much. Third, during dry conditions, maturity can increase the amount of stem contributing to the ration. Cows may increase sorting behaviour, with feed being picked through to find the grain and stems being left behind. If grain is over-consumed, this can result in lead to acidosis, grain overload or bloat.

For silage, it is especially important to watch maturity to ensure the fermentation process can occur properly. Sugars are needed to drive fermentation, and sugar content decreases as the plant matures. Moisture content also decreases with maturity. Enough moisture is needed to ensure the pit is packed well so the anaerobic fermentation process can occur. If not, this can result in heated or mouldy silage.

Nitrates can be present during periods of dry conditions. Nitrates buildup can occur because drought slows plant metabolism which slows or prevent nitrate from being converted to amino acids and proteins within the plant. Nitrate levels can be maintained indefinitely in the plant. Many different plants are susceptible to nitrate accumulation. Crops commonly known to accumulate nitrates include cereals grains, corn, millet, sorghum, radishes, and turnips. Weeds such as Canada thistle, dock, kochia, lamb's quarters and pigweed can also accumulate nitrates.



While rain can end nitrate issues, it is recommended to wait at least 3 days after a significant drought-ending rain event to cut the forages. If plants still look stressed after the rain event they are likely still carrying a high nitrate load.

Nitrates will still be an issue in forage harvested for hay or greenfeed as drying does not decrease nitrates. These feeds can be fed if diluted to safe levels with low nitrate forages. If silage is done right, the ensiling process can decrease nitrates in the forage by 40 to 60%. Nitrate content will not decrease to the same extent in poorly made silage. Nitrates can also be a risk for cattle grazing hay, crop or stubble fields. It is important to test nitrates in all feeds if high nitrates are suspected. Be sure to watch what unit nitrates are reported on your feed test, as they can be reported differently from lab to lab. See the table below for feeding recommendations based on levels of nitrates in the diet.

Because feed quality can be so variable during periods of extreme heat and dry conditions, feed tests should be done to determine the actual protein, energy, fibre, mineral and nitrate content of feeds. The colour of greenfeed and hay is not a reliable indicator of quality.

<b><i>NO<sub>3</sub> (dry matter)</i></b>	<b><i>NO<sub>3</sub>-N (dry matter)</i></b>	<b><i>KNO<sub>3</sub> (dry matter)</i></b>	<b><i>Feeding Recommendations</i></b>
< 5,000 ppm (0.5%)	< 1,200 ppm (0.12%)	< 8,100 ppm (0.81%)	Generally Considered Safe for Livestock
> 5,000 ppm (0.5%) but < 10,000 ppm (1%) ppm	> 1,200 ppm (0.12 %) but < 2,300 ppm (0.23%)	> 8,100 ppm (0.81%) but < 16,000 ppm (1.62%)	Caution: Problems can occur at this level (particularly in pregnant animals)
>10,000ppm (1%)	> 2,300 ppm	>16,200ppm (1.62%)	Do not feed

# LIVESTOCK

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## Herd Retention Decisions

Profitability is the goal of any enterprise. For commercial cow/calf operations, profitability is often the key determining factor in deciding to either expand or liquidate the herd. The two main factors involved in the profitability of a cow/calf operation are feed costs and calf prices. The cost of feed will typically run 65 to 70 percent of total production costs. Calf prices, of course, determine the extent that all production costs are covered including feed costs.

Extreme dry conditions have a huge impact on feed costs. Not only does it reduce yields of forage crops and increase forage prices but dry conditions also reduced pasture availability. Consequently, many producers are faced with increased feeding periods as pastures run out earlier than normal.

Many management decisions are based on break-even prices. Using a 100-head cow herd as an example, the break-even hay cost in 2021 would have been around 7 cents/lb. with 6/7 weight steers averaging \$1.95/lb. and 5/6 weight heifers averaging 1.82/lb. last fall. Using a price of 9 cents/lb. for hay the break-evens for steers last fall would have been around \$2.08/lb. and \$1.98/lb. for heifers. 9 cents/lb. would be a conservative price for forage in 2021 given that there were numerous reports of much higher prices with higher break-even calf prices needed. Homegrown feed costs may seem to result in lower break-evens needed for the cow/calf enterprise but they come at an opportunity cost. The opportunity cost is the foregone revenue from not selling the forage in the feed market. The reduced profitability in the forage enterprise is used to bolster the profitability of the cow/calf enterprise.

Economies of scale will play into herd retention decisions. Larger herds will typically have lower fixed costs per head with a resulting lower break-even calf price required. The opposite is true for smaller operations. This would explain the consolidation in the cow/calf industry. It is much easier to liquidate a small herd than a larger one.

Other factors included in herd retention or dispersal decisions include the age of the operator, increased costs for replacing depreciated facilities and equipment as well as the value of the genetics in the cow herd. A purebred herd will likely have a different market value for its production and as a result, a different break-even structure on the input side.

# Using Alternate Feeds in Dry Conditions

When forage availability is limited, there are many options available to supplement grazing cattle on dry pastures. Supplementing with non-traditional or alternate feeds benefits the animals by providing nutrients. But, there are limitations with each feed.

A couple questions need to be asked before using alternate feeds on pasture. First, how much forage is available? Second, if grazing continues on the perennial pasture, will it be damaged? There comes a point when additional grazing will negatively impact next years' potential growth.

When developing a program that includes alternate feeds; continuity of supply is important. Will there be sufficient amounts available on a regular basis to meet herd requirements? Changing from one feed to another can lead to digestive problems and animals not performing as well as they could. Will the quality be relatively consistent from load to load? Consider price. Is this an economic alternative compared to buying other products, hay, silage, or grain?

Some of the alternate feeds that can be considered:



**Cull Potatoes:** These can either be damaged in storage or during processing. Potatoes have approximately the same energy density as barley grain at 83% on a dry matter basis. Protein is approximately 8 to 9% lower than barley. Fresh potatoes contain 75 to 80% moisture. They can be fed whole or ensiled. The advantage of ensiling potatoes is that they soften during fermentation and the choking risk is reduced. If ensiling, locate the bag on a gentle slope. Once filled, cut a small hole in a corner of the bag at the bottom of the hill to allow the fluid to drain out during fermentation. Seal the hole once the water stops running out.

**Industrial Potatoes:** This is product that is rejected from french fry production and can be used for feed. The shelf life is shorter than for whole potatoes. Fries that have been cooked in oil and then rejected will have a higher energy density than raw potatoes. Fried potatoes will go rancid especially in warm conditions.

**Cookies, Cake, Bread, and Confection Items:** These types of products have a high energy content due to the sugar and wheat flour. The digestion rate is rapid because of the finely ground wheat. Feed this product mid afternoon. Cows typically consume the biggest meal of the day in the morning. They have a smaller meal in the afternoon and this reduces the risk of acidosis, grain overload, and bloat.

**Grocery Store Produce:** Vegetables that are past their best before date or are not suitable for sale can be fed to cattle. They are nutritious and cattle are more than willing to eat anything from asparagus to zucchini. If the produce is mouldy, it should not be fed.

**Barley Malt Sprouts:** Barley grain is germinated at the malt plant. The sprouts are then removed and used as a by-product. The grains are sent to a brewery. Sprouts contain approximately 22% protein, 76% TDN, and 0.6% phosphorus. A good product to feed to increase protein and energy in the ration which improves feed intake and digestive efficiency. Monitor the calcium : phosphorus ratio. A higher calcium mineral (3:1 or 4:1) is recommended.

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**Brewery Spent Grains:** After the grains are used for making beer, the spent grains remain a saleable by-product. Mainline breweries along with local micro-breweries have this product available. Average analysis has protein at 28%, energy at 66%, phosphorus at 0.68%, and sulphur at 0.85%. Adjustments to the mineral package are required due to the high phosphorus content. A higher calcium mineral (3:1 or 4:1) is recommended. Sulphur levels are very high. Feeding should be limited to approximately 4 pounds per head per day depending on what else is provided in the ration.

**Grain Screenings or Screening Pellets:** Quality of this product is variable. It depends on what is available at the elevator or feed mill at the time of pelleting or sale. If purchasing the screenings in a pellet, minerals, trace minerals, and vitamins can be included in the mix to provide a balanced supplement on pasture. Grain screenings obtained from seed cleaning plants or specialty cleaning facilities generally produce a product that is more consistent than those from a grain elevator. For example; if peas are being cleaned, it is possible to obtain a pea screening rather than a mixed screening.

**Wheat Mids:** A by-product of the wheat flour milling industry. The mids contain bran wheat shorts, germ, and screenings. This type of product has a protein content of 15 to 18% and a TDN of 81 to 83%. Phosphorus can be as high as 1%. A higher calcium-type mineral (3:1 or 4:1) should be fed to maintain an overall 2: 1 calcium to phosphorus ratio.

**Wheat Shorts:** A by-product that is made from bran and germ obtained from flour milling. The shorts contain a protein content of 14%, phosphorus 0.45%, and TDN of 70%. With the high phosphorus content, a higher calcium-type mineral (3:1 or 4:1) should be fed. Bloat or grain overload are problems to watch for.

**Wet Distillers' Grains:** Can contain up to 85% moisture and are not considered to be a useable product unless the pasture is within 10 km of the plant. This product contains between 35% and 42% protein depending on whether the product is made from corn (lower protein) or wheat (higher protein). Sulphur content can be up to 0.8% and phosphorus up to 1%. Keep total sulphur content below 0.4% in the final ration. Use a higher calcium type mineral (3:1 or 4:1) to prevent a narrow calcium: phosphorus ratio. The product can ferment in warm conditions and consumption will drop.

**Dry distillers' grains with solubles** are the same type of product as wet distillers' grains. The difference is that the moisture has been evaporated. Quality is similar to the wet product.

When using by-products, all feed ingredients should be sampled and analyzed to develop a balanced ration before implementing in cattle rations. Estimate the amount of grazing that remains and calculate the amount of by-product that is required.



# Advantages and Disadvantages of Grazing Stubble Fields



With forages in short supply and high-priced during times of extreme heat and dry conditions, winter feeding costs can be reduced by adding a home-grown feed source that extends the grazing season.

Grazing stubble fields is a feed resource that works well for dry pregnant cows. The quality of the stubble can be variable. Quality will be dependent on the amount of grain and weed seeds that are thrown over by the combine, amount of stubble re-growth since harvest, and type of crop that was harvested. Feed testing is recommended for all feeds prior to turning cows in to graze.

Wheat, rye, and triticale straw typically have the lowest protein at 4% and energy at 40% TDN. Barley straw is slightly higher quality with 4 to 5 % protein and 42 to 45% TDN, and oats typically are better quality with 4.5 to 5.5% protein and 44 to 47% TDN. Pea straw is usually 2 to 3% higher in protein than the cereal straws, but has the same energy content as barley or oat straw. Another advantage with pea straw is the high calcium content. Cattle will eat canola aftermath and it is suitable to use; however, it is not typically used because the material is pulverized by the combine and is more difficult for the cattle to consume. The only down side with canola straw is the possibility of a high sulfur content which can cause polio.

Aftermath from forage seed crops is often baled off to prevent problems with crop emergence the following spring. It is another feed resource that should not be overlooked. Quality is variable which is no different than the annual crops. Protein content can be as high as 8% with TDN in the low 50% range. Better than cereal straws but not as good as an average quality alfalfa grass hay. There is a risk of endophytes being present in some varieties of tall fescue aftermath. Fescue toxicosis can occur.

If a corn crop has been harvested for grain, 40 to 50% of the plant material (stover) is left behind. It has a higher quality than cereal straws. If the crop was damaged by wind and whole cobs are left in the field, cattle will travel the field, find them and eat them first. Concerns with grain overload or acidosis exist.

Low calcium and magnesium content in many of the straws and aftermaths require a 3:1 or 4:1 mineral supplementation (similar to a feedlot mineral). The 2:1 mineral, in many cases, does not supply sufficient amounts of calcium. It is difficult to have cattle consume a high calcium and magnesium mineral. Calcium is flat tasting and dries out the mouth, and magnesium is bitter which reduces free choice intake.

A pregnant cow in mid pregnancy requires 55% TDN and 7% protein. Many cows are in late pregnancy by the time harvest is complete and they require 9% protein and 60% TDN. If protein is not adequate, feed intake is reduced because it takes longer for the feed to be digested and pass through the digestive system. A lack of energy results in the cow mobilizing fat to meet energy demands. A cow that has lost weight and is thin prior to winter, will have maintenance energy requirements and thus more feed is required to keep the cow warm. There is also an impact on the growth and long-term health of the fetus.

Low quality residual feeds limit grazing to pregnant dry cows. Supplemental hay, silage, or grain can be provided every three to four days. Mineral supplementation should be mixed into silage to improve uniform intake. Supplementing extra energy and protein can be done in a number of different ways. When comparing options, three things must be considered:

- Is it cost effective?
- Does the supplement meet the nutritional requirements of the animals?
- Is it convenient?

Evaluate the structure of the manure to evaluate what the ration is providing. With adequate protein, the manure pats are fairly flat. When protein is low, the manure becomes more rigid and firm. The shape becomes similar to onion rings or a pyramid. This indicates that the feeds are not digested properly and adjustments to the feeding program are required.

Consult with a nutritionist to develop a feeding program that meets animal requirements. Using different types of aftermaths is possible but everything should be balanced. Minerals, trace minerals and vitamins cannot be ignored. These nutrients are important.



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# Bale Grazing Has Benefits and Challenges

Bale grazing is a management practice that can improve long-term sustainability and profitability of an operation. Lower equipment usage, reduced fuel consumption, along with improved soil fertility are three advantages. Placing bales of feed in a location for winter feeding requires planning. There are many factors to consider before adopting this feeding system.

The first consideration is choosing a location for bale grazing. Moving feed into an area imports nutrients. An area with lower soil fertility due to soil type or prior erosion should be considered. Can portable wind fences be set up to provide protection from the wind? Cows can eat soft snow for water. However, if the snow becomes hard, a water source should be within one quarter to a half mile from the feeding area. The spring melt and associated runoff should stay within the field to retain nutrients.

Research at Lakeland Agricultural Research Association (LARA) found over a four-year average for wastage is just under 16% for end-placed bales. This level of waste was deemed acceptable by the farmer when ease of management and pasture improvement are considered. Research at Alberta Agriculture has found that there was 19% waste for bales processed on snow and about 12% for bales unrolled on the snow. Using a portable electric fence is necessary to keep forage losses to a minimum. Cows need to be trained to recognize what an electric fence is. Prior to turnout, expose the cows to a short stub fence in a pasture or pen. They are inquisitive animals and will come up to the wire and learn to respect the electric fence.

When placing the bales, use a grid pattern. Set the bales with the twine side on the ground on forty-foot centres. This results in a good distribution of manure and urine while the bales are consumed. Set row length to provide enough feed for three to four days of feeding. The timeline is a guideline. In colder weather, feed is consumed at a faster rate than in warmer weather. The frequency of moves may be shorter or longer due to temperature fluctuation.

Research from the University of Saskatchewan has shown benefits of increased forage production. Yields increased from 2,200 pounds of dry matter (DM) to 5,500 pounds per acre the year after bale grazing. This increase can be attributed to a number of factors. The increase in surface trash from feed that was not consumed provided insulation between the soil surface and the environment. This resulted in a lower soil temperature. It also protected the soil from the wind and evaporation was reduced. All of which has benefits during periods of extreme heat and dry conditions. Manure and urine deposited in the area increased soil fertility. Nitrogen retention was 40% higher from bale grazing compared to manure that was hauled out of winter feeding pens.

Bale grazing is a feeding system that works. Yardage costs can be reduced by \$0.40 to \$0.50 (or more) per head per day. Soil fertility improves which reduces the amount of fertilizer that needs to be applied. Another cost reduction is that manure and bedding do not accumulate in wintering pens that will need to be hauled out and spread in other locations.

## There are some factors to consider with bale grazing:

**Grounding the Energizer:** Frozen ground is not a good conductor of electricity. Place the ground rods prior to freeze up. Pour water around the rods to improve soil-to-rod contact.

**Thickness of Thatch:** Feed that is not consumed creates a mat of material on top of the soil. If it is too thick, it will prevent emergence of forages the following spring. It may require a pass with a harrow to break up the material so that plants can emerge.

**Thin Cows:** If the herd is fed as one group, animals that do not compete well will become thin. Remove these animals and feed them separately to prevent further weight loss. Old cows and first calf heifers are more prone to being pushed away from the feed.

**Extreme Cold Weather:** Cows are able to stay warm in temperatures down to -20o C. Depending on the quality of the feed supply, it may be necessary to provide extra grain to the animals.

**Mineral Consumption:** Cows tend to congregate close to the mineral feeding station. This can concentrate manure and urine in these areas. Move the station regularly to prevent this problem. Monitor intake. Salt and mineral should be mixed together to improve mineral intake.

**Nitrate Accumulation:** If the same land is used year after year for bale grazing, nutrients can accumulate. Nitrates can become a concern for the forages that grow in the area. Have the soil and feed analyzed to determine nutrient levels.

Bale grazing is a sound management practice but it takes time to become proficient. Talk to other producers that are experienced bale grazers and learn from their experiences. There are numerous websites and publications available for additional information.





## Cow Condition Impacts Reproductive Performance and Herd Health

The ability of a cow to become pregnant is dependent on many factors. One that is often overlooked but is very important is cow condition. When we discuss cow condition, it refers to the amount of fat or energy reserves that a cow has. A cow with more fat is able to produce more milk, more likely to start cycling earlier in the breeding season, and has a higher first-service conception rate than a thin animal.

Body condition scoring is a subjective “hands-on” method of determining the amount of fat a cow is carrying over the short ribs (loin area), upper spine, hooks and pins, and either side of the tail head.

To condition score an animal, using the thumb, pressure is applied to the short ribs on the right-hand side of the animal (when viewing from the rear). The rumen is situated on the left side of the animal and if this area was used, a false evaluation would result. The other structures are not impacted by the rumen and can be evaluated on both sides of the animal.

Cow condition should be evaluated going into winter and again two to three months prior to calving. When administering vaccines or when the animals are in the chute, score 10% of the herd to get an overall estimate of cow condition. Looking at the animals may provide a visual appraisal, but with a long winter hair coat, it is difficult to be accurate.

Once the condition of the animals is determined, thin animals should be separated from the main herd and fed separately to improve their condition prior to calving. A higher grain ration is required for these animals to gain weight. Placing thin or older animals in with the growing replacement heifers or bred heifers is an option if pen space is limited.

Body condition impacts reproductive efficiency. A thin cow and cows that lose weight between calving and breeding season take longer to cycle. Research done by Bellows and Short, found that 34% of thin cows were not cycling 90 days post-calving. Cows in good body condition started cycling 60 days post-calving. Cows and heifers that cycle once prior to bull turnout have a 20 to 25% higher first-service conception rate.

Colostrum is critical to supply antibodies which provide passive immunity to the newborn calf. Colostrum starts to develop 4 to 6 weeks prior to calving. Cows that are thin do not produce the quality or quantity of colostrum compared to cows in good condition. Calves born to thin cows have more health issues the first two weeks of life, and also at 4 months of age.

In early pregnancy, the fertilized embryo implants into the uterine wall. The placenta develops, and is responsible for supplying nutrients to the developing calf. If the cow is thin, more nutrients are used by the cow and less is provided to develop the placenta. This reduces the size of the placenta and the ability to supply nutrients to the calf. Nutrient deficiencies in the first 30 days of pregnancy reduces blood vessel development in the placenta which reduces nutrient transport to the fetus. The overall impact is a calf is lighter at birth compared to its' genetic potential. The size of the organs are typically smaller. For example, the lungs and trachea are 40% lighter from calves born to thin cows compared to calves born to cows in good condition. This restricts movement of oxygen to the tissues which reduces growth rates. These calves are also more susceptible to cardiovascular and respiratory diseases. The ability to withstand stress is reduced. Mortality and morbidity also increase when they enter the feedlot.

Development of other organs and tissues are also limited. Nutrient deficiencies reduce the genetic potential of the calf. The optimum number of stem cells which develop into muscle, bone, connective tissue, fat, and cartilage are not developed. The function of the brain, heart, hormonal and digestive systems and all the organs are stunted. Overall growth and health of the calf is compromised. The finished weight of the animal can be 150 pounds lighter than its genetic potential.

Nutritional deficiencies occur over time. At first, the symptoms may not be noticeable but gradually they develop. As time passes things become progressively worse. Just as it takes time for problems to appear, it can take 4 to 6 weeks of proper supplementation to bring nutrient levels back to normal. It can take longer than this for the animal to fully recover. Feeding a balanced ration year round is necessary to maintain herd health, reproductive efficiency, and strong performance.



Body condition scoring is an easy, hands-on method to determine the amount of fat an animal is carrying without the use of specialized equipment. It provides reasonable accuracy in evaluating the nutritional status of cattle to determine if an animal is underweight, at an ideal weight, or overweight. Body condition scoring is based on feeling the amount of fat cover on a cow rather than visual appraisal since a full haircoat can hide a cow in poor condition.

In Canada, a numerical standardized system from 1 to 5 is used to describe body condition, with 1 being emaciated, 2.5-3 being ideal, and 5 being obese. The fat cover is measured at four major locations on cattle: backbone (spine or topline), short ribs, hip bones (hooks and pins) and tail head. An animal in optimum condition will have a thin layer of fat so it will take some pressure to feel the bones. In an underweight animal, bones will be prominent and sharp, while individual bones will not be felt in an obese animal.

To body condition score, first, run your hands over the backbone to check the condition of the vertebrae. Next assess the condition of short ribs on the right side of the animal by placing a hand over the short ribs with fingers pointing towards the vertebrae and using your thumb to push against the hide. Any padding felt by the thumb is fat, since there is no muscle between the end of the short ribs and the skin. Lastly, determine if there is fat cover, on the hooks, pins and tail head by pressing these areas with your fingertips. On the next page is a description of each score:

### **Condition Score 1 – Emaciated**

- All skeletal structures prominent and sharp to touch
- Minimal tissue cover over backbone, short ribs, hooks, and pins
- No fat around tail head

### **Condition Score 2 – Thin**

- Vertebrae along topline are prominent, but not sharp
- Individual short ribs can be felt but are not sharp
- Some tissue cover around tail head, over hips and flank

### **Condition Score 3 – Ideal**

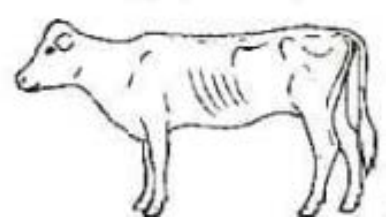
- Hooks and pins slightly visible
- Individual short ribs felt with firm pressure, feel rounded
- Backbone is no longer visible
- Each side of tail head well filled but not rounded

### **Condition Score 4 – Overweight**

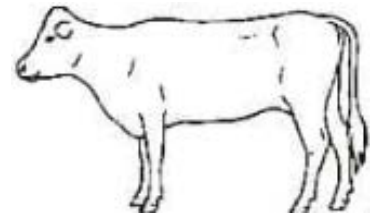
- Can't feel individual vertebrae or short ribs
- Fat cover around tail head evident with slight rounding
- Folds of fat developing over short ribs and thurl (area over pelvis)

### **Condition Score 5 – Obese**

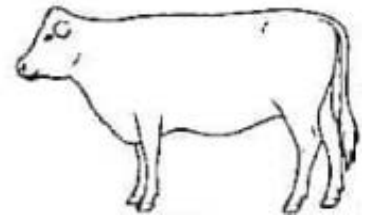
- Flat back, overall bone structure not noticeable
- Tail head and hips covered in fat, short ribs cannot be felt
- Folds of fat apparent over short ribs, thurl, and thighs
- Tail head to pin area buried in fat



**Body Condition Score 1**



**Body Condition Score 3**



**Body Condition Score 5**

Since body condition scoring is somewhat of a subjective measurement, the same person should body condition score all animals every time it is done.





Heat stress occurs when an animal's attempt to dissipate heat is unsuccessful or overwhelmed. This causes animal performance and health to suffer. Heat stress during the breeding season can also result in embryonic death, reduced semen quality and reduced conception. The best approach to dealing with heat stress in cattle is being proactive. Once an animal is in a severe state of heat stress, it might be too late to help without disastrous consequences.

Signs of heat stress include:

- Reduced feed intake
- Bunching near shade or water
- Shallow, rapid, open-mouthed breathing or panting
- Sweating and increased saliva production
- Trembling or lack of coordination



Having a management plan in place before periods of extreme heat occur can help avoid drops in animal performance, reduced conception rates or death losses.

The first step is to identify which animals in your herd will be most susceptible to heat stress. Feedlot animals at the finishing stage, very old animals, very young animals and animals with black hides are most prone to heat stress. These animals should have priority in your planning.

Next, develop an action plan. Make sure cattle have access to ample amounts of cool, clean, good-quality water nearby. Animals in heat stress need to drink water. Large water troughs are recommended during the summer, to supply animals with sufficient water supply. During periods of extreme heat and heat stress, water intake will increase dramatically. Two inches of linear trough space should be provided per animal to adequately allow low-pecking order animals sufficient space to drink. Also, ensure there is sufficient water pressure and flow capacity to keep the trough full.

Make sure cattle have access to shade areas. This will prevent temperature increases due to solar radiation, which is especially important in black cattle. If animals are confined, consider turning them out to an area with trees or shade before the heat of the day.

Control flies to minimize stress on animals. Biting flies cause animals to bunch up which decreases cooling.

Most importantly, do not work cattle during extreme temperatures. If cattle must be worked, do it early in the day. Avoid working cattle in the evenings after a hot day as they need this time to recover. Handle cattle in as short of time as possible, using calm handling techniques to minimize stress. Ensure animals have access to water if being held in pens.

There are additional ways to prevent heat stress for animals that are being housed in pens. To prevent heat stress in these animals, consider:

- Feed in the late afternoon or evening. This will ensure heat created during digestion is created in the cooler night temperatures rather than during the heat of the day.
- Air Movement helps promote cooling. Remove windbreaks or other objects hampering wind flow through pens if possible. Mounds in pens might also provide cattle access to more wind.
- Wet the ground. This can be done with a hose or sprinkler before the peak heat of the day to cool the ground.
- Add bedding for cattle to lay on. Bedding can also decrease ground temperature compared to black dirt.

Lastly, watch the weather forecasts and know when to intervene. Heat stress is driven by several factors including temperature and humidity. Use the forecasts to plan and be prepared. Use the Livestock Temperature Humidity Index (THI) chart on this page to be aware of animals are at risk for heat stress.

Cattle are a great risk for death from heat exposure when:

- The THI is 24 or greater for a 72 hour period
- The THI during a 48 hour period is no lower than 26 during the day and no lower than 24 during the night
- The daytime THI reaches 29 or higher for two consecutive days

Ambient air		Relative Humidity (%)					
Temp. °F	Temp. °C	20	30	40	50	60	70
100	37.8	26	29	30	31	33	34
98	36.7	26	28	29	31	32	33
96	35.6	26	27	28	30	31	32
94	34.4	26	27	28	29	31	32
92	33.3	25	26	27	28	29	30
90	32.2	25	26	26	27	28	29
88	31.1	24	24	26	27	27	28
86	30	23	24	25	26	27	27
84	28.9	22	23	24	25	26	27
82	27.8	22	23	23	24	25	26
80	26.7	21	22	23	23	24	24
78	25.6	20	21	22	23	23	24
76	24.4	19	21	21	22	22	23
Livestock Safety Index (°C)		Normal <23		Alert 24-25.5		Danger 26-28	
						Emergency >29	

**Livestock Temperature Humidity Index (THI) Chart**

The Code of Practice for the Care and Handling of Sheep. 2013. Appendix A

# TREE AND SHELTERBELT MANAGEMENT

**81** Trees in Extreme Conditions

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**83** Protecting The Roots

**84** Winterizing Trees

**85** Insect and Disease





## Trees in Extreme Conditions

The direct impact of drought on trees is characterized by reduced or absence of growth, serious health threat and causing injury or death. Drought also impacts trees indirectly, by increasing their susceptibility to wildfire, insect pests and disease. Severe droughts can cause widespread tree mortality across landscape with profound effects on the function of tree/forest ecosystems and overall environment.

Alberta native plant communities (grass, shrubs and trees) are well adapted for dry summers and fall, as well as for a period of prolonged drought, but there will still be impacts of drought on trees that are devastating and long lasting. Trees that were already stressed by some other issue, like harsh winter/winterkill, poor soils, (road) salts, herbicides and mechanical damage, or insect infestation, are likely to decline even more following a drought.

There are many visible drought stress symptoms due to water deficiency. The effects are not always immediate and the full extent of the damage to the trees can take one to three years to become apparent.

In deciduous ( hardwood) trees, some of the most common recognizable drought symptoms are:

- Scorching ( margins/edge) of the leaves is browning
- Wilting, curling, bending, rolling and mottling of the leaves
- Lighter green to yellow-green foliage
- Leaves dropping/shedding or early autumn colour changes
- Chlorosis
- Smaller size leaves, stunted shoots
- Seed/cone production is increasing as tree is under the stress
- Cracks on bark of young trees

In coniferous trees, drought symptoms are recognizable by shoots drooping, browning, second year needle yellowing and they will often produce an abundance of cones the second year of a drought.

# Management Strategies to Protect Trees

Drought management strategies for shelterbelts and trees involve a variety of techniques to help these plants survive and thrive during periods of limited water availability. Some of these strategies include:

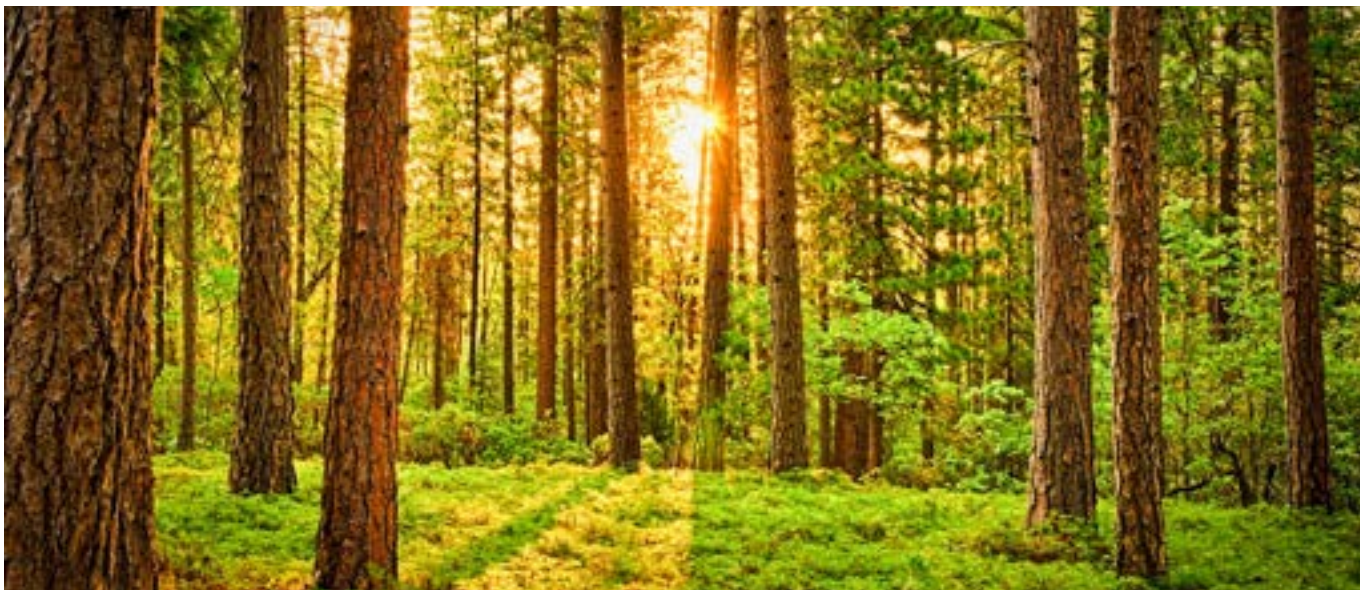
1. **Planting drought-resistant species:** Choosing tree and shrub species that are native to the region and are adapted to survive and thrive in dry conditions can help to ensure their survival during drought.
2. **Providing supplemental irrigation:** During periods of drought, trees and shrubs may need additional water to maintain their health. This can be done through irrigation systems or by hand watering.
3. **Mulching:** Adding a layer of mulch around the base of trees and shrubs can help to conserve moisture in the soil, which can be beneficial during drought conditions.
4. **Pruning:** Removing dead or damaged branches from trees and shrubs can help to reduce the plant's water needs, as these branches are no longer using water. Avoid cutting any live branch with leaves/needles.
5. **Protecting the roots:** During drought, it is important to protect the roots of trees and shrubs from damage. This can be done by avoiding activities that compact the soil around the roots, such as driving vehicles over them. Do not disturb soil by mechanical weed control as you may damage roots and expose soil to loose moisture. Avoid any mechanical damages such as cutting surface roots, damaging root collar or bark on trunk.
6. **Providing shade:** Trees and shrubs can benefit from shade during drought conditions, as it can help to reduce water loss through evaporation. Providing shade can be done by planting other trees or shrubs nearby, or by using shading devices such as fabric or mesh.

Overall, the key to effective drought management for shelterbelts and trees is to implement a combination of strategies that are tailored to the specific needs and conditions of the plants in question.



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# Protecting the Roots, The Most Important Part of the Tree



Protecting the roots of trees and shrubs during drought is an important aspect of drought management. The roots of these plants are responsible for absorbing water and nutrients from the soil, and if they are damaged, the plant's ability to survive drought conditions can be compromised.

One way to protect the roots of trees and shrubs during drought is to avoid activities that compact the soil around them. Compacted soil can make it more difficult for roots to absorb water and nutrients, and can also make the plant more vulnerable to damage from drought. Examples of activities that can cause soil compaction include driving vehicles over the roots, walking on the soil around the roots, or using heavy equipment near the roots.

Another way to protect the roots during drought is to keep the soil around the roots cool and moist. This can be done by applying a layer of mulch around the base of the tree or shrub, which can help to conserve moisture in the soil and keep the roots cool. It is also important to avoid over-watering the plant, as this can lead to waterlogged soil, which can be harmful to the roots.

Overall, protecting the roots of trees and shrubs during drought is crucial for maintaining the health and viability of these plants. By avoiding activities that compact the soil and keeping the soil around the roots cool and moist, it is possible to help these plants survive and thrive during extreme heat and dry conditions.



# Winterizing Trees After Extreme Heat and Dry Conditions



Winterizing trees after a drought is important to help them recover and survive the cold winter months. Some steps you can take to winterize your trees after a drought include watering them deeply, mulching around the base of the tree to conserve moisture, and protecting them from harsh winds. You can also wrap the trunk of the tree in burlap or other protective material to help insulate it. Additionally, it's important to avoid pruning your trees during the winter, as this can weaken them further. Instead, wait until the spring when the trees are more resilient.



Watering is an important part of winterizing your trees after a drought. To properly water your trees, you should soak the root system deeply, which means watering slowly and thoroughly until the soil is saturated. This helps to replenish the moisture in the soil and can help your trees recover from the effects of the drought. You can do this using a garden hose or a watering can, and you should do it early in the day so the water has time to soak in before the temperature drops at night. It's also a good idea to water your trees consistently, rather than just giving them a lot of water all at once. This will help to keep the soil moist and prevent the trees from drying out.



# Insects and Disease

It is a good idea to monitor your trees closely during periods of extreme weather, and to seek the help of a certified arborist if you notice any signs of stress or damage. They can help you to determine the best course of action to protect your trees and keep them healthy.

During times of extreme heat and dry conditions, trees can become stressed and more susceptible to insect and disease infestations. Some common insects that may become a problem during these conditions include:

- bark beetles, which feed on the inner bark of trees and can cause them to die
- aphids, which can weaken trees by sucking sap from the leaves and stems
- webworms, which can defoliate trees and cause them to become more vulnerable to other pests and diseases.

In addition, drought-stressed trees are more likely to be attacked by other pests, such as borers and scale insects, which can further weaken and damage the trees.

Some common tree diseases that may occur during these conditions include:

- leaf scorch, which causes the leaves of the tree to turn yellow or brown and can eventually kill the tree
- powdery mildew, which appears as a white or gray powdery substance on the leaves and stems of the tree and can cause the leaves to yellow and fall off
- canker diseases, which cause sunken, dead areas on the bark of the tree and can eventually girdle and kill the tree.

In addition, trees are more likely to be infected by other diseases, such as root rot and fungal infections, which can further weaken and damage the trees. To protect your trees from insect and disease infestations, it's important to keep them well-watered and healthy, and to monitor them closely for signs of insect activity. If you notice any signs of insect damage, you should contact a certified arborist for help.



