CORN SILAGE & GRAZING GUIDE

PRIDE SEEDS

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PREPARATION

TOTAL RATION SOLUTIONS (TRS) SYSTEM

High palatability, high yield, easy ensiling, and high energy content are a few reasons corn silage and corn grazing acres have steadily increased in Western Canada over the last 10 years.

Incorporating corn as a feed source can drastically change how an operation manages its feed needs. Corn silage and corn grazing can allow for more feed production per acre on an annual basis, compared to most other forages, resulting in opportunities to expand the cattle herd and/or farm more acres. Corn silage and corn grazing are also attractive choices for producers as cattle gains tend to be better than with other traditional feed sources.

PRIDE Seeds has developed the **Total Ration Solutions (TRS) system** to evaluate our corn silage and grazing corn hybrids. This system goes beyond hybrid appearance in the field and considers what matters most to growers at harvest - yield, palatability, digestibility, energy and overall nutritional value.

The TRS system from PRIDE Seeds has branded two types of products for corn silage and grazing corn:

- **PRIDE Seed Corn Hybrids**
  - "TRS Approved" Hybrids
    - Effective Digestible Fibre (EDF) Hybrids — Offer the advantage of high digestibility and palatability for improved feed efficiency — **Silage Specific Hybrid**
    - Effective Dual Purpose (EDP) Hybrids — Have higher energy and feed quality compared to an EDF product & has the flexibility to be used as a grain hybrid — **Dual Purpose Hybrid**
  - Grain Corn Hybrids (for grain harvest)

Effective Dual Purpose (EDP)

Characteristics of EDP hybrids:

- Bred for grain corn production
- Dent kernel genetics on a red cob
- Flexibility at harvest for end use – can silage hybrid or allow hybrid to reach physiological maturity and harvest with a combine
- Narrower harvest window due to quicker whole plant dry down

Effective Digestible Fibre (EDF)

Unique characteristics of EDF hybrids:

- Bred for silage (and grazing) corn production
- Flint-dent kernel genetics on a white cob
- Large plant structure with top end yield for maturity group
- High digestibility and palatability for improved feed efficiency
- Wide harvest window due to slower whole plant drydown

CORN MATURITY

There are three different ways to evaluate corn maturity **– CHU, GDD** and **RM.**

1. **Corn Heat Units (CHU)** measure useful heat for plant growth and development in order to estimate corn maturity using the formula below:

$$CHU = \frac{1.8\,(T_{min} - 4.4) + 3.3\,(T_{max} - 10) - 0.082\,(T_{max} - 10)^2}{2}$$

The CHU formula considers corn physiology – corn does not grow when daytime and nighttime temperatures are below 10°C and 4.4°C respectively.

CHU for each hybrid is evaluated based on the amount of heat required from germination to physiological maturity (black layer).

2. **Growing Degree Days** assess crop development using a base temperature of 5°C using the formula below:

$$GDD = \left(\frac{\text{max. daily temp} + 2\ \text{min. daily temp}}{2}\right) - \text{base temp}$$

This method is less useful in corn, because GDD uses 5°C as the base temperature and corn does not start growing until 10°C. GDD is a useful way to estimate the timing of many events like insect emergence, harvest timing, flowering timing, weed emergence and frost-free days, etc. in crops like wheat, canola, peas, etc.

3. **Relative Maturity (RM)** is a traditional method to compare hybrids based on plant drydown and harvest moisture. RM assumes that a hybrid will lose approximately 0.5% plant moisture per day. This method compares harvest moistures between hybrids within a brand and is not consistent from brand to brand. The 0.5% moisture change per day is an average, as all hybrids drydown at their own rate.

PRIDE Seeds EDF (silage specific) hybrids are bred to allow a wider window for optimal harvest. Their dry down will be slower than a dual purpose or grain-specific corn hybrid.

Corn Emergence

Approximately, 150 – 250 CHU (90 – 120 GDD) are required from planting to seedling emergence depending on soil temperature, seedling vigour and planting depth.

HYBRID SELECTION

Choosing corn silage and/or grazing corn hybrid(s) for the growing season is arguably one of the most important decisions a grower will make. There are a few questions to ask when selecting a hybrid(s):

1. What end use am I seeking?

- Depending on the type of operation, a corn grower may be looking for different characteristics from their corn silage hybrid. Not all hybrids will be a fit for all operations.
- If you're looking for flexibility at harvest, then a dual purpose (EDP) may be a better fit, but if you're concerned about whole plant dry-down, a silage specific (EDF) hybrid may make more sense.

2. What is my maturity zone?

- Choose a hybrid that fits your growing area.
- Growing a hybrid that is too short for the season can negatively impact yield, while growing a hybrid that is too long for the season can result in poor quality and/or difficulty harvesting.

3. What agronomic characteristics are important in a hybrid & how does the hybrid perform?

- For many reasons, corn fields that are planted for corn silage or grazing corn tend to see corn more often than other crops. Selecting hybrids with insect protection traits and/or higher disease tolerance can help in maintaining high yields consecutively.
- Evaluate hybrids for plant characteristics that are important for your management of the field like standability, plant health and early season vigour.
- Using local performance data is a great way to compare the hybrids on your now condensed list.
- When looking for a grazing corn hybrid, standability, fibre digestibility and palatability are key characteristics to look for.

Using CHU to Choose Corn Silage & Grazing Hybrids	
Silage Corn: It is recommended to choose a corn hybrid with 100-200 more CHU than your CHU maturity zone. The goal is to pack as much starch into the kenels while maintaining an ideal whole plant moisture before harvest or killing frost. The corn should not reach physiological maturity.	**Grazing Corn: It is recommended to choose a hybrid with 100-250 more CHU than recommended for the maturity zone.** Growers are relying on a killing frost to stop development, rather than a silage chopper. Like silage corn, the kernels should not reach physiological maturity before a killing frost event.

Planning for Harvest During Hybrid Selection

- For growers with a lot of acres or limited harvest equipment, choosing a short-, mid-, and long-season hybrid may help ensure that high quality silage is going to the bunk throughout the entire harvest period.
- For growers relying on a custom chopping operation to harvest their silage, a silage-specific product with slower drydown rates can help manage harvest moisture.

PLANTING POPULATION

The ideal plant population results in maximum sunlight absorption by the leaves, as sunlight is the driving force of photosynthesis. Plant growth and development is maximized when the leaf surface area is maximized.

Corn Population Basics

1. Corn population is based on **seeds per acre**.
2. Optimum plant population tends to range from 32,000 to 36,000 plants per acre in Western Canada – lower and higher populations are used when factors dictate.
3. Factors dictating planting population include:
   - Climate
   - Soil type & productivity
   - Resources available & management decisions
   - Planting date
   - Hybrid characteristics (plant structure, root type, etc.)
   - Economics
   - CHU region
   - End use

The 'general' effect of changing corn silage populations:
Increasing plant populations (36-42,000 plants per acre) • Increased yield • Reduced whole plant drydown rate • More inputs required • Hybrids with an upright plant structure or planted on narrower row spacing can benefit
Decreasing plant populations (28-32,000 plants per acre) • Reduced yield • Quicker whole plant drydown rate – tactic in short season areas • Hybrids with a semi-flex of flex ear can benefit from lower established populations • Hybrids with large stature and pendulum leaf structure maximize there photosynthetic ability • In areas with leaf and ear disease pressure, lower established populations can reduce disease pressure due to increased air flow between and within the rows

Evaluating the Planting Population

1. Visual

a. **Sunlight Interception:** Once the plant has reached maximum height, look down the row at how much sunlight is getting through the canopy. Sunlight hitting the soil surface is lost potential energy that drives photosynthesis and can ultimately influence final yield.

b. **Tiller Assessment:** Check for tillers and number of ears per stalk. Tillers and multiple ears per stalk tend to be a sign that the plant population could be increased based on the given environmental and management conditions during that year.
Note: Conditions change year to year and populations that result in tillers one year may not result in tillers the following year. Tiller development can often occur early in the growing season when conditions are favourable and the planting population is in the right range. These tillers will not influence hybrid performance.

2. Calculated

a. **Emergence Counts:** Once all plants have emerged, count 1/1000th of an acre and multiply by 1000 to get an estimate of the plant population.

b. **Population Trials:** Testing the performance of a hybrid at multiple populations in a strip trial can tell a lot about hybrid performance and feed quality.

SEED SIZING & TRUFLEX GRADING SYSTEM

Corn seed can come in a variety of sizes and shapes ranging from large rounds (kernels from the base of the ear), flats (from the centre of the ear), and small rounds (from the tip of the ear).

Regardless of kernel size or shape, all seeds have the same genetic material and yield potential. And while genetic potential determines corn yield potential, a variety of other management practices and stresses throughout the growing season have a larger impact on yield (Nielsen 1996).

In a study conducted by Iowa State University (2005), it was found that after tasseling, there were no differences in rate of growth and yield potential despite kernel size. This study did conclude:

- Obtaining a uniform and optimum plant population is more important than the differences in seed size (emphasizing the importance of optimal planting conditions).
- Subjecting the seed to stress early in development is harmful.
- Early growth and emergence can be affected by seed size and shape:
  - Smaller seeds that are planted in cooler soils, or crusted soils, may have reduced emergence due to a smaller energy reserve.
  - Larger seeds require more moisture than smaller seeds to germinate, thus smaller seeds may provide an advantage in dry conditions.

Adjusting planter settings based on seed size and shape is essential to ensure accurate seed positioning, placement and seeding rate.

At PRIDE Seeds, we have developed the TrueFlex grade system, which uses seed grade weights to help optimize plantability. Each grade is run through various meters to develop recommendations and we use third party testing to verify maximum planter performance and settings.

Four different corn seed sizes are offered: TFL, TFM1, TFM2 and TFM3.

TFL	> True Flex Large 80MVK - 26.0 kg plus (<3075 seeds per kg)
TFM1	> True Flex Medium 1 80MVK - 21 - 25.9 kg (3800 - 3100 seeds per kg)
TFM2	> True Flex Medium 2 80MVK - 17 - 20.9 kg (4700 - 3825 seeds per kg)
TFM3	> True Flex Medium 3 90MVK - 17 - 20.9 kg (5300 - 4300 seeds per kg)

FERTILITY REQUIREMENTS FOR CORN

When it comes to growing high yielding silage corn or grazing corn, fertility is top of mind for growers and agronomists. Soil testing is vital for determining soil levels of nutrients and is used to make the most economical decisions for fertilizer applications. The "4 R" principals (right rate, right source, right placement & right time) should be considered when applying fertilizer to all crops, including corn.

This section will cover the four macronutrients critical for corn production – Nitrogen, Phosphorus, Potassium & Sulphur.

N deficiency causes yellowing on the lower, older leaves. Yellowing starts at the leaf tip and progresses in a 'V' pattern down the leaf mid-rib towards the base of the leaf. Photo: Stephanie Myslik, 2023.

1. Nitrogen (N)

N is an essential building block in plant proteins, genetic material, and enzymes required for chlorophyll production and provides a boost to help plants grow rapidly.

To manage nitrogen effectively and to reduce the risk of nutrient and economic loss, slow-release nitrogen sources or split applications can be used. Top dressing nitrogen is a common practice used when there is the risk of nutrient leaching or when yield potential is high. The normal window for side dressing is between V3 and V7; before rapid growth of corn occurs.

Nitrogen	Application Methods:	Plant Use:	Required for:	Plant Avail. Form:
	• Fall, Spring & post-planting • Broadcast & incorporate • Band • Side dress/ fertigation	• Approx. 2/3 required in vegetative growth & approx. 1/3 required in reproductive growth	• Essential building block in plant proteins, genetic material, and enzymes • Chlorophyll production • Provides a boost to help plants grow rapidly	• Nitrate (NO_3^-) • Ammonium (NH_4^+)
	application rates depend on soil type, previous crop, target yield, environment, source and placement of nutrient			

2. Phosphorus (P)

P is vital for root development, stalk strength and grain fill. Phosphorus assists in the transfer of energy and helps in the formation of metabolites.

- Based on soil tests, the appropriate level of phosphorus fertilizer should be applied during pre-plant applications and during planting.
- **At planting, a starter fertilizer** including phosphorus is commonly applied to provide the seedling with available phosphorus, while soil temperatures are low and soil phosphorus release is reduced.
- **Banding phosphorus** fertilizer 2'' away and 2'' down from seed reduces the likelihood of phosphorus precipitating in the soil due to reduced surface area exposure and keeps the nutrients close to the growing root system.

Phosphorus	Application Methods:	Plant Use:	Required for:	Plant Avail. Form:
	• Banding below surface prior to seeding • Banding 2" away and 2" below the seed or in-furrow with liquid products at planting	• Early season demand is high • Required through most of the growing season	• Aids in plant growth, maturity & seed development • Assists in energy transfer • P helps in the formation of metabolites	• Ortho-P ($H_2PO_4^-$ or HPO_4^-)
	application rates depend on soil type, previous crop, target yield, environment, source and placement of nutrient			

3. Potassium (K)

K is important for the movement of water, nutrients, and carbohydrates within the plant, and for stalk strength. Potassium plays a critical role in metabolic and enzyme activation.

Banding potassium is more efficient than broadcasting due to the lack of nutrient mobility. Potassium fertilizers can be high in salt, so watching fertilizer salinity is critical. Course soils can be more prone to potassium deficiencies.

	Application Methods:	Plant Use:	Required for:	Plant Avail. Form:
Potassium	• Banding is more efficient than broadcast (especially when low levels needed) • Preplant banding or side band at planting • In furrow applications with some liquid fertilizers	• Rapid uptake starts during rapid growth (approx. V7) until grains start to form	• Enzyme and metabolic pathway activation • Stalk strength • Water, nutrient, and carbohydrate flow • Cell wall strength	• Potassium cation (K^+)
	application rates depend on soil type, previous crop, target yield, environment, source and placement of nutrient			

4. Sulphur (S)

S is an essential component in amino acids required for protein formation.

S is taken up in the form of sulphate. Two forms of sulphur are commonly available as fertilizer – elemental sulphur and plant available sulphur. S rates can be closely associated with N rates in a ratio of 8:1 (N:S). Elemental sulphur takes at least one growing season to become plant available sulphur.

	Application Methods:	Plant Use:	Required for:	Plant Avail. Form:
Sulphur	• Banding away from the seed • Broadcast • Sidedress applied with Liquid UAN	• 45% uptake before R2	• Component in amino acids	• Sulphate (SO_4^{2-})
	application rates depend on soil type, previous crop, target yield, environment, source and placement of nutrient			

WATCH-OUT: Corn planted into Canola Stubble

Planting corn into canola stubble can reduce soil phosphorus availability due to the disruption of the soil mycorrhizae networks from the previous year's canola crop. Corn, soybeans and cereal crops are a host for the mycorrhizal network, while canola (and other brassicas) are not a host. The mycorrhizae network aids in releasing soil phosphorus. Phosphorous deficient plants may appear darker green or purplish and have shorter, weaker stalks. *Refer to phosphorus table above for application.*

PLANTING

PLANTER TIPS

Planting is a farming operation growers have significant control over, and there is really only one chance to do it right to maximize yield potential. Planting sets the foundation for the rest of the season. Approximately 20% of yield potential is determined at planting.

Corn seed is planted with a planter to ensure seed singulation, even in-row placement, and even depth placement. Metering systems for corn are usually singulated meters, rather than volumetric metering systems. Finger pick-up and vacuum planters are the most common systems used in Western Canada.

	Finger Pick-up Planter	Vacuum Planter
Advantages	• Low cost • No additional power needed to run vacuum fan • Simple design, which is easy to understand & adjust on your own	• Lower maintenance • Increased planting accuracy • Easy to add precision parts to track your planting accuracy in real time
Disadvantages	• Requires regular maintenance (brushes & seed belt) • Less adaptable to different seed sizes & shapes	• Hoses, fans & seals can leak, which affect performance • Higher sensitivity to heavy winds, steep slopes & rough fields

Below is a summary of basic corn planter parts and settings that should be reviewed before heading to the field and in the field:

1. Checking the **levelness of the planter** is an adjustment that should be made early when setting up a planter.
    - The levelness of the planter affects every other adjustment you will make.
    - For the planter to be level, it must be parallel to the ground and all row units level to the frame they are connected to.

2. **Seed discs** are crucial for proper seed placement and must be sharp enough to cut a 'V' trench in the seed bed.
    - When all discs on the planter don't have the same disc circumference, the seed depth will not be consistent throughout the field.
    - Worn-out seed discs will make 'W' patterns rather than the targeted 'V' pattern in the seed bed.
    - The worn-out discs leaving the "W" pattern can cause a shallower seed depth and air pockets around the seed.

3. **Row cleaners** sweep residue out of the way of the seed disc, so residue does not inhibit seed emergence. Row cleaners should ride on top of the soil and only penetrate when they are moving debris out of the row.
    - When row cleaners are set too deep, trenches are created for water to sit in and planting depths can become uneven.
    - When row cleaners are set too shallow, residue can cause hair-pinning, which contributes to improper seed-to-soil contact, increased cold injury potential, and increased moisture loss.

4. **Planter down pressure** is essential for optimum seed-to-soil contact and seed depth.
    - Down pressure should always be checked and adjusted in the field with the planter in the down position. The planter should be a quarter full, because it is easy to get enough down pressure when the planter is full.
    - When gauge wheels are set too low (too much down pressure), the seed trench will be packed too tightly resulting in side wall compaction and potentially "hatchet roots".
    - When gauge wheels are set too high (not enough down pressure) there will not be enough pressure to pack the seed bed wall around the seed, resulting in inconsistent seed depth and poor seed-to-soil contact.

5. **Set the planting depth** to 2" (1.5" to 2.5").
    - Corn seed should be planted into half an inch of moisture. If there is no moisture as 2", the depth needs to be set deeper. Use caution when planting deeper than 2.5" or shallower than 1.5".

    Setting Planter Depth:
    - Raise the machine to remove weight from gauge wheels.
    - Move the depth-adjusting handle on the back of the row units.
        - Forward = decrease planting depth
        - Rearward = increase planting depth
    - Each adjustment changes the planting depth 6 mm (1/4 in.).
    - Once the depth is set on the first-row unit, adjust all rows to the same setting.
    - To check the depth, lower the planter and drive a short distance at normal planting speed.

6. Always refer to **planter Owner's Manual** for settings and adjustments.

FIELD SELECTION

Numerous factors play a role in field selection for growing corn silage or grazing corn. A few factors to consider:

1. **Previous year's crop** – Cereal and pulse crops are commonly used in rotation with corn. Utilizing pulse fields can be beneficial due to the higher nitrogen levels from the previous year. Avoid using fields where the previous crop was canola, due to the disrupted mycorrhizae network that can inhibit phosphorous uptake.
2. **Soil type** – Heavy clay soils can result in delayed planting during a cold spring and sandy soils can result in reduced yield in dry seasons. Specific hybrids can perform in tough spring conditions, while other hybrids will struggle to emerge and may result in reduced plant stand or delayed development for the remainder of the season.
3. **Closeness to yard** – Corn silage fields and grazing corn fields may be kept closer to home/yard to make silage harvest and turning cattle into grazing corn easier. Fields closer to home also tend to be the fields that get the most manure.
4. **Previous year herbicide and weed control efficiency** – Attempt to choose fields with low weed pressure as corn is an extremely poor competitor with weeds. Also, review previous seasons herbicide applications to be sure there is no residual or carry-over effect.

Due to the condensed growing season in Western Canada, it is common for growers to work their field ahead of planting. This practice helps warm the soil, manage residue and is an opportunity to incorporate fertilizer.

PLANTING DATE, SOIL TEMPERATURE, PLANTING DEPTH

Soil Temperature

Begin planting when the soil temperature has reached 10ºC (minimum 8ºC) at planting depth and perhaps as importantly, there is a warming trend forecasted.

The seed's first exposure to the soil and moisture needs to be warm so that germination and emergence conditions are optimized. Planting corn into cool (and wet in some instances) soils significantly increases the risk for cold stress and seedling disease. There are two types of cold stress: imbibitional chilling and chilling injury.

1. **Imbibitional chilling** occurs when the seed imbibes water and there is a drastic change in water temperature during the imbibition process.
2. **Cold injury** occurs when the soil temperature changes drastically after the seed has imbibed water.

Overall, cold injury does tend to be less severe than imbibitional chilling injury, but the results of imbibitional chilling and cold injury are ultimately the same – reduced stand, reduced plant vigour and delayed emergence due to corkscrewing of mesocotyl.

Planting Date

Recommending a specific calendar date to start planting corn is not possible as every spring is different. Commonly, corn fields in Western Canada are planted in the first 3 weeks of May to maximize season length. **Soil conditions and upcoming forecast are the greatest drivers in determining when to start planting.**

Considerations for hybrid planting order:

- Plant late-flowering hybrids before early-flowering hybrids to maximize grain fill for the late-flowering hybrids.
- Plant full-season hybrids first to take advantage of their higher yield potential.
- Plant short-season hybrids early to attempt to spread out harvest in the fall.
- Staggering planting dates can help spread the silage harvest window.

Planting Depth

It is important to get planting depth right, as it is essential for proper root development and plant growth. Corn needs to be planted deeper than other crops grown in the prairies (canola, flax, wheat, barley, oats etc.). The ideal planting depth is **2" (1.5 – 2.5") into half an inch of soil moisture.**

At this depth, good seed-to-soil contact is achieved. Good seed-to-soil contact is vital for water uptake and the germination process. The seed needs to be placed into soil moisture for water uptake to occur. The soil moisture at planting depth should be even throughout the seedbed to promote uniform imbibition and germination leading to even emergence.

In addition, 2'' planting depth allows for development of a strong nodal root system, essential for rapid plant growth and development. As the nodal root system develops, the seminal root system's (first emerging roots) role in water uptake declines. The nodal roots are essential for structural support and the majority of nutrient and water uptake.

Consequences of planting too shallow or too deep:

Too Shallow (less than 1.5")	**Too Deep** (deeper then 2.5")
• Poor development of nodal root system • Early season lodging • Poor plant health mid-late season • "Rootless corn syndrome"/"Floppy Corn"	• Exposure to cold soil temperatures • Delayed / no emergence • Leafing out underground

Taking time to set planting depth and checking depth from field to field should lead to **fewer** potential problems during the growing season. Remember, planting technology is only as good as the planting conditions.

GROWING SEASON

CORN ROOT DEVELOPMENT

Root development is critical for nutrient uptake, water uptake and structural support. Root development in corn is unique and quite sequential.

Understanding Germination, Emergence and Root Development

1. A seed will imbibe water, which dissolves nutrients in the embryo.
   - These nutrients participate in a series of biochemical reactions that result in germination.

2. The first structure to emerge from the seed is the **radical root.**

3. After emergence of the radical, the **coleoptile** (not a root structure) emerges
   - When sunlight falls on the coleoptile tip, enzymes are activated that soften the tip, resulting in the first true leaf breaking through the soil surface.

4. Emergence of the **lateral seminal roots**
   - The radical and lateral seminal roots make up the **seminal root system**. The seminal root system uptakes water for the growing seedling, but this root system does little nutrient uptake.

5. Once the seedling has emerged above ground, the seminal root system growth slows and the **nodal root system** develops.
   - The nodal root system develops at nodes right above the mesocotyl of the stem (~0.5-0.75" below the soil surface).
   - The first set of nodal roots develop at the lowermost node and sets of nodal roots continue to develop at their respective nodes progressing toward the soil surface.
   - Nodal roots develop in pairs and nodal root development is aligned with leaf collar development.
   - If the seedling has two sets of nodal roots (4 nodal roots), it is at/near the V2 leaf stage.

6. Nodal roots grow from stem nodes and progress upward until the plant enters its reproductive phase of growth. Once the nodal roots grow from stem nodes above the soil surface, they are called **brace roots**. The brace roots will also uptake nutrients and water and provide structural support.

Brace roots are nodal roots that develop above the soil surface and make up the above-ground root system in corn. Brace roots aid in plant stabilization, and scavenge nutrients and water in the the top soil layer.

EVALUATING EMERGENCE & STAGING CORN PLANTS

Corn Emergence

Corn is a poor competitor with other corn plants and when plants do not emerge evenly, the late emerging plants struggle from day one and their development can be behind all season. This delayed development usually results in reduced yield from these late emerging plants.

Why is corn emergence important for corn silage?

1. Ear Development

- The corn ear (grain, cob and husk) makes up approx. 65% of corn silage yield.
  > The other 35% of yield comes from the tassel, leaf sheath, leaf blade and stalk.
- Smaller ears from late emerging plants result in overall less tonnage and may have delayed, development resulting in less energy within the ear.

2. Plant Biomass

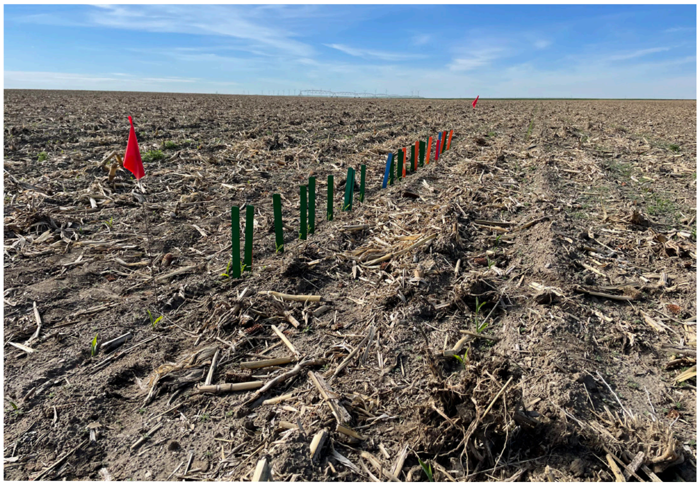
- Plants that emerge late can have reduced biomass due to intense competition, further reducing yield potential.
- Over a lot of acres, a small loss in tonnage per acre can really add-up.

How to Evaluate Emergence:

1. Mark out 1/1000th acre after planting, but prior to emergence.
2. Put stakes/flags beside newly emerged plants within the 1/1000th acre.
3. Make a note of how many plants emerged and what colour stakes/flags were used.
4. Repeat steps 2 and 3 for 5 days total. Check the 1/1000th acre at a similar time every day.
5. At harvest, hand-harvested corn ears within 1/1000th acre and organize based on emergence day. Make note of plants without ears as well as plants and ears that emerged after the 5-day observation period.
6. Estimate yield using the formula below:

$$\text{Yield (bu/ac)} = \frac{\text{average ear length x average ear girth x plant population}}{90}$$

Having a target of 80% of plants emerging within the first 48 hours is a reasonable goal in Western Canada. Increasing the percentage of plants that emerge within a shorter window of time can be a goal to work towards to improve overall yield.



In 2021, emergence was tracked using different colour stakes to mark emergence date in the spring, then at harvest the ears were harvested so yield could be estimated. (AP = after planting)

Corn Staging

Staging corn plants correctly is essential for understanding and assessing crop development and for making herbicide, fungicide, and fertility applications and recommendations.

There are 4 staging methods used throughout the industry and it is important to know the difference between each method.

Staging Method	Description
Leaf Collar Method (V-Stage Method)	• Count the number of leaves present with a collar. > A **leaf collar** is the lightly coloured band located at the base of an exposed leaf blade, close to where the leaf blade contacts the stem of the plant. • Leaf stages are described in V stages: a plant with 4 leaf collars is in the V4 stage of development (Vn: where n = number of leaves with collars).
Leaf Over Method ("Droopy" Leaf Method)	• Count all leaves that have arched over (leaf tip is pointing down). • Using this method, not all leaves will be counted – the smallest leaves emerging from the whorl are not counted.
Leaf Tip Method	• Count all the leaf tips from the bottom to the top of the plant. > Young leaves emerging from the whorl are included in the count.
Corn Height Method	• Measure from the soil surface to the highest point of the arch on the uppermost leaf with a tip pointing down. > This method is rarely used on its own and is paired with other staging methods.

1st Leaf Identification

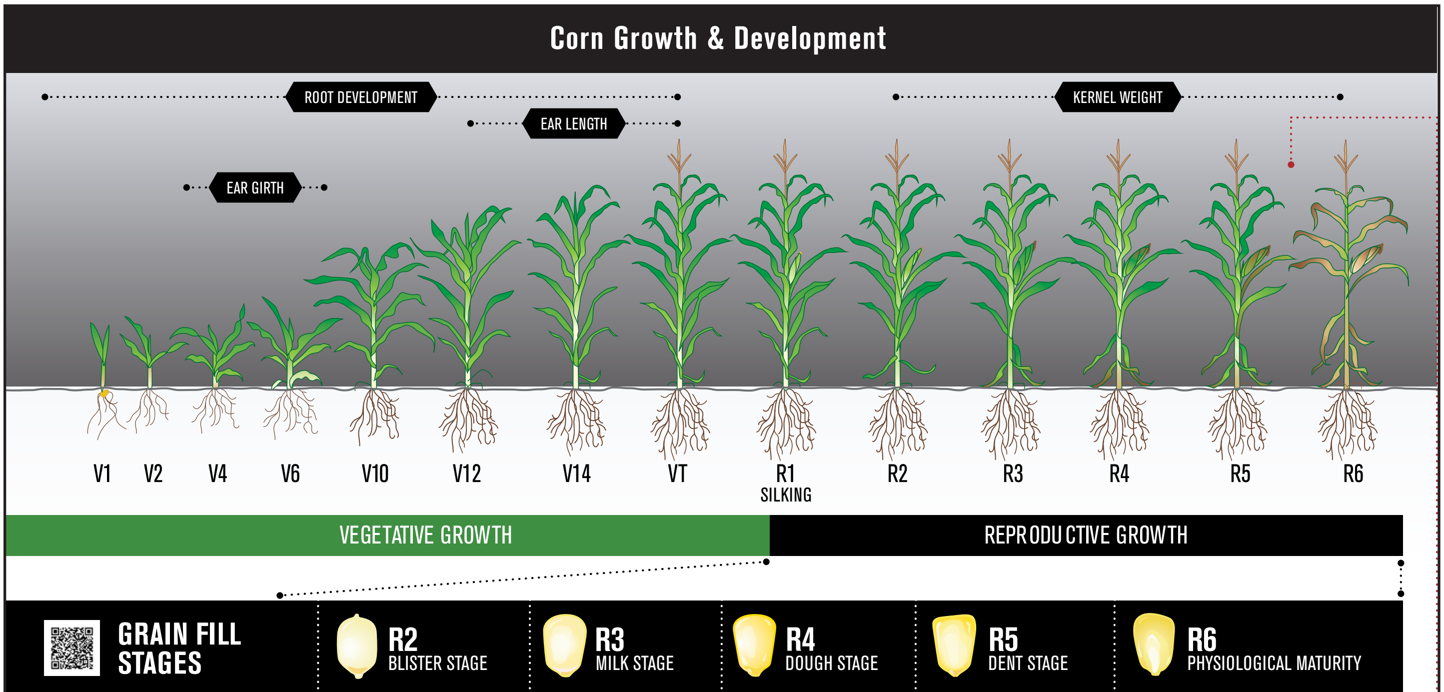
The first leaf will always have a rounded tip and this leaf needs to be included in the leaf count. As the plant grows and develops, this first leaf will die, but still needs to be included in the final leaf count.

CORN DEVELOPMENT – VEGETATIVE AND REPRODUCTIVE GROWTH

There are two phases of corn growth – **vegetative and reproductive.**

The **vegetative growth phase** starts when the leaf tip emergences from beneath the soil surface and lasts until the tassel has emerged. The stages during the vegetative growth phase are identified by the collar leaf method/V-stage method. During this phase of growth, the plant is rapidly acquiring biomass and is developing its tall structure.

The **reproductive growth stage** directly follows the vegetative growth stage. There are six stages in the reproductive growth stage. This stage focuses exclusively on ear development.



ESTIMATING PHYSIOLOGICAL MATURITY

Growth Stage	Soft Dough	Full Dent (R5)	Half Milk Line (R5.5)	3/4 Milkline (R5.75)	Blacklayer (R6)
Kernel Moisture	–	50-55%	40-45%	35-40%	30-35%
Est. Days to Maturity	~32	~21	~10	~5	~0

Vegetative Growth Phase Milestones

VE – Emergence:

- Occurs when the coleoptile/spike breaks the soil surface by the mesocotyl. Emergence can occur 5 days after planting, but can take up to 3 weeks in cool spring conditions.
- The gemination and emergence process requires ~ 180 CHU/125 GDU.

V1 – V4:

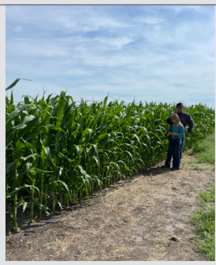
- V1: start of the critical weed-free period.
- The growing point is below ground, therefore frost damage will delay development, but will not kill the plant.
- Minimal stem elongation during this stage and the nodal root system is developing.

V5 – V8

- V5: the growing point is now above ground and more significant damage is possible if a hard frost occurs.
- V6: end of critical weed-free period.
- Growing conditions at V5/V6 can influence ear girth.
- Stem internode elongation and rapid growth period begins – rapid growth syndrome may occur.
- Brace roots start development above ground to support the plant as it elongates.

V9 – V17/Vn

- Stem internode elongation and rapid growth period continues.
- Growing conditions at V10-V12 can influence ear length (number of kernels long).
- The plant has an increased sensitivity to heat and drought stress.



VT

- Occurs when the tassel has emerged – this is the final vegetative stage.
- The tassel produces and sheds pollen grains. Pollen shed lasts 7-10 days, with maximum pollen shed occurring for 2-4 days.
- One tassel can shed approximately half a million pollen grains at peak pollination (usually day three) and will shed several million pollen grains over five to eight days.

Reproductive Growth: R1-R6 Phase Milestones

R1: Silking Stage

The R1 and VT stages occur very closely together and is commonly referred to as the "pollination period", which tends to start mid-July to early-August in Western Canada.

- VT and R1 stages are critical to overall yield potential.
- There is one silk for each potential kernel. The silk will grow and extend out of the husk tip, allowing for pollination to occur.
- Silks allow for the transport of genetic material from the pollen grain to the ovule and when fertilization occurs, an immature kernel will result.
- Extreme heat and/or drought can cause silks to dry out quickly and reduce pollen viability resulting in poor pollination.

R2: Blister Stage

During R2, kernels are accumulating starch and appear white with a clear fluid inside. Kernels can easily be popped with your thumb nail.

- Silks are turning brown and rapidly drying out following fertilization.
- Resources from the leaves are beginning to be relocated to the developing kernels.
- Blister stage occurs 10-12 days following silking.
- Stress during R2, can result in kernel abortion, negatively effecting yield.

R3: Milk Stage

During R3, kernels are turning yellow and rapidly filling with a white, milky fluid resulting in higher levels of starch in the kernel.

- Good plant health and active photosynthesis during R3 sustains potential for kernels to have good size and test weight.
- Kernels that have been aborted or failed to be fertilized will be apparent at this stage and the number of kernels per ear is set for the most part.
- R3 occurs approximately 20 days after the R2 stage.
- Stress during the following stages may reduce carbohydrate accumulate.

Shake Test

During R2, growers can perform the **"Shake Test"** to visually assess pollination.

1. Take an ear from a plant that has finished R1.
2. Remove the corn husks without disturbing the silks.
3. Shake the ear:
   - Silks that fall off are dying and an immature kernel is developing.
   - Silks that do not fall off are still attached to the ovule and that kernel will not develop and will not contribute to yield.

R4: Dough Stage

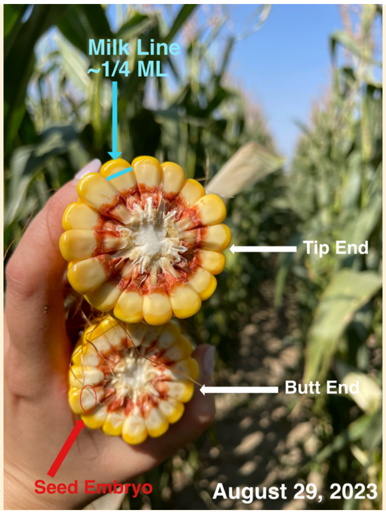
During R4, the white milky kernel filling is becoming thicker and pasty as kernels continue to accumulate starch, while gaining in size and consistency. The outer edges of the kernel are becoming firm.

- The cob has now developed its red-pinkish colour.
  - **PRIDE Seeds EDP (dual purpose) hybrids develop their red-pinkish colour.**
  - **PRIDE Seeds EDF (silage specific) hybrids cobs will remain white in colour as they mature.**
- At the end of the R4 stage, a few dented kernels may be present on the ear.
- The R4 stage begins approximately 26-30 days after silking.
- A killing frost during R4 may cause 25-40% yield loss.

R5: Dent Stage

During R5, many kernels will have formed a dent on the kernel crown and each kernel crown has developed their characteristic shiny, dark yellow, mature kernel colour.

- A hard, white layer of starch will be apparent at the top of the kernel – this is commonly referred to as the **milk line**.
  - The milk line separates the solid, starchy area of the kernel (beginning at the crown) from the liquid, milky area of the maturing kernel. During R5, the milk line will progress towards the base of the kernel.
  - Assess kernel milk line on the tip end of the ear
- R5 begins approximately 38 days after R1.



Silage Harvest: Optimal silage harvest occurs in the last half of the R5 stage – R5.5 to R5.8 – depending on the hybrid and conditions. At R5.5, the milk line is approx. 50% down the length of the kernel, compared to R5.8 where the milk line is closer to 75% down the length of the kernel.

As the milk line progresses down the kernel, the plant will be drying down and the whole plant moisture will be decreasing.

R6: Physiological Maturity

R6 has been reached once the kernel has filled with starch and a black layer has formed at the base of the kernel. Kernels have achieved maximum dry weight.

- Kernel moistures will range between 30-35% and moisture loss will continue to allow for suitable harvest threshing and lower kernel moistures.
- Physiologically mature corn chopped for corn silage will likely be dry resulting in poor fermentation and difficulty packing. Kernel processing could also be challenging. Grazing corn that has reached physiological maturity will be less palatable for cattle (due to dryness of whole plant) and kernels will be more difficult for cattle to process and utilize the nutrients.

WEED CONTROL

The critical weed-free period (CWFP) in any crop is the period when weed interference can cause the most harm to crop yield. V1 to V6 is the CWFP in corn.

During V1 to V6, plants are very susceptible to nutrient and water stress caused by weed competition. Weeds can quickly outcompete corn in the V1 to V6 stage leading to reduced plant growth and yield potential. Corn plants that develop in a weed-free environment will become established and out-compete small weeds. When the crop canopy closes over, sunlight reaching the weeds will be minimized. Research from Dr. Peter Sikkema, at the University of Guelph, shows that taller, more mature weeds have a more significant impact on yield and return on investment than smaller weeds when they are left in the field during the CWFP.

Weeds that emerge following the CWFP will have a less significant impact on silage yield, but the weeds may negatively impact silage quality, reduce silage harvest efficiency and increase weed seedbed presence in the field.

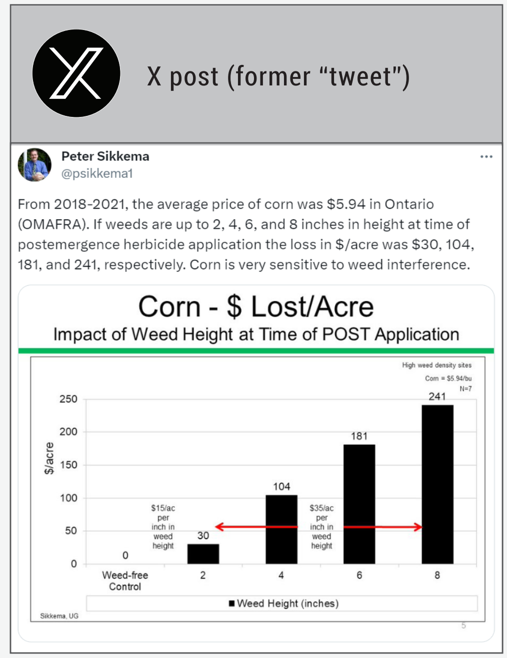


Figure 1: Economical loss in corn based on weight height. Data from Peter Sikkema, May 18, 2023, University of Guelph. (https://twitter.com/psikkema1/status/1659169937955454980)

In additional to the use of plant resources, competitive weeds (and plants) trigger a stress response. Plant competition can induce stress causing chemical and physical behaviour to change in the plant. All plants use light to communicate and when weed plants interfere with a corn plant's light signal, physiological processes are disrupted resulting in stress and overall yield potential loss (Horvath et al. 2023).

A combination of chemical, mechanical, and cultural weed control methods can be used in combination to improve weed control practices.

There are many herbicides registered in Western Canada used to control weeds in corn fields. Commonly, producers use a 2-pass in-crop herbicide program to control weeds in their corn. Using glyphosate with a herbicide tank mix partner during the in-crop herbicide application(s) can be a strategy for managing tough to control weeds. There are also pre-plant, pre-emerge and post-harvest options available to growers. Scouting and weed identification is key to having a strong herbicide program.

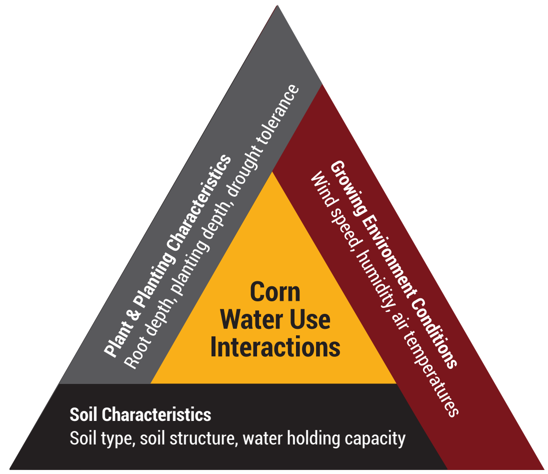
Consult the herbicide label information for information about re-cropping restrictions, tank mix partners, target weeds and any potential injury symptoms.

CORN WATER USE

Crop water use is the amount of water used by the plant to grow and cool. Corn water use is dependent on 3 critical factors: soil characteristics, environmental conditions and hybrid characteristics.

In Western Canada, peak water use for corn tends to fall in between the last two weeks in July and first two weeks of August. During this time, the crop is using 8-9mm/day depending on the hybrid, plant stand and environmental conditions (indicated by grey area on graph water use curve).

Corn water use continually increases through vegetative growth and peaks during the pollination stage. (VT & R1) before dropping off during the remaining reproductive stages. When there is minimal available water during the mid-vegetative stages (V6-V8), the number of kernel rows per ear and stem/leaf cell expansion can be affected resulting in shorter plants with smaller leaves and slender ears. Insufficient water supply during the pollination period can result in poor pollination due to pollen grains and silks drying up, ultimately reducing the number of kernels per ear.



Potential Drought Effects on Corn Silage

- Reduced dry matter yield
- Reduced digestibility
- Increased fibre content
- Increased fibre digestibility
  - Lower lignin production is dependent on the timing of the drought. Late season drought would impact yield, but not decrease lignin production

How do corn plants protect themselves from drought?

Corn plants will roll up their leaves to prevent further moisture loss. This is a defence mechanism the corn plant has developed to handle hot temperatures and low humidity conditions. Leaf rolling does not always result in yield loss. When the leaves stay rolled for longer than 12 hours a day, yield tends to suffer.

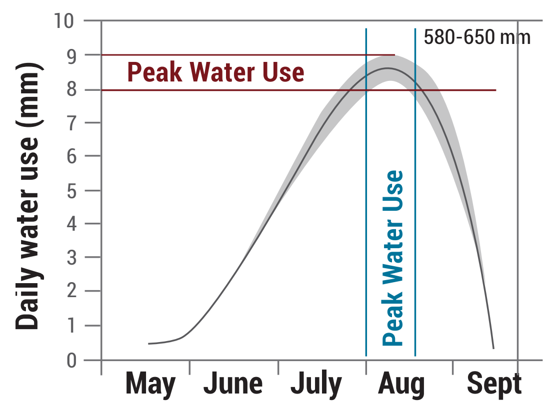


Figure 2: Corn water use. Graph adapted from McKenize & Woods (2011) AgriFacts Crop Water Use and Requirements.

Corn Water Use by the Numbers:

1. 120 bu/ac (~16 ton/ac) crop yield requires ~21 inches of water.

2. ~350 L of water is taken up and evaporated per kg of dry matter produced.

3. Evapotranspiration (ET) values vary greatly from day to day during the growing season – 0.04 to 0.40 inches/day.

  a. Soil type, climate and growth stage will influence ET rates.

HARVEST & FEED RESULTS

ESTIMATING HARVEST & HARVEST TIMING

Determining the proper time to harvest corn for silage is critical because it influences the overall quality of the feed that is ensiled, stored and fed. The most important maturity factor for silage quality is whole plant moisture content.

Generally, the best time to harvest corn silage is when the whole plant moisture content is between 62% and 68% (32–38% dry matter (DM)). Harvesting at this point tends to result in greater success for packing, ensiling and storage.

Predicting when to harvest silage is difficult because there is no easily identifiable plant trait that can be used to estimate the whole plant moisture content reliably and accurately.

Methods to ESTIMATE Harvest:

1. **Silking date:** Corn silage harvest can be estimated by adding 42-47 days to the silking date. Hybrid characteristics and environmental conditions during grain fill can affect this timeline.

2. **Kernel milk line:** Can be a useful indicator of when to begin measuring the whole plant moisture content.
   - The relationship between kernel milk line and whole plant moisture content varies by hybrid type (i.e. silage specific hybrids) and weather conditions.
     - > On three different hybrids, 75% milk line can indicate 65% whole plant moisture (and over 85% of maximum grain yield achieve) on one hybrid, while 50% milk line can indicate 65% whole plant moisture on the second hybrid and 75% milk line can indicate only 72% whole plant moisture on the third hybrid.

Corn ear in the R5 stage at 1/4 milk line. The milk line progresses from the kernel cap to the kernel tip. Always assess kernel milk line on the tip end of the corn ear.

3. **Average daily drydown rate:** The average drydown rate for corn in the R5 stage is ~0.5% per day. Using this drydown benchmark, growers can estimate the of days until a target whole plant moisture is reached.
   - For example, if a field measures 30% dry matter at the early sampling date, and the target harvest DM content is 35%, then the field must gain an additional 5% of DM (lose 5% whole plant moisture). Using the drydown benchmark, there are an estimated 10 days of maturity/drydown required before harvest should be started.

Sampling fields to measure whole plant content should be done well before the anticipated harvest date in case corn is drying down faster than expected.

Consequences of Harvesting when % DM is too high or low:

Harvesting corn TOO WET (low % DM) results in:	Harvesting TOO DRY (high % DM) results in:
• Souring • Seepage of the silage leading to decreased nutrient density • Reduced shelf life	• Mould development & spoilage • Silage cannot be adequately packed to exclude oxygen • Increased fibre content and decreased palatability and protein content

MAKING QUALITY SILAGE

Some of these components are managed from the corn chopper, while others are managed at the bunk. Making high quality silage requires numerous components to be done correctly during harvest.

Cut Height

6 – 8" above the soil surface to maximize quality & yield

- Increasing cut height tends to improve overall quality due to the low digestibility and high fibre content of the lowest portion of the corn stalk. Higher cut height tends to increase dry matter, starch content, acid detergent fibre, neutral detergent fibre content.
- It is estimated that for every 4" of increased cutting height, yield is reduced by approx. 1 ton/ac (wet).

Kernel Processing

Cracking kernels to enhance digestibility and improve feed efficiency

- Proper kernel processing can result in higher milk production, better feed efficiency, and improved animal health. Kernel processing improves nutrient availability, enhances rumen function, reduces sorting and increases shelf life.
- **Kernel Processing Score (KPS):** A visual assessment of kernel processing quality based on the percentage of corn kernels that are cracked or broken into small pieces in harvested corn silage. A KPS of 1 indicates poor kernel processing, while a KPS of 5 indicates excellent kernel processing.
  - Testing KPS in-field:
  1. Fill a 32-oz cup with corn silage.
  2. Dump contents onto flat surface.
  3. Count the number of whole and half kernels.
     - If the count exceeds 2-3 kernels, then adjustments should be considered.

Length of Cut

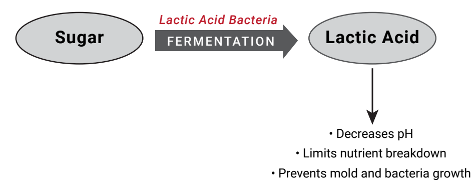
TLC of 3/8"-3/4" for processed corn silage

- The effectiveness of the fibre in corn silage is dependent upon the theoretical length of cut (TLC), which is set on the chopper. Optimum particle size of corn silage is dependent upon many factors, including the fermentability of the diet and the effectiveness of other forages in the diet.
  - Processed Corn Silage TLC length: 3/8"-3/4".
  - Unprocessed Corn Silage TLC length: 3/8"-5/8".

Inoculants

Ensure lactic acid producing bacteria are present in high concentrations for the ensiling process

- Lactic acid-producing bacterial inoculants are alive and inactive until rehydrated with moisture from the chopped silage.
- The ensiling process relies on bacteria to produce lactic acid to "pickle" (ensile) the silage and prevents the silage from spoiling.
- Lactic acid-producing bacteria occur naturally on the chopped silage, but other bacteria are also present, which are competing for the resources the lactic acid-producing bacteria require to "pickle" the chopped silage.



Packing & Sealing

Making an anerobic environment for the ensiling process

- The purpose of **packing** the pit is to remove excess oxygen that can inhibit the ensiling process.
- Tractor weight and fill rate need to be matched and each silage layer should be packed 6" at a time.
- The target packing density for corn silage is: 16-18 lb/ ft^3. Density can be checked with a core sampler, density probe or the "Thumb Test".
- **Cover and seal the full** bunker quickly following harvest using oxygen barrier film and UV resistant plastic.
- Covering and sealing the bunker reduces dry matter loss and spoilage risk.
- Once covered, weigh down the plastic barrier.

Ideal moisture content for different types of storage systems:

Corn Silage (Processed)		
Storage Type	Bunker	Bagged
Target whole plant moisture	62-72%	60-70%
Corn Silage (Unprocessed)		
Storage Type	Bunker	Bagged
Target whole plant moisture	62-70%	62-70%

HARVESTING DROUGHT & FROST DAMAGED CORN

Weather doesn't always cooperate with your feed plans, therefore drought-stressed corn and early-frosted corn is a reality some years. Yield and/or quality can be affected by these weather events.

The severity of damage from drought and frost is dependent on the duration and timing of the weather event. When harvesting frosted and drought-stressed corn, it is critical to watch the whole plant moisture content. Note that the dry down of frosted and drought-stressed corn is not much faster than the normal dry down rate of corn (0.5% per day).

	Frost	Drought
Duration	• **A few hours at 0°C** can kill leaves, but the corn stalks can recover. • **5 to 10 minutes of -2 to -3°C** can significantly impact the viability of leaves, stalk, ears, husks & ear shank. • If the plant material is still green, then it is still alive and photosynthesizing.	• The earlier in the day leaf rolling starts and/or the longer duration of the leaf rolling, the greater stress the crop is under and the potential for yield loss is greater.
Timing	• **Before V5:** growing point is below ground and will regrow – expect a delay in development. **After V5/V6**: the growing point is above ground and a killing frost will kill the plant. • The more immature the corn is, the greater damage a frost will have on silage quality & yield: > **Milk (R3) & dough (R4) stages:** plants are relatively high in whole plant moisture, wait to harvest. > **Early R5 stage:** may want to consider harvesting – need to balance potential dry matter loss with ideal whole plant moisture. > **Late R5 (mid-to-late dent):** nearly ready or ready for harvest; need to move quickly to get corn harvested before whole plant moisture drops below ideal levels.	• **Vegetative growth:** reduced plant height; can influence ear girth and length. • **Silking/ Pollination:** influences kernel fertilization and future ear development; yield potential can be greatly influenced by drought stress during this period. • **Reproductive growth:** reduced kernel set, kernel size and kernel weight.

Assessing Late Season Frost Damage:

The **severity** of the damage may be minimized based on the length and minimum frost temperature; do not rush to **assess the damage.**

- 1-2 days following the frost event symptoms start to appear, but it can take 5-7 days before degree of damage can be accurately assessed.
- The **symptoms of frost damaged** corn are water-soaked appearance on the leaves and brown plant matter.
- Any portion of the plant that remains green 5-7 days after the frost is still actively photosynthesizing and has not been damaged by the frost.

When harvesting frosted and or drought-stressed corn, it is important to consider the following:

1. Use a **bacterial inoculant** to improve fermentation, as the natural occurring bacteria may have been killed or in low concentrations.

2. Raise the **cut height** if nitrate levels are a concern. Raising the height of the cutting bar can increase silage quality because the lower stalk has the highest level of nitrates and lowest digestibility.
   - Nitrates levels can be significantly reduced during fermentation process – 25-65% nitrate reduction during fermentation.
   - Risk for higher nitrates increases if corn silage is harvested within three days of a rainfall.
   - Raising cutting height to 12" will leave majority of nitrates in field, if nitrate levels are concern.

When feed with high nitrate concentrates is fed to livestock, nitrate poisoning can result. Nitrate poisoning negatively affects the animal's heath and productivity.

3. **Check the moisture** as plants can look drier than they actually are.

INTERPRETING FEED RESULTS

Understanding and interpreting feed analysis is no small task, but it is critical to maximizing feed efficiency and developing feed rations. Listed below is a condensed explanation of a handful of results included on most feed tests.

Feed reports generally report feed analysis values in two ways – **as fed** and **dry basis**.

1. **As Fed** reports values based on how the lab receives the sample and includes the moisture content. As water content in the feed samples increases, the amount of other nutrients present per pound of feed decreases.
2. **Dry Basis** reports the actual amounts of nutrients available to the animal consuming the feed. This value is the percentage of nutrients excluding the water content. Rations are formulated using the dry basis nutrient values.

Understanding Feed Test Results

Dry Matter (DM, %) is the percentage of silage that is not moisture. Feed high in DM is drier feed, while feed low in DM is wetter feed. The target DM for corn silage is 32-38%.

% DM = 100% - % Moisture

Carbohydrates are divided into 2 different categories – non-fibrous carbohydrates (starch) and fibrous carbohydrates (cellulose, lignin and hemicellulose).

Starch (%) is the percentage of non-fibrous carbohydrate that is present in silage. Higher values are preferred, as starch provides energy. Starch is nearly twice as digestible as fibre and kernel development is key for harvesting corn silage with good starch values. Low starch levels in corn silage can be due to in-season stress (drought, hail, etc.) and/or chopping while the DM is too low.

Fibrous carbohydrates are measured using the **Acid Detergent Fibre** and **Neutral Detergent Fibre** values.

Acid Detergent Fibre (ADF)

The ADF value measures the least digestible portions in forage – cellulose and lignin. These fibres provide structure to the plant. The ADF value indicates **feed digestibility** and is part of the calculation used to predict the energy content in silage. Lower ADF values are desired as high ADF values can indicate poor feed digestibility.

Neutral Detergent Fibre (%)

The NDF value measures the total fibre in a plant – hemicellulose, cellulose, and lignin. Generally, as starch content increases the NDF content is diluted and the NDF content of the plant is reduced. The NDF values are an indication of **feed consumption**. Low NDF values result in high consumption. High fibre content causes the animals' rumen to fill quicker, resulting in reduced consumption.

The **NDF digestibility (NDFd)** value reflects the digestibility of the hemicellulose, cellulose and lignin in a feed sample in the rumen over a set number of hours. This test mimics the rumen digestibility. Higher values are desired.

There are numerous proteins values derived from a feed test. The **crude protein value (%)** is based on the amount of nitrogen (N) in the feed sample. Corn silage is rarely viewed as a high protein feed source and the target protein content for silage is 7-9%. When protein values are higher than target, the corn silage may have been harvested too early and is immature. Other protein values reported on a feed report include available protein and degradable protein, adjusted crude protein.

Total Digestible Nutrients (TDN, %) values summarize the value of the energy content in the feed. This value includes the digestible carbohydrates, digestible protein, and digestible fat. The equation may over-estimate an animal's energy use as available energy depends on the feed and production status of the animal.

Net Energy (Mcal/lb) values report the energy that is available for milk production (Net Energy Lactation (NEL), weight gain (Net Energy Gain – NEG) and body maintenance (Net Energy Maintenance – NEM) after digestive and metabolic processes occur.

Pounds of milk per ton (lb of milk/ ton) estimates the production potential based on the quality of the feed. The equation for this value considers the protein, NDF, NDFd, starch & non-fibre carbohydrate content in the feed.

Pounds of milk per acre (lb milk/ acre) estimates the production potential based on the quality of the feed and the quantity of feed harvested per acre. Producers with limited land may try to increase this value so they are maximizing milk production potential from every acre available.

lb of milk/ ton x dry yield (ton) / acre = lb milk/ acre

Pounds of beef per acre (lb beef/ acre) is the beef industry's equivalent to lb of milk/ acre. The calculation considers the digestibility of the energy components and the potential beef production based on silage quality and yield per acre.

As mentioned above, this is just a start. Consulting a nutritionist and utilizing resources online can help further increase knowledge about the ins and outs of feed tests to maximize your herd's feed efficiency.

Target Values for Corn Silage

Feed Parameter	Target Value for Corn Silage
Dry Matter	30-40%
Starch	> 28%
ADF	22-30%
NDF	36-50%
Lignin	2-4%
NDFd	63-68%
Crude Protein	6-8%
TDN	> 65%
NEL	> 0.64 Mcal/lb
Values will vary based on feed source, hybrid differences, geographical differences. Target values can vary farm to farm and based on the feed program. Ask a nutritionist for specific targets for your herd.	

How to take a feed sample:

Feed results are only as good as the feed sample that is taken and sent to the laboratory for analysis. Obtaining a representative sample of forage for nutrient analysis is critical to understanding the feed quality.

1. Scoop a handful of silage into a bucket.
2. Repeat step 1 in 4-7 other places in the silage pile.
3. Mix all silage samples together in bucket.
4. On a flat surface, dump the bucket and split the silage into 4 even quarter sections.
5. Fill a Ziplock bag with silage from 1 quarter section.
6. Freeze sample before sending to laboratory for feed analysis, if necessary, to preserve quality.

GRAZING CORN & OTHER CORN FEEDS

GRAZING CORN

Feed costs have been identified as the largest single cost in livestock production, making up 55 to 70% of the total cost of production. To reduce feed costs, producers are exploring options to extend the grazing season. Corn grazing gives growers the opportunity to:

1. Reduce feed costs while feeding a high-value feed source.
2. Reduce harvest and winter machinery costs.
3. Eliminate manure handling and increase nutrient management effectiveness.
4. Increase land productivity due to increased forage yield.
5. Save time.

Grazing Corn Hybrids PRIDE Seeds:

- A3993G2 RIB
- A4414RR
- AS1017RR EDF
- AS1018G2 RIB EDF
- A4705HMRR
- A4939G2 RIB
- AS1047RR EDF

The Essentials of Corn Grazing:

1. Select hybrids that are a fit for grazing corn.

- The best hybrids for grazing corn have good standability, high forage yields, high nutrient digestibility, low fibre levels, and high fibre digestibility.
- Use hybrids that are adapted to the area in terms of maturity, disease and insect resistance, and drought tolerance.
- Plant two or three different hybrids with different maturities to spread risk.

2. Understand land-use requirements.

- Research from Manitoba Agriculture (Manitoba Agriculture, n.d.) indicates that a 1400 lb cow requires ~250 cow days / acre.
- To determine the number of acres required, input values relevant to your operation in the formulas below.

Grazing Corn

Based on *250 cow days/acre:*

<u># of days you want to graze</u> * <u># of cows</u> = cow grazing days

<u>cow grazing days</u>/ *250 cow days/ac* = number of acres required

3. Feed test and meet the nutrient requirements of the animal.

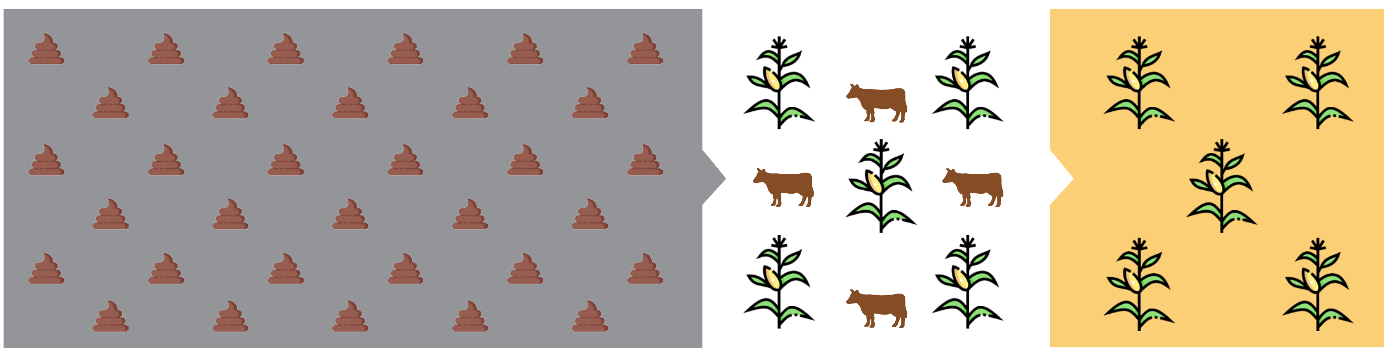
- Knowing the nutrient density of the feed in front of cattle is essential for meeting the cattle's nutrient requirements and maintaining body condition score.
  - > Other feed sources may need to be supplemented.
- Adjust based on the winter conditions, cold temperatures and cold winds will increase cattle's energy requirements.
- Implementing a good trace mineral program will be important for cattle feeding on grazing corn. Copper, zinc, and manganese are the fertility minerals and these need to be in good supply for pregnant cows and heifers.

4. Help new cows learn how to feed on grazing corn.

- Native cows may struggle to figure out how to feed on the tall corn crop. To help make the transition smoother, consider fencing off the first 5-7 rows of corn and adding a couple round hay bales so that the cattle have something to graze on before they try the new feed source.

5. Limit Graze

- Cattle will eat the corn cobs first, then go for the leaves, husks and stalks. Containing the cattle into one area for 3-4 days encourages the cattle to clean up more of the stalk and stover.
- Animals tend to leave the stalk and stover to last – it is up to the farm to decided what level of utilization they are comfortable with before moving the cattle to a fresh patch of grazing corn.
- 100% consumption is not a realistic goal. 80-90% consumption is a good target.



6. Be ready to deal with winter conditions.

- You can not treat an extensive winter grazing system, like corn grazing, the same way you would treat summer pasture.
- Wind protection is critical – natural shelter belts or portable windbreaks work well.
- Accessible winter water sources are important; many different options are available (insulated troughs, frost-free nose pumps, etc.).

7. Have a backup plan...or two.

- 62% of cow-calf operations in Western Canada have 2-3 winter feeding methods.
- Early fall frost, lack of rain and cool springs can negatively impact growth and development of the corn crop and can negatively affect feed quality.
- Having a plan with multiple scenarios or options can help ensure adequate feed supply for your herd when Mother Nature does not cooperate with Plan A.

(Beef Cattle Research Council 2022)

COMPARING DIFFERENT CORN FEED SOURCES

In addition to corn silage and grazing corn, corn can be used in different ways. Consider high moisture grain corn, corn earlage and grain corn as a feed source.

High moisture grain corn is harvested at 24% or greater moisture, stored and allowed to ferment and used as feed for livestock.

Corn earlage is ensiled ears (cob and kernel) and in some cases also the husks and part of the stalk. There are two types of earlage:

1. **Snaplage:** ensiled corn grain, cobs and husks typically harvested with a forage harvester equipped with a corn snapper header so that only the ear and a portion of the ear shank is removed, chopped, and ensiled.
2. **High-moisture Ear Corn or Corn and Cob Meal:** This refers to corn grain and cob material that is harvested with a combine set to return the grain and a portion of the ground cob to the hopper.

Grain corn is harvested between 20-27%, dried and stored. Prior to feeding, it will be processed to increase nutrient utilization.

Below is a chart comparing high moisture grain corn, corn earlage, grain corn and corn silage as a feed source:

	High Moisture Grain Corn	Earlage	Grain Corn	Silage Corn
Harvest Timing	After physiological maturity target moisture: 24 to 33%, maximum – 40%	After physiological maturity crop's moisture content: 60-65% DM (35-40% moisture)	• Target moisture: 20-27%, can be as high as 30% • Safe storage moisture is 14-15%	• Target 65% whole plant moisture (62-68%) • R5.5 - 5.8 (before phys. Maturity); kernel milk line
Harvest Equipment	Combine	Varies • **Combine**: set machine to break up cob and return to grain tank • **Snapper header on forage harvester** equipped with KP – ear, husk and cob harvested • **All crop header on forage harvester:** take everything above the ear	Combine	Forage Harvester with corn attachment
Processing	Prior to storage • **Rolling:** less fines and lower risk of acidosis • **Grinding:** faster ruminal fermentation, greater acidosis risk when feed is >50% HMC	• Kernel Processor on forage harvester	• Dry Rolling • Grinding • Steam Flaking	• Kernel Processor on harvester • Cut length - TCL - theoretical cut length - 3/8" - 3/4" (KP); 3/8" - 5/8" (no KP)
Advantages	• Similar in energy and protein to grain corn • No drying costs • Potential to increase yield (ear drop, bird damage, longer season hybrid) • Earlier corn harvest • Longer window for grazing	• No drying costs • Increase DM yield compared to HMC • Earlier corn harvest • Potential to increase yield (compared to grain corn) • High palatability	• Marketing opportunities • High energy content	• High energy forage • Less labour per ton than other forage crops • High yielding
Disadvantages	• Limited marketing option: livestock market only • Additional storage and processing • Management • Ferments in rumen faster than grain corn; need better bunk management	• Limited marketing option: livestock market only • If harvested late, cob digestibility is low • Lower in protein than other corn grain products	• Drying Costs • Late harvest – season depending	• Harvest timing is critical
Storage	• HMC >27% – water may be needed for good packing/fermentation • Bunker Storage: Store large quantities of product harvested in a short period of time; Will require roller or hammer mill for processing quickly; Pack bunk with tractors • Other storage options: Plastic Silage Bags, Oxygen Limiting Silos • Additives may be beneficial to reduce losses	• Bunker Storage, Plastics Silage Bags, Oxygen Limiting Silos • Similar to corn silage storage – packing, covering and addition of inoculant	• Grain Bin	• Bunker, Plastics Silage Bags, Oxygen Limiting Silos
Nutrient Content	• Energy content similar to dry-rolled corn • Higher ruminal and total tract digestion	• Depends on the type of Earlage: more shank, stalk and trash = lower energy content • Increased roughage compared to HMC and grain • Very few feeding limitations – gradually introduce into ration • Will not have enough energy to serve as the sole source of concentrate in beef finishing rations • Higher in energy than corn silage with similar protein content • Lower energy than HMC and grain corn	• Higher in energy than corn silage with similar protein content • Lower energy than HMC and grain corn	• High Energy Content • Low Protein content • High palatability

TERMINOLOGY & REFERENCES

FEED TERMINOLOGY

Acid Detergent Fibre (ADF): A chemical analysis that determines the digestibility of the plants cell wall components (cellulose & lignin) in the rumen. Forages with low ADF values tend to have higher fibre digestibility. Target values range from 22–30%.

Balanced Ration: The complete mix of ingredients formulated to provide a specific animal species and class with appropriate amounts of all nutrients required for maintenance and a given level of performance.

Concentrates: Animal feeds that are rich in energy and/or protein, but low in fibre, such as corn, soybean meal, oats, wheat, molasses, etc.

Crude Protein (CP): Crude protein measures the nitrogen content of corn silage, including both true protein and non-protein nitrogen. Protein is 16% nitrogen.

Adjusted Crude Protein (ACP): This is the crude protein value corrected for ICP content. In most nutrient analysis reports, when ICP is greater than 10% of CP, the adjusted value in formulating rations is reported.

Insoluble Crude Protein (ICP): This is nitrogen that has become chemically linked to carbohydrates. This linkage is mainly due to harvesting corn silage when the moisture is less than 65% moisture. When silage ICP values are high, the silage has a discoloured appearance and often has distinctly sweet odors.

Digestibility: The extent to which a feedstuff is absorbed in the animal body as it passes through an animal's digestive tract. It varies greatly with the type of feedstuff and type of animal concerned.

Dry Basis: The actual amounts of various nutrients available to the animal consuming the feed; percentage of nutrients in the feed excluding water content.

Dry-Matter (DM): Dry-matter is the moisture-free content of feed samples. Because moisture dilutes the concentration of nutrients, but does not have a major influence on intake, it is important to always evaluate rations on a dry-matter basis.

Dry Matter Intake (DMI): How much the animal will consume.

Ensile: The processing of fermenting/"pickling" a forage in an anerobic environment

Metabolizable Energy (ME): The energy available in the ration to support lactation.

Metabolizable Protein (MP): The protein available in the ration to support lactation.

Milk 2006 Corn Silage Evaluation: Model used to analyze fibre and non-fibre carbohydrates, their digestibility and determine energy values from them. This model is used to produce lb milk/ton value.

Net Energy (NE): Mainly referred to as net energy required for maintenance (NEm), for animal gains (NEg), and for lactation (NEl). Net energy (NE) should be used to formulate diets and predict animal performance.

Neutral detergent Fibre (NDF): A measure of cellulose, lignin and hemicellulose and reflects the amount an animal can consume. As NDF values increase, the DMI values generally decrease.

Neutral Detergent Fibre Digestibility (NDFD): This is a measure of the digestibility of neutral detergent fibre by mimicking digestion within the rumen.

Palatability: The appeal and acceptability of feedstuffs to an animal; can be affected by the feed's odour, texture, moisture, physical form and temperature.

Pounds of Beef Per Acre (lb beef/ac): Value that considers the digestibility of energy components in field; the beef industry's equivalent to lb. of milk/ac

Pounds of Milk Per Ton (lb milk/ton): a value from the Milk 2006 Corn Silage Evaluation System that summarizes silage quality per harvested ton using estimated CP, NDF, NDFD, starch and non-fibre carbohydrates values.

Pounds of Milk Per Acre (lb milk/ac): A value that encompasses silage quantity and quality. It is determined by multiplying the lb milk/ton value by the dry yield per acre.

Rumen: The rumen is the forestomach of a ruminant animal (cattle, sheep) and is a large, muscular organ that is the site of most of the fibre digestion that occurs. It serves as the primary site for microbial fermentation of ingested feed.

Silage additives: The substance that is added during the ensiling process to enhance production of lactic acid and/or a rapid decrease in pH of the feed.

Starch: Non-fibrous carbohydrate found mainly in the corn kernel and is responsible for the majority of energy content in corn silage

Supplement: A supplement is rich in one or more of protein, energy, vitamins or minerals, and, in combination with the base feeds, produces a more complete feed. A supplement feed or feed mixture is used to improve the nutritional value of the ration, complementing the nutrients in the base feed.

Total Mixed Ration (TMR): A mixture of mechanically mixed ration ingredients that typically combine roughages (forages) and concentrates such as grains to optimize animal performance.

Total Digestible Nutrients (TDN): The sum of the digestible fibre, protein, lipid, and carbohydrate components of the diet. TDN is directly related to digestible energy and can be calculated based on ADF.

Theoretical Length of Cut (TLC): The chop length of the corn silage from the chopper.

CORN MATH

1/1000th Acre

Row Width (in)	Row Length Equivalent to 1/1000th Acre (ft & in)	Row Length Equivalent to 1/1000th Acre
15	34' 10"	34.8 ft
18	29'	29 ft
20	26' 2"	26.1ft
22	23' 9'	23.8 ft
28	18' 8"	18.7 ft
30	17' 5"	17.4 ft

1/1000th acre calculation

$$\text{1/1000}^{\text{th}}\text{ acre} = \left(\frac{43.56}{\text{row spacing (in) /12 in/ft}} \right)$$

Calculating Acres/Bag

$$\text{\# of acres/bag} = \left(\frac{\text{80,000 seeds/bag}}{\text{planting rate (seeds/ac)}} \right)$$ *Changes based on planting rate*

$$\text{\# of bags} = \left(\frac{\text{\# of acres} \times \text{planting rate (seeds/ac)}}{\text{80,000 seeds/bag}} \right)$$ *Changes based on # of acres and planting rate*

Leaf Staging Comparison

	Leaf Staging Method		
Corn Height	Leaf Over	Leaf Tip	Leaf Collar (V-stages)
5-6 cm	2	3	1 (V1)
9-17 cm	4	5-6	3 (V3)
18-33 cm	6	7-8	4-5 (V4-V5)
36-54 cm	8	9-10	5-6 (V5-V6)

Grazing Corn

Based on *250 cow days/acre:*

<u># of days you want to graze</u> * <u># of cows</u> = cow grazing days

<u>cow grazing days</u>/ *250 cow days/ac* = number of acres required

Converting Units

Tons (US) vs Tonnes (Metric)

1 US ton = 2000 lb = 907.2 kg = 0.907 tonne

1 tonne = 1000 kg = 2204.6 lb = 1.102 US Ton

1 tonne = 1.102 US ton

Converting kg & lb

lb = # of kg × 2.205

1 lb = 0.454 kg

$$\textbf{kg} = \frac{\text{\# of lb}}{2.205}$$

1 kg = 2.205 lb

Determining Acres & ft2

Acres $= \dfrac{\text{of ft}^2}{43560\ \text{ft}^2\text{/acre}}$ **ft²** = # of acres × 43560 ft²/acre acre

Estimating Yield

GRAIN:

Yield (bu/ac) $= \dfrac{\text{average ear length x average ear girth x plant population}}{90}$

**90 represents the average number of kernels in a bushel (90,000 kernels/bu); if grain fill conditions have been stressful, increase this value to 100 or 110.*

SILAGE:

Based on grain yield:

Stressed corn: every 5 bu/ac of grain corn = 1 ton silage/ac (30% DM)

ex. 50 bu/ac grain corn = 10 ton/ac silage $\left(\dfrac{\text{50 bu/ac grain corn}}{\text{5 bu/ac}}\right)$

Grain corn yielding > 100 bu/ac: every 7-8 bu/ac of grain corn = 1 ton silage/ac (30% DM)

ex. 120 bu/ac grain corn = 16 ton/ac silage $\left(\dfrac{\text{120 bu/ac grain corn}}{\text{7 bu/ac}}\right)$

Based on sample weight:

Estimated corn silage yield $= \dfrac{\text{Weight from 1/100th acre harvest (lb)}}{4}$

Calculating Silage Yield – Harvest, Dry and Adjusted

Yield (tons) $= \dfrac{\text{\# of lb}}{\text{2000 lb/ton}}$ **Yield (tonnes)** $= \dfrac{\text{\# of kg}}{\text{1000 kg/ton}}$

Yield per acre $= \dfrac{\text{harvested weight}}{\text{acres harvested}}$ **Dry yield (100% DM)**

Dry yield (100% DM) $= \dfrac{\%DM}{100} \times$ harvested weight

Dry yield (100% DM) per acre $= \dfrac{\%DM}{100} \times$ harvested weight per acre

Adjusted yield per acre $= \dfrac{\text{dry yield/ac}}{\text{\% DM/ 100}}$

ex. Adjusted to 62.5% moisture $\longrightarrow \dfrac{\text{dry yield/ac}}{0.375} =$ yield adjusted to 62.5% moisture

ex.2 adjusted to 35% DM $\longrightarrow \dfrac{\text{dry yield/ac}}{0.35} =$ yield adjusted to 65% moisture

lb milk/ acre = lb of milk/ ton × dry yield / acre

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