Straw Management in Western Canada Wheat and Barley Cropping Systems

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Management of straw and residue plays a significant role in western Canadian cropping systems. How farmers manage straw and residue can impact long-term soil health, soil nutrient levels, moisture retention, soil erosion, seeding management, as well as next year's crop establishment.

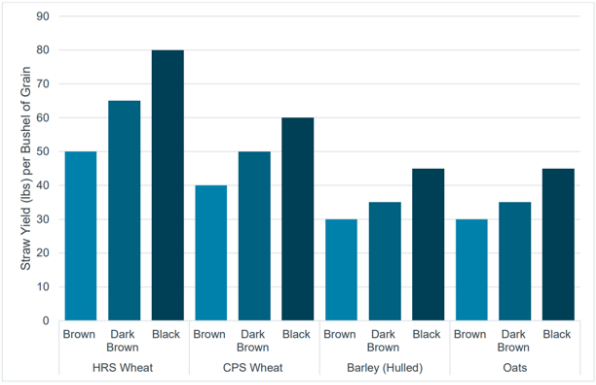
Each farm operation is unique in its crop rotation, equipment, growing environment (precipitation and season length), soil type, as well as short and long-term goals. Access to livestock can also increase the complexity of decision-making. Additionally, accessibility to markets for straw can impact straw management decisions.

Each farm must weigh the pros and cons of straw management options as it relates to their cropping system and long-term goals. Once all relevant factors are assessed, the best management practices for that farm can be implemented.

Crop Residue Production

For cereal crops, about 1.66 lbs of straw is produced for every pound of grain harvested. However, this value can vary from 1lb to 4lbs[1]. Quantities of straw produced in wheat or barley crops will vary based on the crop, variety, soil zone, soil and environmental conditions, and yield of that crop.

Figure 1: Straw yield per bushel of grain, by soil zone



Source: Alberta Agriculture, Food and Rural Development, Increasing Cow/Calf Profitability using Chaff and Chaff/Straw Feedstuffs [2]

[1] Harvesting Surplus Cereal Straw | Cereals: Barley, Wheat, Oats, Triticale | Government of Saskatchewan
[2] Increasing Cow/Calf Profitability Using Chaff and Chaff/Straw Feedstuffs. 2008. Alberta Agriculture, Forestry, and Rural Economics

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Depending on farm goals, agroecological zone, and available markets, the management of straw may differ. Although chaff can provide value to certain production systems[3], this document will focus on straw management.

Nutrient Content in Straw

Straw contains nutrients that should be accounted for when making residue management decisions[4]. Table 1 shows the average nutrient contents for wheat, barley and oat straw **not including chaff.**

Table 1: Average nutrient contents of straw for wheat, barley, and oat (chaff not included, not picked up) at 10 per cent moisture content

	Nitrogen	Phosphorus	Potassium	Sulphur
	lbs/tonne	lbs/tonne	lbs/tonne	lbs/tonne
Wheat	16.7	1.7	22.4	3.0
Barley	16.8	1.7	28.4	3.1
Oats	17.1	2.0	35.1	3.5

Source: Straw Manufacturing in Alberta. 2020. Alberta Agriculture, Forestry, and Rural Economic Development

Farmers should assess the nutrient content of the straw and then determine the fertilizer equivalent value. If the straw is being removed and sold, this information is valuable for two reasons.

i) Determines the fertilizer equivalent value of the nutrients being removed and sold compared to the price received for the straw. However, baling, and physical removal will need to be considered in pricing as well.

ii) It provides the value of nutrients being removed from their field in the form of straw so field nutrient balance can be maintained.

Table 2: Nutrient price per pound of specific fertilizer sources based on fertilizer price

Product	Analysis	$/tonne[1]	N/lb	P_2O_5/lb	K_2O/lb	S/lb
Urea	46-0-0	$ 900.00	$ 0.89	x	x	x
MAP	11-52-0	$1,100.00	x	$ 0.96	x	x
Potash	0-0-60	$1,100.00	x	x	$ 0.83	x
Ammonium Sulphate	21-0-0-24	$ 580.00	$ 1.25	x	x	$ 1.10

[1] *Approximate values of various fertilizer sources in the summer of 2022*

To assess the nutrient value straw, multiply the amount of nutrient per tonne of straw (Table 1) by the value of each pound of nutrient within the desired fertilizer source (Table 2). From this, a value per tonne of straw can be determined (Table 3). Alternatively, farmers can use the Manitoba Agriculture Straw Cost Calculator, which takes into consideration the value of nutrients.

Example calculation:

If 1 tonne of wheat straw is removed per acre assuming average fertilizer prices from

Nutrient	Calculation	$ Value/tonne
Nitrogen	2204.6 lbs (1 tonne) @ 16.7lbs N/tonne X $0.89/lb of N	$ 14.82
Phosphorus	2204.6 lbs (1 tonne) @ 1.7lbs N/tonne X $0.89/lb of P	$ 1.63
Potassium	2204.6 lbs (1 tonne) @ 22.4lbs N/tonne X $0.89/lb of K	$ 18.63
Sulphur	2204.6 lbs (1 tonne) @ 3lbs N/tonne X $0.89/lb of S	$ 3.29
	Total	$ 38.37

The *actual* nutrient value content in straw will vary depending on many factors. Farmers who wish to assess actual straw nutrient values are recommended to collect representative samples and submit for analysis at a soil testing lab.

Table 3: Average nutrient contents of straw for wheat, barley, and oat and estimated value per tonne of straw based on current (2022) fertilizer values (chaff not included, not picked up) at 10 per cent moisture content

Crop Type	Nitrogen		Phosphorus		Potassium		Sulphur		Total	
	lb N/tonne	$ of N/tonne[1]	lb P_2O_5/tonne	$ of P_2O_5/tonne[1]	lb K_2O/tonne	$ of K_2O/tonne[1]	lb S/tonne	$ of S/tonne[1]	Total $/tonne	$/lb of straw[1]
Wheat	16.7	$14.82	1.7	$1.63	22.4	$18.63	3	$3.29	$38.37	$0.017
Barley	16.8	$14.91	1.7	$1.63	28.4	$23.62	3.1	$3.40	$43.56	$0.020
Oat	17.1	$15.18	2	$1.92	35.1	$29.19	3.5	$3.84	$50.12	$0.023

[1] *Approximate values of various fertilizer sources in the summer of 2022*

Source: Alberta Agriculture and Forestry (Straw Manufacturing in Alberta. 2020. Alberta Agriculture, forestry, and rural Economics[5])

The Release of Straw-bound Nutrients Over Time

When calculating the nutrient content of straw, one may be inclined to contribute the straw nutrient content to next season's fertilizer plan. However, straw-bound nutrients are released back into the soil over multiple years due to the length of time it takes for the straw to break down. Instead, farmers should consider the nutrients tied up in straw as a long-term investment that, if maintained on the field, will mitigate the decrease of soil nutrients over time.

[3] Increasing Cow/Calf Profitability Using Chaff and Chaff/Straw Feedstuffs. 2008. Alberta Agriculture, Forestry, and Rural Economics
[4] Cereal Straw: a hidden value on your farm. 2019. Alberta Wheat and Alberta Barley Commissions
[5] Straw Manufacturing in Alberta. 2020. Alberta Agriculture, forestry, and rural Economics

Breakdown and release of straw-bound nutrients will vary depending on several factors including moisture, temperature, soil biology, carbon to nitrogen ratio, size of the straw particles, amounts added and other soil characteristics.

Table 4: A non-exhaustive list of factors affecting the decomposition of straw in the soil over time

Factor	Shorter breakdown period	Longer breakdown period
Straw size	Smaller straw size	Larger straw size
Environment	Warmer Sufficient moisture	Cooler Excess/lack of moisture
Tillage	Increased soil to residue contact	Less residue to soil contact

Cereal straw has a high C:N ratio. Therefore, breakdown of straw will initially require the use of plant available nitrogen from the soil. A portion of the soil nitrogen will become unavailable to the following year's crop for a portion of the season to assist with straw breakdown. After the straw is broken down, that nitrogen will once again be available for crop growth.

Each nutrient may carry a different on-farm value depending on soil characteristics and nutrient levels

Although straw holds fiscal value in the nutrients that it holds, the on-farm value of those nutrients may vary depending on the current nutrient status of the farm it is being removed from. For example, Table 1 demonstrates the high potassium levels in straw. If a farm has low soil potassium, the value of the potassium in straw may hold equal or greater value than the value of potassium in synthetic fertilizer form. A decrease of soil potassium from repetitive yearly straw removal may decrease the field yield potential if removal of the straw lowers soil potassium to marginal levels. Conversely, a farmer with excess soil potassium may not contribute as much value to the potassium in straw.

Farmers and agronomists must assess the value of each nutrient within the straw in relation to their farm and farm goals to understand the straw's farm value. Working with an experienced agronomist is recommended when assessing the farm value of straw.

Organic Matter Value in Straw

In addition to nutrient value, straw holds value in organic matter potential. As straw breaks down in the soil through microbial processes, straw material will eventually become a stable organic matter.

Value of organic matter to crop production

Organic matter is a critical component of soil health. It influences nearly all soil properties and plays an important role in crop production.

- **Soil moisture:** Soil organic matter can play a role in buffering soil from moisture extremes. Increased organic matter can improve water infiltration under excess moisture conditions, and improve water holding capacity under drought conditions.
- **Soil structure and mitigation of compaction and erosion**: Stable soil aggregates (soil particles that are bound together) promote good structure and are an indicator of healthy soil. Their formation is encouraged by the presence of organic matter. A well-aggregated soil promotes water and air entry and can better resist erosion and compaction.
- **Nutrients:** Not only does soil organic matter contain important nutrients such as nitrogen, phosphorus and sulfur that become available as the organic matter decomposes, but it also can hold other important nutrients such as potassium, magnesium and calcium.
- **Breakdown of herbicides:** Soils with low organic matter can have an increased risk of herbicide carryover, particularly under dry conditions. Organic matter provides sites for herbicides to bind to, preventing them from impacting sensitive crops. In addition, soils with high organic matter often have increased microbial activity, speeding up herbicide breakdown.

Methods to Manage Excess Straw and Residue

The most effective straw management system utilizes multiple tools in a system. Through use of a systems-based approach, straw volume can potentially be reduced. Below are options that farmers might consider to manage excess straw.

Prior to dropping straw

Variety selection

Crop type as well as variety selection impact the amount of crop residue produced. Semi-dwarf varieties are available and will help reduce the amount of residue. Reference your provincial seed guide and contact your local seed grower to discuss options that are available to you.

Alberta Seed Guide: https://www.seed.ab.ca/variety-data/cereals/

Saskatchewan Seed Guide: https://saskseed.ca/seed-guides/

Manitoba Seed Guide: https://www.seedmb.ca/pdf-editions-and-separate-section-pdfs/

Rotation

Although each crop type has specific residue challenges[6], a good rotation will help mitigate the build-up of residue over multiple years. In general, cereal crops produce a larger quantity of straw compared to canola and peas. Sowing cereals multiple years in a row may lead to an excessive build-up of straw. Therefore, alternating between cereals and broadleaves will allow enough time between cereals crops for the cereal straw to break down and decompose.

Plant growth regulators

There are currently three plant growth regulators (PGRs) available to wheat and barley farmers in western Canada: ethephon (Ethrel), chlormequat chloride (Manipulator), and trinexapac-ethyl (Moddus). PGRs are synthetic compounds that can be applied to wheat or barley to target reducing lodging by shortening the plant stems. The stem shortening effect that PGRs can provide may be a useful tool for farmers to reduce issues with excess straw.

It is important to note that PGR response is highly variable depending on variety, environment, and year[7]. Additionally, due to the nature of PGR's effect on plant growth, it is recommended that farmers have a clear understanding of the potential benefits and negatives of PGR use. For more information on PGR use in wheat and barley read: Plant Growth Regulators: What Agronomists Need to Know.

Straw choppers

Choppers help cut straw into smaller pieces at harvest while creating a more even straw distribution behind the combine. Straw management at harvest can reduce reliance on practices such as tillage or multiple harrow passes to manage straw. There are several factory and aftermarket options that can be matched to the combine header size for more even residue distribution. It is important to work with the manufacturer and dealer to fine-tune chopper settings for what is best for your operation.

Regular maintenance of all chopper components is crucial, especially after a heavy crop. Issues including dull knives, worn flails, or bent shafts can impact straw chopping.

A study funded by Sask Wheat and Sask Canola and conducted by PAMI completed in the fall of 2020 looked at original equipment and aftermarket choppers for residue distribution. The data from three sites showed that aftermarket choppers had several benefits including a more even residue distribution. The aftermarket choppers created more smaller fractioned residue of less than 0.5 inches compared to particles longer than 3 inches. The original choppers also left most of the residue directly behind the chopper.[8]

[6] Equipment Issues in Crop Residue Management for Direct Seeding. 1999. Alberta Agriculture, Forestry, and Rural Economic Development
[7] Plant Growth Regulators: What Agronomists Need to Know. 2018. Alberta Agriculture, Forestry, and Rural Economics
[8] Performance Story: Effect of Cereal Crop Residue Distribution on the Following Year's Canola Emergence and Yield — Sask Wheat Development Commission

You can find more information about this project here: Performance Story: Effect of Cereal Crop Residue Distribution on the Following Year's Canola Emergence and Yield — Sask Wheat Development Commission

After straw is on the ground

Baling

Benefits	Challenges
Potential income source	Additional cost of equipment rental or custom operation unless owned
Additional feed source for livestock	Removal of nutrients/organic matter from the field
Potential reduction in seeding and emergence issues (assuming residue would otherwise be considered excessive or poorly distributed)	Increased risk of soil erosion
	Locating market to sell bales

Tillage

The value and disadvantages of tillage can vary greatly depending on agroecological zone. Below are a few points to take into consideration.

Benefits	Challenges
Increased soil to straw contact to accelerate the straw breakdown	Increased erosion risk
Moisture loss could speed up spring field access	Damage to soil aggregation and protective surface residue cover
Reduced spring frost risk on frost risk crops	Negative environmental impacts (carbon release)
	Fuel consumption and costs
	Loss of soil moisture

Harrowing

Harrowing is a common practice used to help redistribute straw and aid in residue breakdown. It can be done in the spring or the fall. It is better to harrow in the fall before the straw has a chance to settle and begin to break down.[9]

Harrowing redistributes the straw more than it incorporates. According to Manitoba Agriculture, there is only 5% of straw buried per pass with heavy harrows as compared to 40-60% with a tandem disc.[10] Harrowing does not spread chaff as that must occur at harvest by the combine.

Benefits	Challenges
Increases straw to soil contact	Does not move chaff
Breaks straw into smaller pieces for quicker breakdown and easier seeding	Requires dry residue
	Fuel consumption and costs

Swath Grazing

Swath grazing, the practice of windrowing straw and grazing cattle to feed is a management practice that can provide benefits to farmers with excess straw.

Benefits	Challenges
Eliminates the cost of baling	Access to and management of livestock
Returns nutrients and organic matter back to the field	Potential lack of certain minerals for livestock
Cattle may feed on weeds	Potential non-uniform distribution of nutrients and manure

[9] Equipment Issues in Crop Residue Management for Direct Seeding. 1999. Alberta Agriculture, Forestry, and Rural Economic Development
[10] Province of Manitoba | agriculture - Tillage, Organic Matter and Crop Residue Management (gov.mb.ca)

For more information on swath grazing, see Swath Grazing in Western Canada: an Introduction

Burning straw

In some conditions, such as in the presence of high moisture and on heavy clay soils, straw can be difficult to manage. In cases such as these, burning straw residue may be a management practice that farmers use. If burning straw, always consider the following:

- **Be aware of local regulations:** In Manitoba, farmers must follow the Controlled Crop Residue Burning Program, which restricts burning between August 1 and November 15 based on daily burn authorizations and requires burning permits in municipalities near the city of Winnipeg. Similar guidelines may exist in other areas.
- **Supervise fire at all times**
- **Use fireguards:** To prevent fires from spreading, till a fireguard around the field.
- **Do not burn crop residue at night:** Due to temperature inversions that often occur at night, smoke lingers near the ground rather than dispersing.
- **Consider wind direction and speed:** Ensure smoke will not travel towards roads, towns or neighboring residents. When winds are light, ignite swaths at 30-to-40-foot intervals. When wind speeds are moderate, burn against the wind to prevent fire from spreading.

Summary Benefits and Risks Summary

In summary, both removal and retention of excess straw will come with long- and short-term benefits or challenges. Additionally, each management option will have farm-specific benefits and challenges that each farm must assess concerning specific farm goals. There is no perfect scenario. Farms are recommended to work with experienced agronomists to assess the straw management options that best align with long and short-term goals.

Remove straw from the field

Advantages	Disadvantages
Less seeding challenges (compared to excess straw) depending on equipment availability	Increased risk of erosion
Reduced frost risk for certain crops	Nutrient removal
More even emergence (assuming that maintaining the straw would have led to variable straw cover)	Bales must be removed on time to ensure no delay in other field operations
Value from straw sale	Loss of organic matter
Value to livestock	

Maintain straw on field

Advantages	Disadvantages
Promotes soil surface protective cover and organic matter replenishment to increase soil health	More attention required to spread and manage straw
Returns straw-bound nutrients to the soil	Potential seeding and emergence concerns if the straw is not chopped and spread appropriately
	Straw requires available soil nitrogen for initial breakdown