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Making the Most of Cereal Straw

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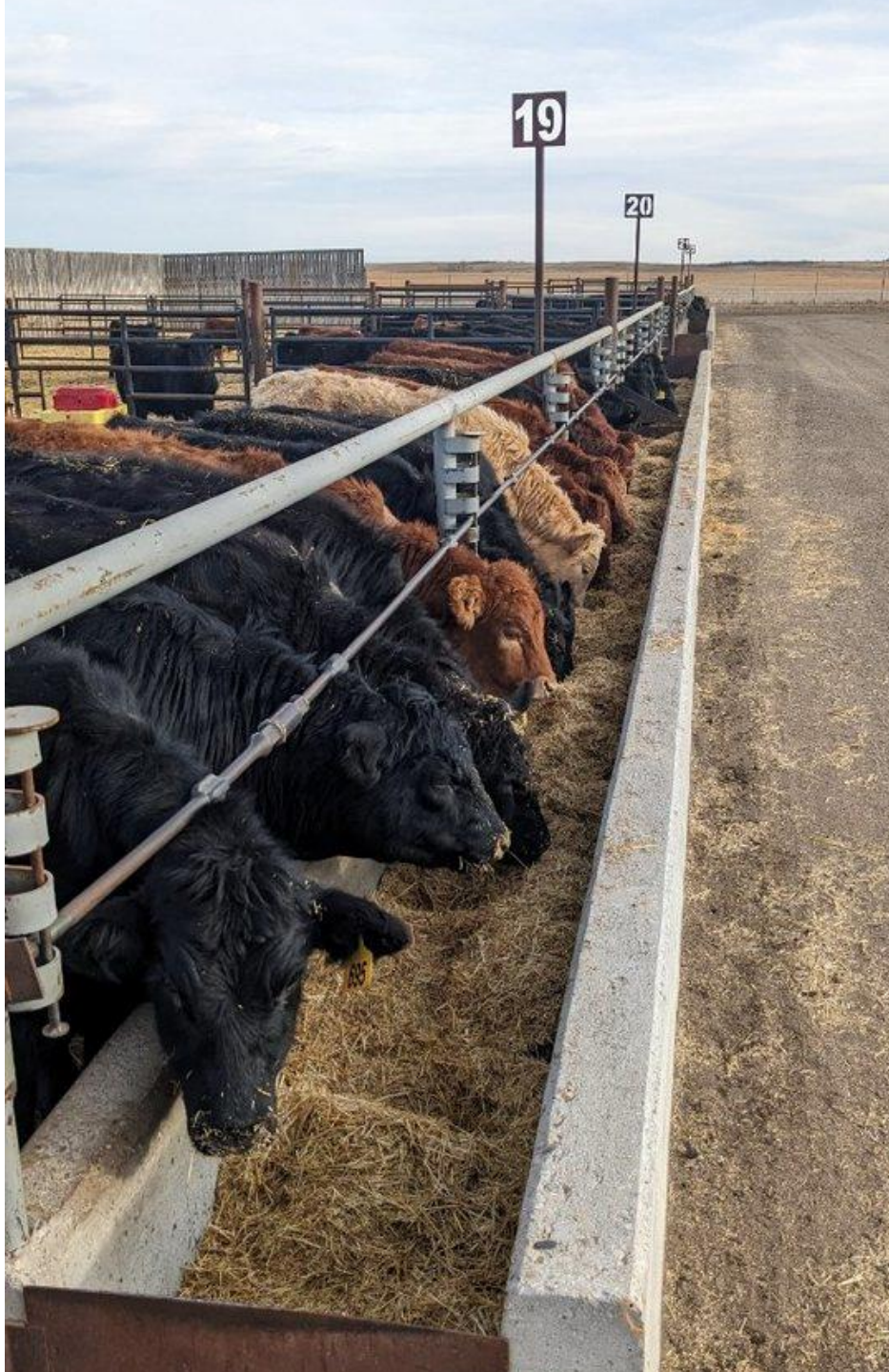

Western Canada Feedlot Management School

2026 WCFMS
February 11, 2026

Forage Shortage!!!

FINANCIAL POST

NEWS · INVESTING · MARKETS · PERSONAL FINANCE · INNOVATION · FP COMMENT · ENTREPRENEUR · EXECUTIVE · FP MAGAZINE

The relentless drought in Alberta has doubled hay prices and that's bad news for Canada's cattle

If it doesn't rain soon, some ranchers could be forced to sell animals to feedlots early

https://business.financialpost.com/commodities/agriculture/the-relentless-drought-in-alberta-has-doubled-hay-prices-and-thats-bad-news-for-canadas-cattle

Straw Production in Canada

- Canada produces yearly approximately
  - 35 to 40 MMT of wheat
  - 8 to 11 MMT of barley
  - 16 to 22 MMT of canola
- ~0.36 kg of straw is produced for every kg of grain (McCartney et al., 2006)
- Even in drought years lots of straw is produced
- Straw can be a practical and economical solution to feed scarcity in times of drought

Common Characteristics of Straw

- < 7% crude protein
- High NDF (>50% for legumes and 60% for grasses)
- High ADF
- High Lignin
- High uNDF

High Fibre

- Low digestibility (< 50%), low energy (TDN, NEg)
- Promote low DM intake → low growth performance

Forage quality varies greatly among and within straw sources

	Barley silage	Barley straw	Wheat straw	Oat straw
DM, %	33.6 ± 7.9	85.1 ± 10.4	91.8 ± 3.3	84.2 ± 9.2
CP, % of DM	12.0 ± 3.0	6.1 ± 1.5	5.1 ± 2.1	4.8 ± 2.6
NDF, % of DM	54.8 ± 7.2	71.6 ± 3.6	73.6 ± 7.4	73.8 ± 5.1
ADF, % of DM	34.7 ± 5.1	50.1 ± 2.4	50.2 ± 3.6	49.3 ± 5.6
Lignin, % of DM	4.8	5.2	7.4	7.07
Ca, % of DM	0.41	0.52	0.33	0.30
P, % of DM	0.30	0.21	0.11	0.14
TDN	50.6 ± 4.6	48.3 ± 1.4	50.0 ± 4.7	44.3 ± 5.0
NEm, Mcal/kg	1.33	0.91	0.97	0.76
NEg, Mcal/kg	0.75	0.36	0.42	0.23

Feed Testing!!!

Source: NASEM (2016)

Feed Digestion in the Rumen

Rumen Microbiome

Complex Fibrous Substrates

VFA and Microbial Protein

Less than **50%** is digested in low quality forages such as straw

Animal Requirements vs. Ruminal Microbes Requirements

- Ruminal microbes requirement
  a) Water
  b) Ammonia (Urea)
  c) Amino acid, peptides (feed protein)
  d) Ca, P, S, Mg, Co
  e) Branched-chain volatile fatty acids (VFAs)
     - Primers for required branched fatty acids in bacterial membranes

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Straw in Backgrounding Diets

Item	CTL	LWS	HWS
Diet Ingredient, % of DM			
Barley grain	33.85	23.85	23.85
Barley silage	60.00	25.00	-
Wheat straw	-	25.00	50.00
Canola/Flax screenings	-	12.50	12.50
Canola meal	5.00	12.50	12.50
Urea	0.25	0.25	0.25
Mineral/vitamin	0.90	0.90	0.90
Chemical composition, % DM			
DM, %	45.5	62.3	64.5
CP, %	12.8	14.5	13.1
Starch, % of DM	**34.5**	**21.9**	**16.1**
aNDFom, % of DM	30.1	39.4	47.8
ADF, % of DM	20.1	26.2	32.2
uNDFom, % of DM	**10.2**	**15.7**	**20.4**
Ether extract, % of DM	2.6	**4.8**	**3.5**
NEm, Mcal/kg	1.78	1.64	1.39
NEg, Mcal/kg	1.15	1.04	0.81

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Straw in Backgrounding Diets

Backgrounding growth performance

Parameter	CTL	LWS	HWS	SEM	*P*-value
Initial BW, kg	283	285	285	3.12	0.98
Final BW, kg	397^{a}	375^{b}	342^{c}	3.76	<0.001
DMI, kg/d	7.95^{a}	7.44^{ab}	5.71^{c}	0.111	<0.001
DMI, % BW	2.34^{a}	2.25^{ab}	1.82^{c}	0.034	<0.001
NDFI, % BW	0.70	**0.89**	**0.87**		
uNDFI, % BW	0.24	**0.35**	**0.37**		
ADG, kg	1.38^{a}	1.09^{b}	0.70^{c}	0.022	<0.001
Gain:Feed	0.174^{a}	0.147^{b}	0.122^{c}	0.0029	<0.001

↓21% ADG ↓15% G:F

↓49% ADG ↓30% G:F

Montenegro et al. (2025)

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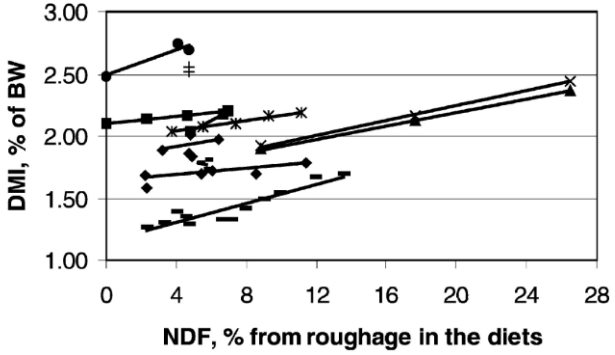
Straw in Backgrounding Diets

Backgrounding economic performance

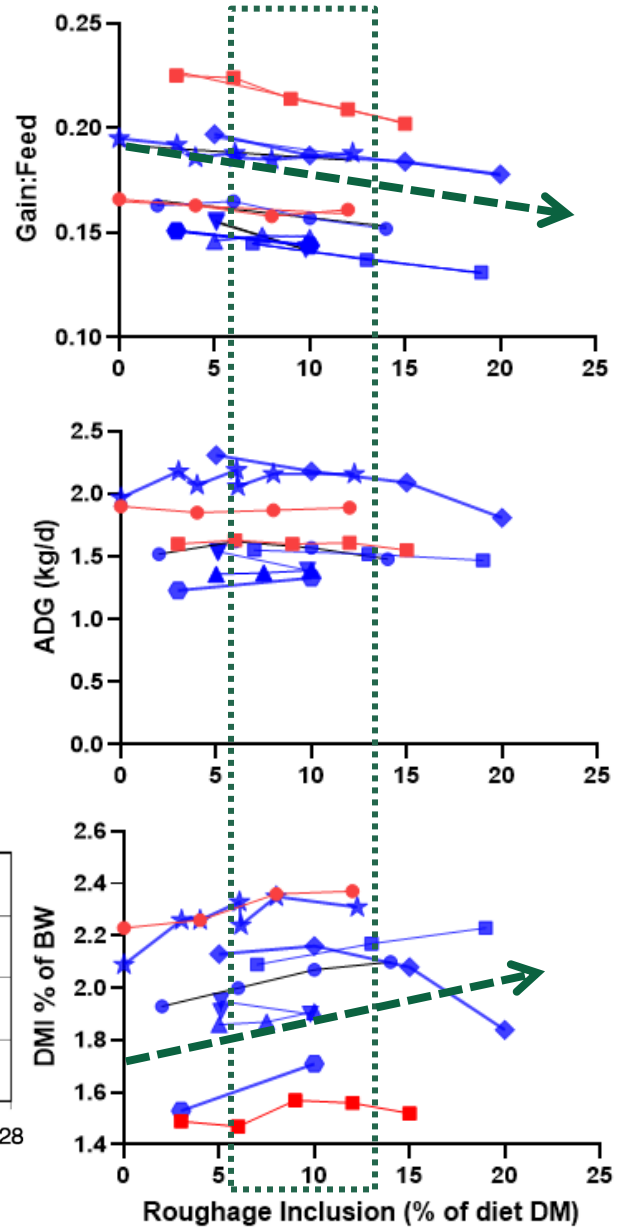
Parameter	CTL	LWS	HWS	SEM	*P*-value
Feed Cost, $/steer/d	2.55a	2.20b	1.51c	0.029	<0.01
Cost:Gain, $/kg	1.81c	1.94b	2.10a	0.042	0.02

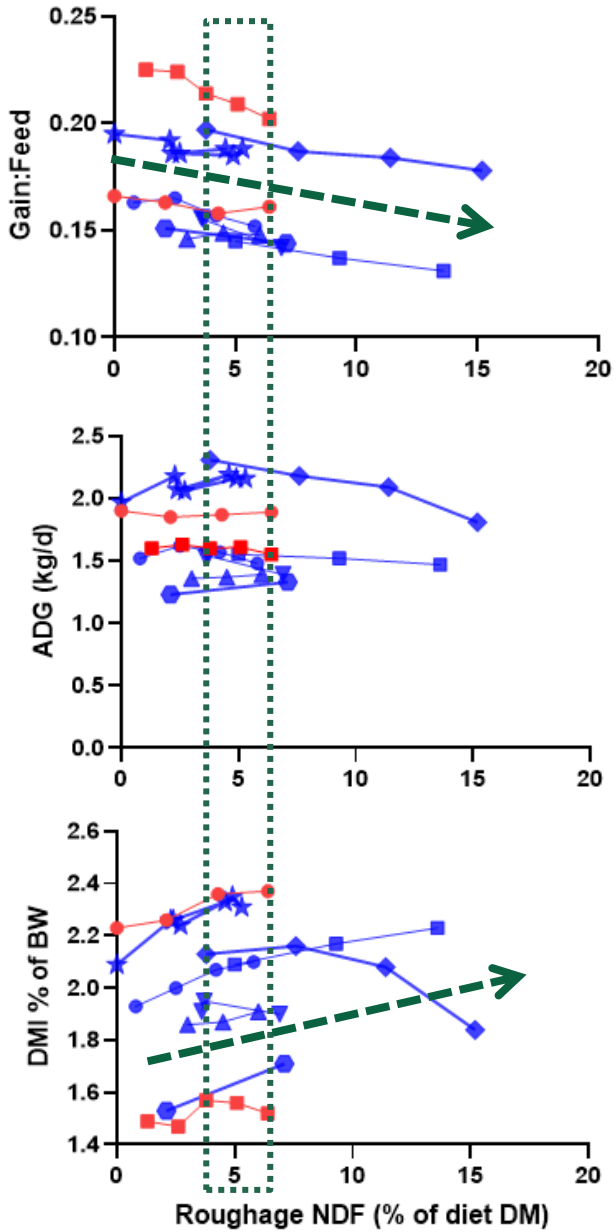
Montenegro et al. (2025)

Roughage Inclusion in Finishing Diets



Galyean and Defoor (2003)





- Koenig et al. 2020
- Koenig and Beauchemin 2011
- McDaniel et al. 2024
- Word et al. 2024
- Swanson et al. 2017
- Benton et al. 2013
- Hales et al. 2013
- Schneid et al. 2024
- Gentry et al. 2016

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Straw in Finishing Diets

Item	CTL	LWS	HWS
Diet ingredient, % of DM			
Barley grain	85.64	78.14	73.14
Barley silage	10.00		
Wheat straw	-	5.00	10.00
Canola/Flax screenings	-	12.50	12.50
Canola meal	2.50	2.50	2.50
Urea	0.25	0.25	0.25
Mineral/vitamin	1.61	1.61	1.61
Chemical composition			
DM, %	73.8	78.5	78.1
CP, % of DM	13.4	15.1	14.6
Starch, % of DM	**53.3**	**45.5**	**42.9**
aNDFom, % of DM	16.9	20.6	23.2
ADF, % of DM	8.3	10.6	13.2
uNDFom, % of DM	**5.2**	**8.7**	**10.2**
Ether extract, % of DM	**2.7**	**4.9**	**4.2**
NEg, Mcal/kg	1.49	1.46	1.38
$peNDF_4$	7.2	8.0	10.3

% NDF from roughage (diet DM basis)

CTL = 4.1%
LWS = 4.0%
HWS = 7.9%

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Straw in Finishing Diets

Table. Dry matter intake (DMI) of finishing steers treatment diets.

Item	CTL	LWS	HWS	SEM	*P*-value
Shrunk initial BW, kg	366	366	366	1.58	0.97
Shrunk initial BW, kg	663a	657a	**646b**	4.29	0.02
DMI, kg/d	11.6	11.8	11.6	0.16	0.47
DMI, % BW	2.30	2.34	2.34	0.031	0.58
ADG, kg	2.02a	1.94b	1.91b	0.025	0.02
Gain:Feed	0.173a	0.166b	0.162b	0.003	0.05

↓4.0% ADG
↓4.0% G:F

↓5.4% ADG
↓6.4% G:F

Montenegro et al. (2025)

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Straw in Finishing Diets

Table. Carcass characteristics of finishing steers treatment diets ↓3% HCW

Item	CTL	LWS	HWS	SEM	*P*-value
HCW, kg	400a	398a	**388b**	3.32	0.01
Dressing %	60.3ab	60.6a	60.0b	0.28	0.05
Ribeye area, cm^2	100.5ab	102.0a	97.4b	1.48	<0.01
Marbling score	386a	387a	367b	7.91	0.03
Yield Grade					
Y1	55.2	48.8	41.2	-	0.07
Y2	**37.9b**	**46.1ab**	**55.3a**	-	0.05
Y3	6.9	5.0	3.5	-	0.33
Quality Grade					
AAA	**51.7a**	**47.2ab**	**35.1b**	-	0.03
AA	**48.3b**	**52.9b**	**64.9a**	-	0.05

Montenegro et al. (2025)

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Straw in Finishing Diets

Finishing economic performance

Item	CTL	LWS	HWS	SEM	*P*-value
Feed Cost, $/steer/d	4.29a	4.21a	4.02b	0.059	0.01
Cost:Gain, $/kg	1.71	1.75	1.74	0.028	0.35

Montenegro et al. (2025)

JOURNAL ARTICLE

Effect of silage source, physically effective neutral detergent fiber, and undigested neutral detergent fiber concentrations on performance and carcass characteristics of finishing steers

Murillo C S Pereira, Wenzhu Z Yang, Karen A Beauchemin, Tim A McAllister, Katharine M Wood, Gregory B Penner

Translational Animal Science, Volume 5, Issue 1, January 2021, txaa236, https://doi.org/10.1093/tas/txaa236

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Replacing 50% of silage with straw

Experimental diets

Item	CTL	STRAW
Ingredient, % of DM		
Barley grain	87.9	87.7
Barley silage	10.0	5.0
Wheat straw	**-**	**5.0**
Mineral	0.18	0.18
Limestone	1.43	1.43
Urea	0.50	0.66
Chemical composition, % of DM		
DM	81.1	83.0
CP	12.5	12.1
Starch	53.5	52.1
NDF	19.1	20.7
uNDF	**6.7**	**7.8**
peNDF4.0	**13.4**	**13.8**

% NDF from roughage (diet DM basis)

CTL = 4.2%
STRAW = 5.8%

Pereira et al. (2021). Transl. Anim. Sci. 5:1-13.

Replacing 50% of silage with straw

	CTL	STRAW	SEM	*P*-value
Initial BW, kg	431	432	12.4	0.61
Final BW, kg	634	631	14.0	0.51
DMI, kg/d	12.0	11.9	0.26	0.60
DMI, % BW	1.90	1.88	0.020	0.72
ADG, kg	1.61	1.56	0.020	0.25
Gain:Feed	0.134	0.132	0.002	0.56

Pereira et al. (2021). Transl. Anim. Sci. 5:1-13.

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Replacing 50% of silage with straw

	CTL	STRAW	SEM	*P*-value
HCW, kg	376	372	8.73	0.18
Dressing %	**59.3**	**58.9**	0.17	**0.01**
REA, cm^2	87.8	87.8	1.87	0.97
Marbling score	427	433	11.0	0.62
Yield Grade				
Y1	11.1	14.4	1.31	0.12
Y2	53.3	**63.3**	2.01	<0.01
Y3	**35.6**	18.9	1.81	<0.01
Quality Grade				
AAA	66.7	67.8	1.83	0.69
AA	32.2	31.1	1.81	0.69

Pereira et al. (2021). Transl. Anim. Sci. 5:1-13.

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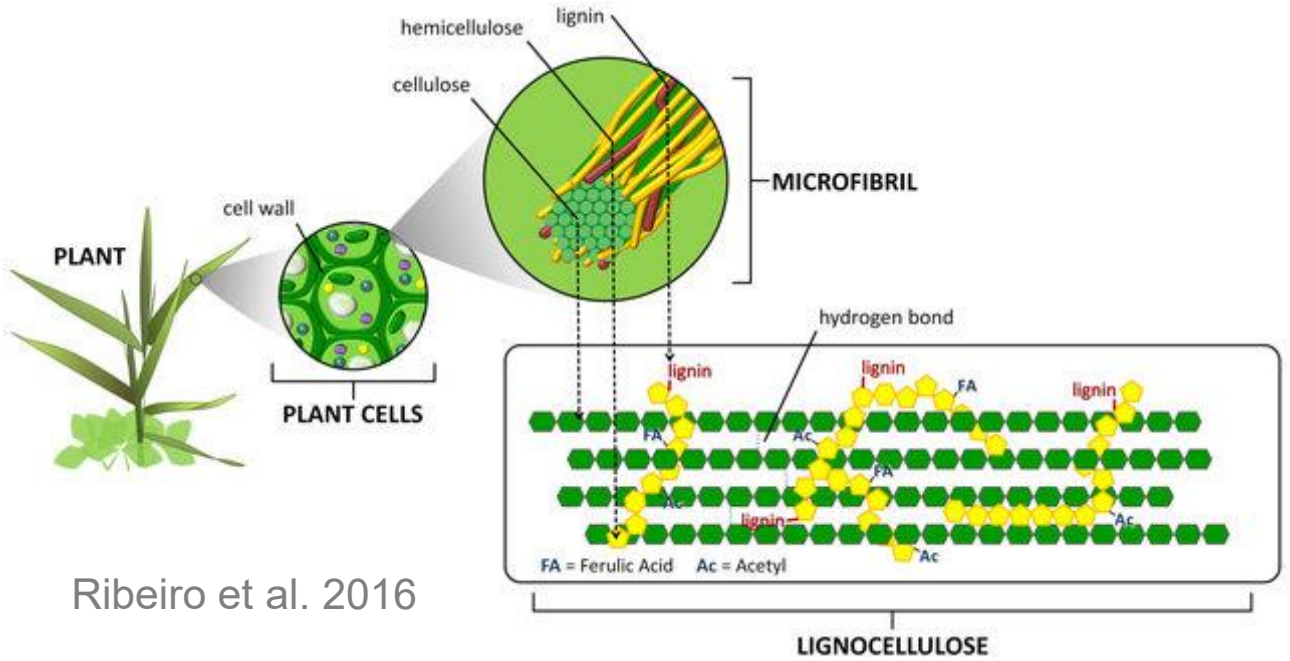
Chemical Treatment

- Most common are alkali treatments
  - a) NaOH, KOH, $Ca(OH)_2$, CaO, NH_3, and urea
  - b) Partial solubilization of hemicelluloses, lignin, and silica (Fibre)
  - c) Disruption of the fibre structure
  - d) Increase rate of hydration
  - e) ↑ DM intake and DM digestibility



Ribeiro et al. 2016

CaO Treatment

- Mix 5% CaO to straw (w/w) and hydrate it to 50% moisture
- Mixed results in the literature

NRC Research Press

ARTICLE

Effect of replacing barley silage with calcium oxide-treated barley straw on rumen fermentation, rumen microbiota, nutrient digestibility, and growth performance of finishing beef cattle

Katelyn R. Stehr, Stephanie A. Terry, Gabriel O. Ribeiro, Robert J. Gruninger, Gregory B. Penner, John McKinnon, Darryl Gibb, and Tim A. McAllister

Canadian Journal of Animal Science • 25 February 2021 • https://doi.org/10.1139/cjas-2020-0071

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Straw and CaO

	CTL	STR	CaO-STR	CaO-STR-I
Diet Ingredient, % of DM				
Dry rolled wheat	73.0	73.0	73.0	
Corn DDGS	10.0	10.0	10.0	
Barley silage	12.0			
Barley straw		12.0		12.0
CaO straw			12.0	
Cao				0.6
Mineral/vitamin suppl.	5.0	5.0	5.0	4.4
Chemical composition, % DM				
DM, %	75.0	84.7	83.1	83.1
CP, % of DM	13.4	12.6	12.7	12.7
Starch, % of DM	47.2	44.8	45.4	45.1
aNDFom, % of DM	19.1	23.0	22.2	23.1
ADF, % of DM	9.4	11.8	11.7	11.9
Ether extract, % of DM	2.9	2.8	2.7	2.8

% NDF from roughage (diet DM basis)

CTL = 5.1%
STR = 9.1%

Stehr et al. (2021). CJAS 101:493-506.

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Straw and CaO

	CTL	STR	CaO-STR	CaO-STR-I	SEM	*P*-value
Initial BW, kg	519	522	518	529	7.7	0.28
Final BW, kg	711	686	681	714	10.9	0.13
DMI, kg/d	13.5	12.6	12.4	13.1	0.35	0.30
DMI, % BW	2.12	2.06	2.04	2.04	0.04	0.64
ADG, kg	1.79a	**1.53b**	**1.52b**	1.72ab	0.057	<0.01
Gain:Feed	0.131a	**0.121b**	**0.121b**	0.131a	0.0124	0.01

↓15% ADG ↓7.6% G:F ↓4% ADG

Stehr et al. (2021). CJAS 101:493-506.

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Straw and CaO

↓5.8% HCW

	CTL	STR	CaO-STR	CaO-STR-I	SEM	*P*-value
HCW, kg	442	**415**	**418**	438	7.0	0.32
Dressing %	62.2	**60.4**	**61.5**	**61.3**	0.43	0.08
REA, cm^2	92.0	89.9	88.1	92.7	2.16	0.11
Yield Grade						
Y1	0.0	7.1	0.0	0.0	2.81	1.00
Y2	13.3	14.3	13.3	6.7	7.63	0.97
Y3	86.7	78.6	86.7	93.3	7.26	0.87
Quality Grade						
AAA	100.0	85.7	93.3	100.0	6.51	0.94
AA	0.0	14.3	6.7	0.0	2.81	0.98

Stehr et al. (2021). CJAS 101:493-506.

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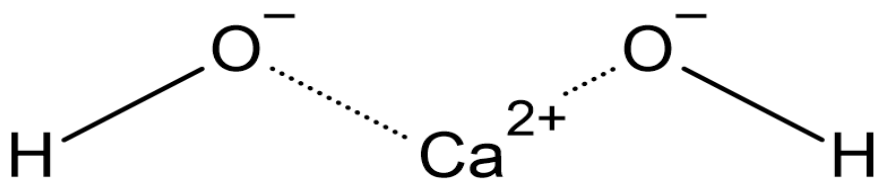
Calcium Hydroxide $Ca(OH)_2$



- Treating wheat straw, corn stover, and corn cobs with calcium hydroxide may improve digestibility and cattle performance (Rounds et al. 1976; Klopfenstein 1978; Paterson et al. 1980; Peterson et al. 2015; Gentry et al. 2018)
- Compared to other chemical treatments, $Ca(OH)_2$ is less caustic and approved for use in Canada (Gandi et al. 1997; Shreck et al. 2015)

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Straw and $Ca(OH)_2$

Straw Type	Calcium Treatment
Wheat straw (W)	Limestone (CTL)
Canola straw (C)	Calcium hydroxide (CH)
Flax straw (F)	

Ross et al. (2025)

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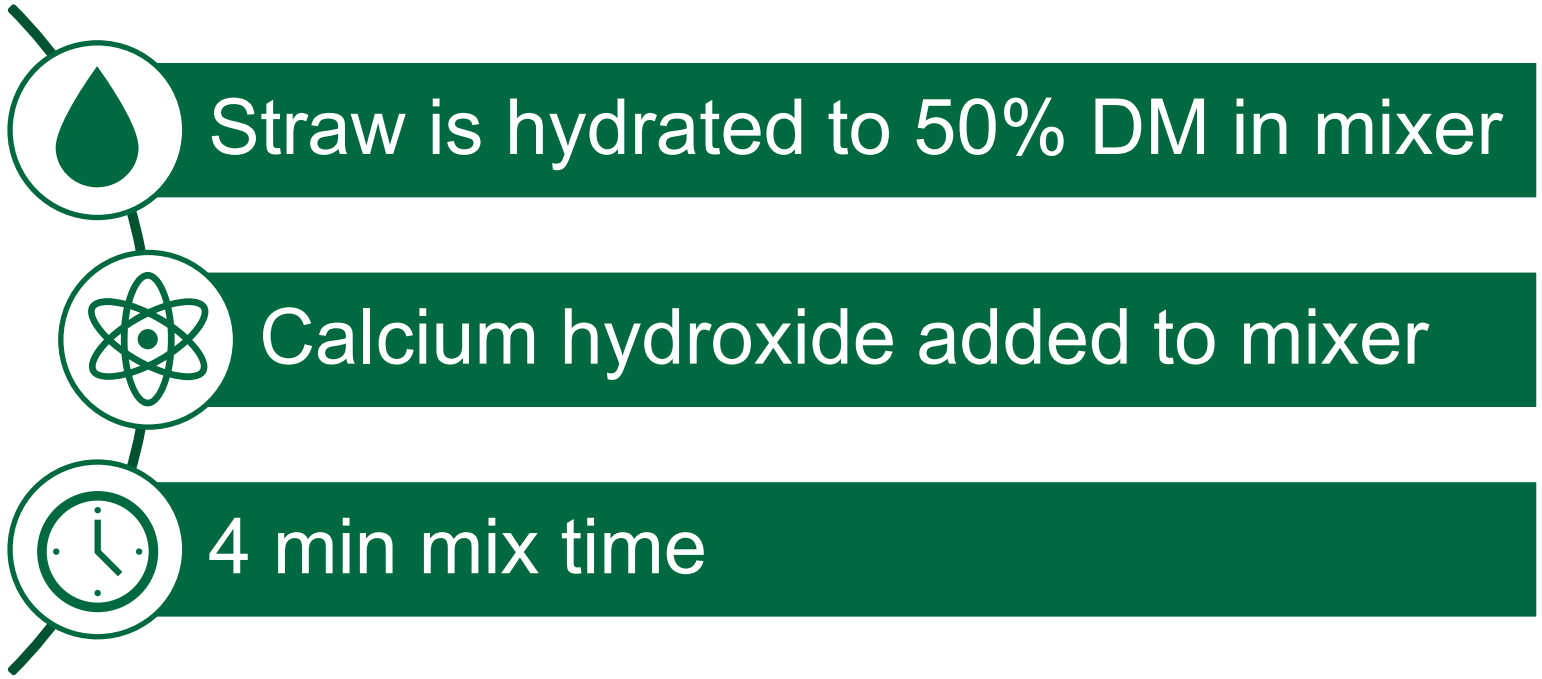
Straw and $Ca(OH)_2$



Ross et al. (2025)

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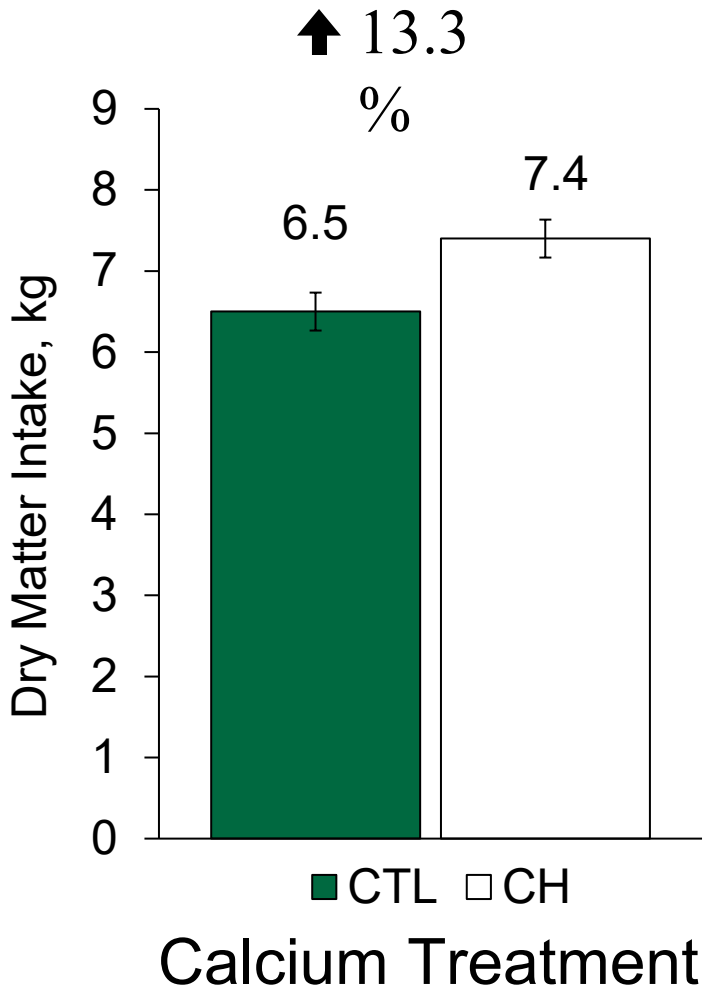
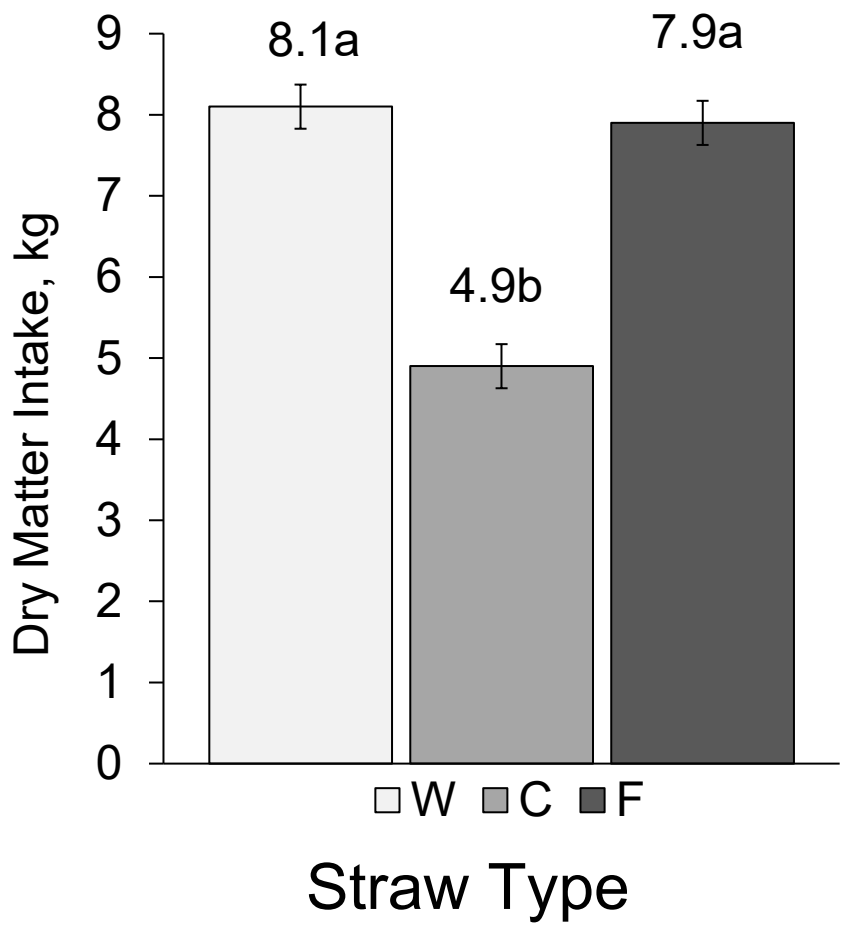
Straw and $Ca(OH)_2$





T × S: $P = 0.98$

Calcium Treatment: $P = 0.01$

Straw type: $P < 0.01$

Ross et al. (2025)

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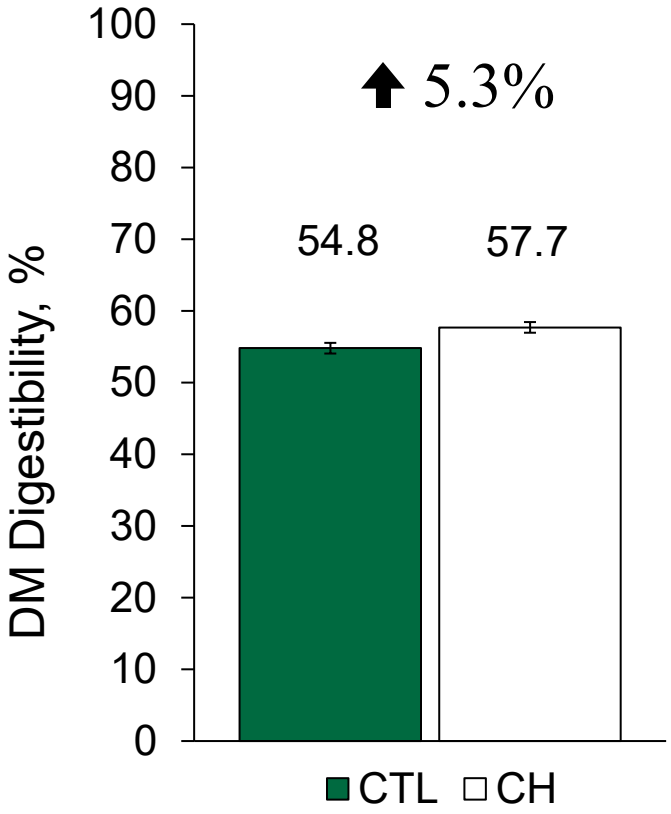
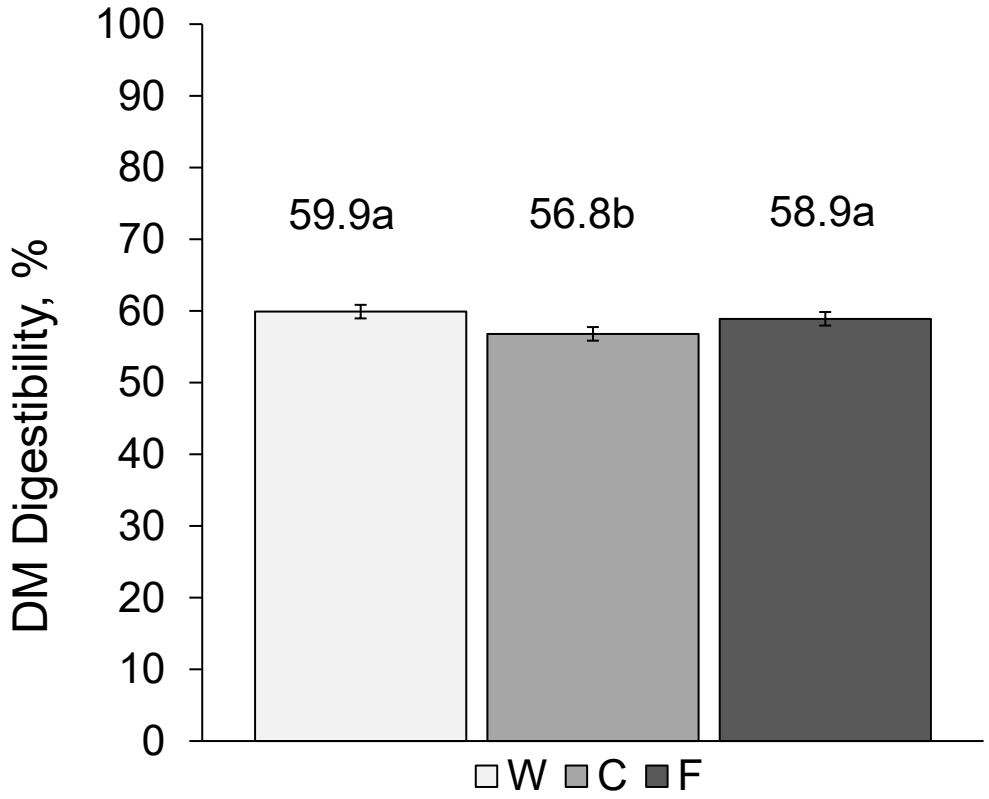
Straw and $Ca(OH)_2$



Calcium Treatment



Straw Type

T × S: $P = 0.61$

Calcium Treatment: $P = 0.02$

Straw type: $P < 0.01$

Ross et al. (2025)

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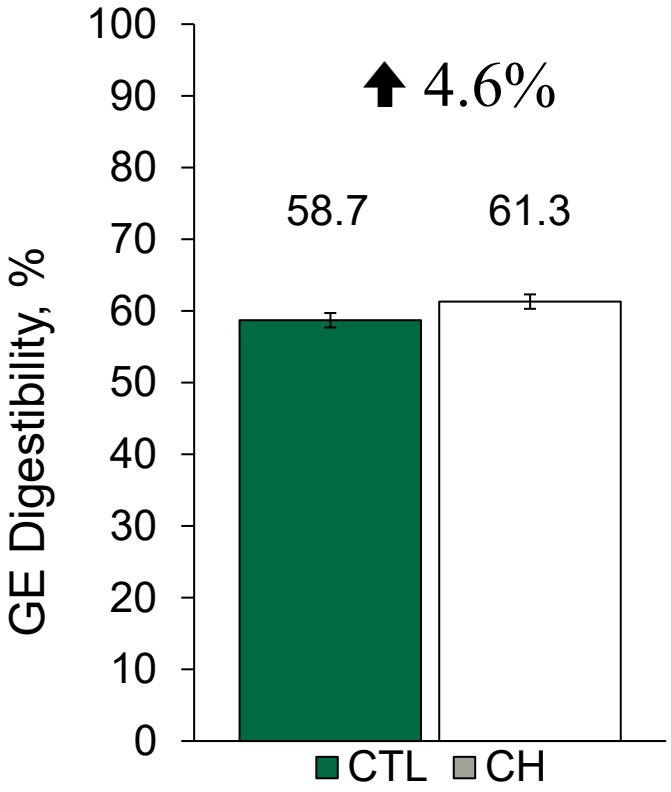
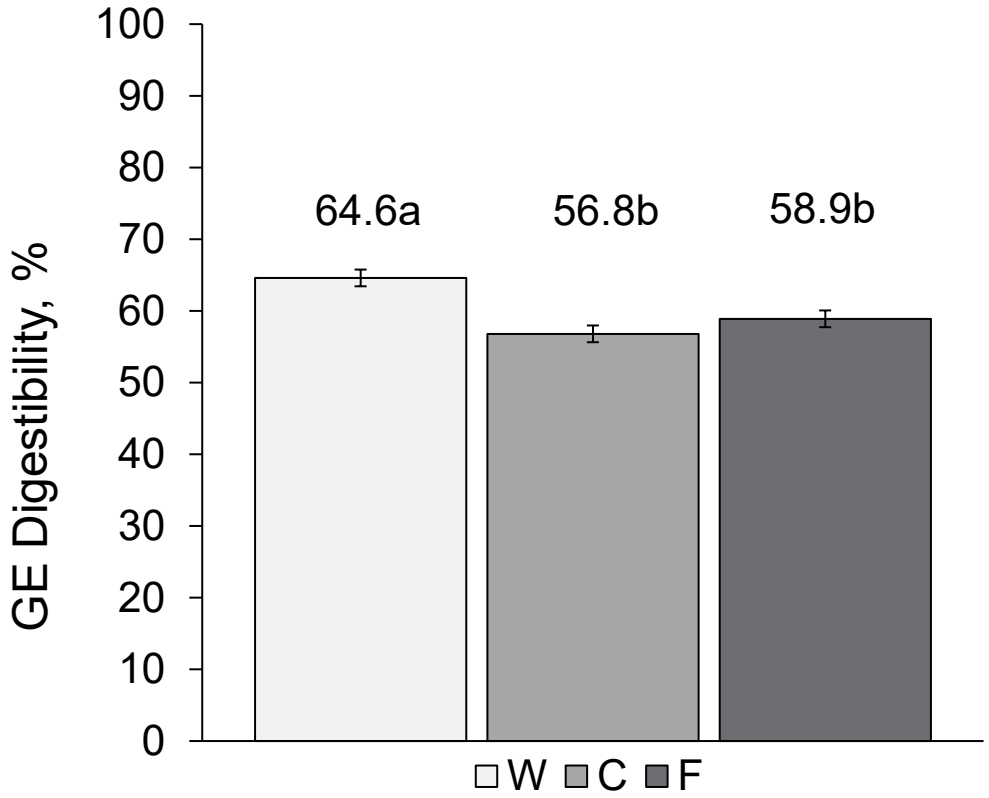
Straw and $Ca(OH)_2$



Calcium Treatment



Straw Type

T × S: $P = 0.91$

Calcium Treatment: $P = 0.03$

Straw type: $P < 0.01$

Ross et al. (2025)

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Summary

- Analyze available feedstuffs and supplement accordingly
  a) Balance rations for protein and energy
  b) Provide an appropriate mineral and vitamin supplement
- Adjust roughage NDF inclusion in the diet (5-6% of diet DM)
- Make sure diet uNDF is not above 7-8% of diet DM (barley grain-based diets)
- Add water to improve mixing and prevent sorting
- Consider alkali treatments
- **Straw can be a valuable resource if its limitations are understood and corrected**

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Table. Pricing of main diet ingredients used to calculate diet cost, (as fed basis).

Ingredient	$/Tonne
Barley grain	266.70
Barley silage	87.00
Wheat Straw	103.75
Canola Screenings	232.00
Flax Screenings	226.70
Canola Meal	484.08
Limestone	307.00