



## Forage Production, Quality and Cost Comparison for Selected Varieties of Forage Oats, Forage Barley, Forage Wheat, and Spring Triticale

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### Summary

*Annual cool-season cereal forages are excellent feed sources for livestock. Determining which forage type to plant becomes the question. Forage oats were the highest-producing cereal crop in 2019, ranging from 2.6 to 3.7 tons/acre. During the drought year in 2020, no differences were found between the forage types: oats, barley, wheat, and triticale.*

*On average, the spring triticale varieties had the highest crude protein content, with all over 11% at the early dough stage in 2019 and all but BYS FT in 2020. Among the oat varieties, only the forage oat Goliath had a crude protein content greater than 11% in 2019. The forage oats, barley and wheat had a crude protein content between 10 and 11% in 2020.*

*The forage barley varieties, along with BYS FT spring triticale, contained the lowest levels of acid detergent lignin: less than 4% in 2019 and 2020 with all forage oats less than 4% in 2020. Total digestible nutrients also were highest in the forage barley varieties and BYS FT spring triticale in 2019 and highest in the forage wheat in 2020. The forage oat varieties were the lowest cost forages to produce based on seed cost in 2019, with the Everleaf 126 the lowest at \$9.05 per ton of forage. However, in 2020 forage oat, barley and wheat were the lowest cost forage types, with M120 forage oat and Hayes forage barley lowest at \$11.03 and \$11.93, respectively.*

### Introduction

Annual forages are a common feedstuff for the livestock industry and are planted each year in North Dakota. Approximately 2.65 million acres of hay were harvested in North Dakota in 2018 (U.S. Department of Agriculture - National Agricultural Statistics Service, 2019), with alfalfa comprising 1.47 million acres and other hay types 1.2 million acres. Annual cereal crops are a popular hay type planted for spring and summer forages.

The awnless forage barley was developed for drier climates in the late 1970s and 1980s. Forage barley can produce good-quality hay but tends to be lower

quality than oats and triticale. Barley can be established on well-drained soils and is considered to be the earliest maturing small grain.

Forage oats have been popular in cover crop mixtures and can make exceptional hay with good tonnage and high quality. Oats can be established on well-drained, fertile soils. Many varieties of forage oats have been developed for the northern Plains, with the age of maturity varying among varieties.

Spring triticale is a hybrid developed by crossing wheat and rye. Drought tolerance is the primary advantage spring triticale has over other spring cereal forage crops. Trials conducted in Alberta, Canada, showed spring triticale to be higher yielding than barley or oats from 1995 to 2000 (Salmon et al., 2001).

### Study Area

This study was conducted on the Central Grasslands Research Extension Center (CGREC) in 2019 and the Tri-county Agronomy Plot near Wishek in 2020.



Forage oats in the annual cereal forage variety trial near Wishek, ND in 2020. Photos by Kevin Sedivec

**Table 1.** Precipitation and average temperature during the study period May through August at the Central Grasslands Research Extension Center in 2019 and 2020 (NDAWN, 2020).

Month	Precipitation (inches)		Percent of Normal		Average Temperature (°F)		Departure from Average (°F)	
	2019	2020	2019	2020	2019	2020	2019	2020
May	2.99	1.81	122	74	49	51	-5	-3
June	3.47	1.35	102	39	64	67	0	4
July	4.15	2.13	130	66	69	71	-1	2
August	2.52	2.73	109	118	64	69	-4	1

Experimental plots at CGREC were on soils of the Hecla-Ulen soil series, classified as loamy fine sands; and plots at Wishek on soils of the Lehr-Bowdle soil series and classified as loamy (USDA, Natural Resources Conservation Service, 2020). Precipitation was at or above average for May through August in 2019 and well below average for May through July in 2020 (Table 1). In 2019, average temperature was 1 to 5 degrees F cooler than the long-term average for the duration of the study, except in June; and in 2020, 1 to 4 degrees F warmer than the average for the duration of study, except in May (Table 1).

### Procedures

- The trial was planted on May 28, 2019, on 25- x 50-foot plots that previously were left fallow, and May 12, 2020, on 5- x 25-foot plots that were previously seeded to wheat.
- All plots at CGREC have been no-till for five years or more. All plots were sprayed with 1 quart of glyphosate + 1 ounce of Sharpen/acre to kill volunteer yellow foxtail (*Setaria pumila*) on the same day the plots were seeded. All plots at Wishek have a history of tillage.
- In 2019, the following varieties were studied: four varieties of forage oats (Goliath, 4010 Everleaf 126, Mustang 120, BYS FO), four varieties of spring triticale (Bunker, Merlin, BYS FT, 141) and three varieties of forage barley (Haymaker, Axcel, Hayes). The Hayes forage barley was heavily invaded by ground squirrels and was not included in the final analysis.
- In 2020, the varieties included: four varieties of forage oats (Goliath, 4010 Everleaf 126, Mustang 120, BYS FO), seven varieties of spring triticale (Bunker, Merlin, BYS FT, Surge, Thor, Flex 719,

Exp. 2063) and three varieties of forage barley (Haymaker, Axcel, Hayes), and one variety of forage wheat.

- In 2019, all varieties were seeded at 90 lb/acre.
- In 2020, all forage oat varieties were seeded at 64 lb/acre except Everleaf 126 (80 lb/ac). All forage barley and triticale were seeded at 90 lb/acre except Bunker (100 lb/ac).
- The targeted harvest stage was early dough.
- All nutritional analysis was conducted at the North Dakota State University Nutrition Lab using AOAC standards (AOAC, 2019).
- Total digestible nutrients were determined using acid detergent fiber and the energy equation for grass (98.625-[1.048\*ADF]).
- Study design was a randomized block design with four replications and was analyzed used a general linear model in SAS (SAS version 9.4; SAS Inst. Inc., Cary, N.C.). Means were separated using the post hoc test Duncan's Multiple Range Test (Duncan, 1955).

### Results

Forage oats were the highest-producing cereal forages in 2019 (Table 2). Everleaf 126 and Goliath were the highest-producing forage oat. We found no difference in yield between the spring triticale and forage barley varieties (Table 2). All forage oat varieties and spring triticale Merlin Max had the best stand establishment, and forage oat varieties Everleaf 126, Goliath and BYS FO were best at suppressing weeds, with yellow foxtail the most common weed.

We found no difference in yield among all forage types and varieties in 2020, except Haymaker forage

**Table 2.** Days to early dough, plant height, harvest date, and yield for selected varieties of forage oats, forage barley, spring triticale and forage wheat at Central Grasslands Research Extension Center in 2019 and Wishek Tri-county Agronomy Plot in 2020.

		Days to Early Dough		Plant Height (inches)		Harvest Date		Yield (100% DM) <sup>2</sup> (ton/ac)	
Cereal Crop <sup>1</sup>	Variety	2019	2020	2019	2020	2019	2020	2019	2020
FO	Everleaf 126	66	64	41	26	Aug. 8	July 15	3.68 <sup>a</sup>	1.99 <sup>ab</sup>
FO	Goliath	50	57	48	32	July 23	July 8	3.24 <sup>ab</sup>	1.71 <sup>ab</sup>
FO	Mustang 120	50	57	48	35	July 23	July 8	2.67 <sup>bc</sup>	2.03 <sup>ab</sup>
FO	BYS FO	50	57	44	30	July 23	July 8	2.57 <sup>bcd</sup>	1.65 <sup>ab</sup>
ST	BYS FT	50	57	36	33	July 23	July 8	1.88 <sup>cde</sup>	1.69 <sup>ab</sup>
ST	Merlin Max	50	57	37	28	July 23	July 8	1.75 <sup>de</sup>	1.51 <sup>ab</sup>
ST	Bunker	50	57	39	32	July 23	July 8	1.41 <sup>e</sup>	1.40 <sup>b</sup>
ST	141	50	57	41	---	July 23	July 8	1.31 <sup>e</sup>	-----
FB	Axcel	56	57	27	23	July 24	July 8	1.45 <sup>e</sup>	2.00 <sup>ab</sup>
FB	Haymaker	56	57	31	27	July 24	July 8	1.34 <sup>e</sup>	2.17 <sup>a</sup>
FB	Hayes	---	57	---	24	-----	July 8	-----	1.93 <sup>ab</sup>
ST	Flex 719	---	64	---	39	-----	July 15	-----	1.46 <sup>ab</sup>
ST	Surge	---	57	---	32	-----	July 8	-----	1.58 <sup>ab</sup>
ST	Thor	---	57	---	34	-----	July 8	-----	1.44 <sup>ab</sup>
ST	Exp. 2063	---	64	---	31	-----	July 15	-----	1.88 <sup>ab</sup>
FW	3099	---	64	---	25	-----	July 15	-----	1.80 <sup>ab</sup>

<sup>1</sup> FO = forage oat, ST = spring triticale, FB = forage barley, FW = forage wheat.

<sup>2</sup> Varieties with the same letter (a, b, c, d, e) in a column are not statistically different ( $P>0.05$ ).

barley was greater than Bunker triticale (Table 2).

Forage barleys Axcel and Haymaker, and spring triticale BYS FT had the highest total digestible nutrient (TDN) levels in 2019 (Table 3). Forage wheat had the highest TDN content in 2020 (Table 3).

The Everleaf 126 forage oat was the poorest-performing forage in terms of crude protein, with Bunker triticale the superior forage in this trial in 2019. All the triticale varieties except 141 had a crude protein content greater than 11% in 2019 and BYS FT in 2020 (Table 3).

The forage barley varieties contained the lowest levels of acid detergent lignin, followed by forage oat BYS FO; all three were less than 4% in 2019 and 2020 (Table 3).

All forage cereal varieties provided the minimum

requirements of phosphorus for 1,200-pound gestating and early lactating beef cattle in both years (National Research Council, 2016).

All forage cereal varieties were deficient of calcium for the minimum requirements for gestating 1,200-pound beef cattle (National Research Council 2016) in 2019 (Table 3). However, all the oat and barley varieties, and triticale varieties Merlin Max and Flex 719 provided the minimum levels in 2020.

All forage cereal varieties were analyzed for potassium nitrate to determine if toxic levels occurred. With 2020 considered a drought year, nitrate toxicity in feeds fed to livestock can be more common in cereal forages, especially oats.

Forages with potassium nitrate levels in a range of 0 to 7,220 ppm are considered safe for livestock (Block,

**Table 3.** Forage quality content for selected varieties of forage oats, forage barley, spring triticale and forage wheat at Central Grasslands Research Extension Center in 2019 and Wishek Tri-county Agronomy Plot in 2020.

Cereal Crop <sup>1</sup>	Variety	Crude Protein <sup>1</sup> (%)		Acid Detergent Fiber <sup>1</sup> (%)		Acid Detergent Lignin <sup>1</sup> (%)		Total Digestible Nutrients <sup>2</sup> (%)		Calcium <sup>3</sup> (%)		Phosphorus <sup>3</sup> (%)	
		2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
FO	Everleaf 126	8.8 <sup>b</sup>	10.5 <sup>d</sup>	35.2 <sup>ab</sup>	32.9 <sup>bcd</sup>	4.6 <sup>a</sup>	3.8 <sup>fgh</sup>	61.9 <sup>ab</sup>	64.8 <sup>abc</sup>	0.27	0.40 <sup>a</sup>	0.21	0.26 <sup>bcd</sup>
FO	Mustang 120	9.5 <sup>ab</sup>	10.1 <sup>d</sup>	35.2 <sup>ab</sup>	34.2 <sup>abcd</sup>	4.2 <sup>ab</sup>	3.9 <sup>efg</sup>	61.8 <sup>ab</sup>	63.9 <sup>abcd</sup>	0.24	0.29 <sup>bcd</sup>	0.21	0.19 <sup>h</sup>
FO	BYS FO	9.9 <sup>ab</sup>	10.0 <sup>d</sup>	35.5 <sup>ab</sup>	34.9 <sup>abc</sup>	4.0 <sup>b</sup>	3.8 <sup>fgh</sup>	61.4 <sup>ab</sup>	63.8 <sup>bcd</sup>	0.27	0.33 <sup>b</sup>	0.27	0.23 <sup>efgh</sup>
FO	Goliath	11.0 <sup>ab</sup>	10.0 <sup>d</sup>	37.2 <sup>a</sup>	32.1 <sup>cd</sup>	4.5 <sup>ab</sup>	3.7 <sup>ghi</sup>	59.7 <sup>b</sup>	65.4 <sup>ab</sup>	0.22	0.29 <sup>bcd</sup>	0.21	0.20 <sup>gh</sup>
ST	BYS FT	11.0 <sup>ab</sup>	10.2 <sup>d</sup>	33.7 <sup>ab</sup>	34.2 <sup>abcd</sup>	4.3 <sup>ab</sup>	4.0 <sup>edf</sup>	63.4 <sup>ab</sup>	63.9 <sup>abcd</sup>	0.23	0.22 <sup>fg</sup>	0.27	0.24 <sup>cdef</sup>
ST	Bunker	12.0 <sup>a</sup>	11.2 <sup>bcd</sup>	35.8 <sup>ab</sup>	34.6 <sup>abcd</sup>	4.3 <sup>ab</sup>	4.4 <sup>bc</sup>	61.1 <sup>ab</sup>	63.6 <sup>abcd</sup>	0.22	0.25 <sup>ef</sup>	0.27	0.24 <sup>cdef</sup>
ST	Merlin Max	11.4 <sup>ab</sup>	11.9 <sup>bc</sup>	36.6 <sup>ab</sup>	35.3 <sup>abc</sup>	4.7 <sup>a</sup>	4.6 <sup>b</sup>	60.2 <sup>ab</sup>	63.1 <sup>bcd</sup>	0.27	0.31 <sup>bcd</sup>	0.27	0.28 <sup>bc</sup>
ST	141	10.4 <sup>ab</sup>	-----	36.7 <sup>a</sup>	-----	4.4 <sup>ab</sup>	-----	60.2 <sup>b</sup>	-----	0.25	-----	0.23	-----
FB	Axcel	10.5 <sup>ab</sup>	10.4 <sup>d</sup>	32.3 <sup>b</sup>	32.3 <sup>bcd</sup>	3.5 <sup>c</sup>	3.5 <sup>hi</sup>	64.8 <sup>a</sup>	65.2 <sup>abc</sup>	0.28	0.42 <sup>a</sup>	0.22	0.22 <sup>efgh</sup>
FB	Haymaker	9.7 <sup>ab</sup>	10.7 <sup>cd</sup>	33.4 <sup>ab</sup>	34.4 <sup>abcd</sup>	3.4 <sup>c</sup>	3.4 <sup>i</sup>	63.7 <sup>ab</sup>	63.8 <sup>abcd</sup>	0.28	0.40 <sup>a</sup>	0.22	0.21 <sup>fgh</sup>
FB	Hayes	-----	10.3 <sup>d</sup>	-----	33.1 <sup>abcd</sup>	-----	3.4 <sup>i</sup>	-----	64.7 <sup>abcd</sup>	-----	0.32 <sup>bc</sup>	-----	0.24 <sup>defg</sup>
ST	Flex 719	-----	13.5 <sup>a</sup>	-----	32.6 <sup>bcd</sup>	-----	4.2 <sup>cd</sup>	-----	65.0 <sup>abc</sup>	-----	0.32 <sup>bc</sup>	-----	0.35 <sup>a</sup>
ST	Surge	-----	12.3 <sup>ab</sup>	-----	35.9 <sup>ab</sup>	-----	4.4 <sup>bc</sup>	-----	62.7 <sup>cd</sup>	-----	0.26 <sup>cdef</sup>	-----	0.28 <sup>bc</sup>
ST	Thor	-----	12.3 <sup>ab</sup>	-----	35.6 <sup>abc</sup>	-----	4.1 <sup>cde</sup>	-----	62.9 <sup>bcd</sup>	-----	0.26 <sup>def</sup>	-----	0.29 <sup>b</sup>
ST	Exp. 2063	-----	11.0 <sup>cd</sup>	-----	36.8 <sup>a</sup>	-----	5.0 <sup>a</sup>	-----	62.1 <sup>d</sup>	-----	0.21 <sup>fg</sup>	-----	0.27 <sup>bcd</sup>
FW	3099	-----	11.0 <sup>cd</sup>	-----	30.9 <sup>d</sup>	-----	4.2 <sup>cde</sup>	-----	66.2 <sup>a</sup>	-----	0.19 <sup>g</sup>	-----	0.24 <sup>cdef</sup>

<sup>1</sup> FO = forage oat, ST = spring triticale, FB = forage barley, FW = forage wheat.

<sup>2</sup> Varieties with the same letter (a, b, c, d, e, f, g, h) within a column are not statistically different ( $P>0.05$ ).

<sup>3</sup> We found no difference ( $P>0.05$ ) among varieties in calcium or phosphorus content in 2019.

**Table 4.** Nitrate toxicity (potassium nitrate) levels for selected varieties of forage oats, forage barley, spring triticale and forage wheat at the Wishek Tri-county Agronomy Plot in 2020.

Cereal Crop <sup>1</sup>	Variety	Potassium Nitrate (ppm) <sup>2</sup>
FO	Everleaf 126	4500 <sup>cd</sup>
FO	Goliath	5500 <sup>bcd</sup>
FO	Mustang 120	8500 <sup>ab</sup>
FO	BYS FO	9500 <sup>a</sup>
ST	BYS FT	<2500 <sup>d</sup>
ST	Merlin Max	3380 <sup>d</sup>
ST	Bunker	<2500 <sup>d</sup>
FB	Axcel	2750 <sup>d</sup>
FB	Haymaker	5880 <sup>abcd</sup>
FB	Hayes	3750 <sup>d</sup>
ST	Flex 719	4000 <sup>d</sup>
ST	Surge	4630 <sup>cd</sup>
ST	Thor	4750 <sup>cd</sup>
ST	Exp. 2063	7750 <sup>abc</sup>
FW	3099	<2500 <sup>d</sup>

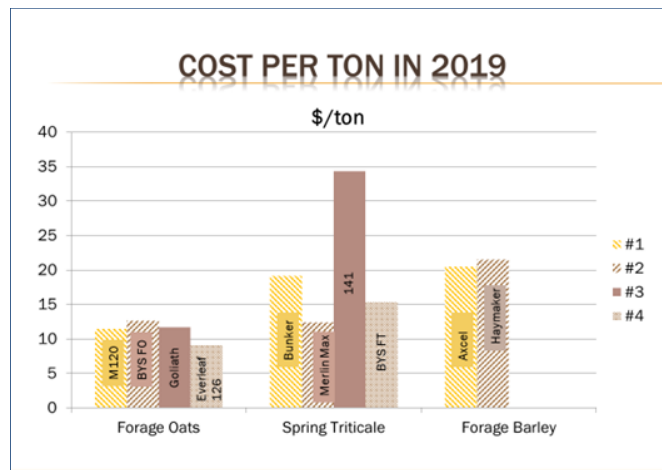
<sup>1</sup> FO = forage oat, ST = spring triticale, FB = forage barley, FW = forage wheat.

<sup>2</sup> Varieties with the same letter (a, b, c, d) are not statistically different ( $P>0.05$ ).

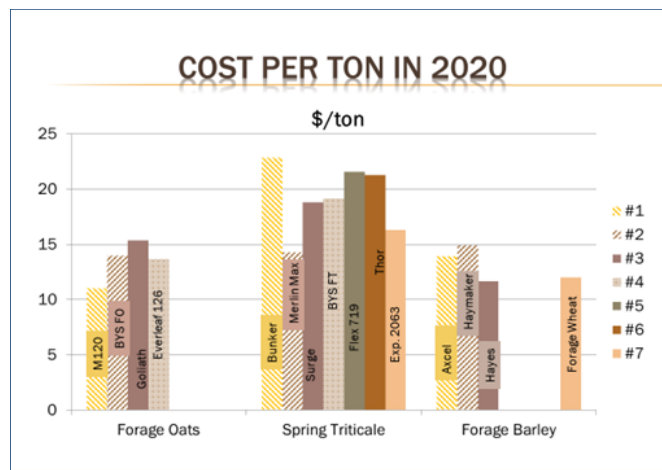
2020). Forage varieties with a mean potassium nitrate level over 7,220 in 2020 included forage oats Mustang 120 and BYS FO, and triticale Exp. 2063 (Table 4).

Because input costs were the same for planting and harvesting all forage cereal crops studied in 2019 and 2020, the only variable would be seed cost. The cost to produce 1 ton/acre of forage was lowest for all four forage oat varieties in 2019, ranging from \$9.05 per ton for Everleaf 126 forage oats to \$12.61 per ton seed cost for BYS FO forage oats. The seed cost to produce 1 ton/acre of Merlin Max spring triticale was \$12.37. All other varieties ranged from \$19.15 to \$34.35 per ton for seed cost (Figure 1).

In 2020, cost associated directly from seed price to produce a ton of forage per acre was lowest for oats and barley (Figure 2). Only the triticale variety Merlin Max was at similar costs to oats and barley in 2020.



**Figure 1.** Cost to produce a ton of forage based on seed price in 2019.



**Figure 2.** Cost to produce a ton of forage based on seed price in 2020.

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