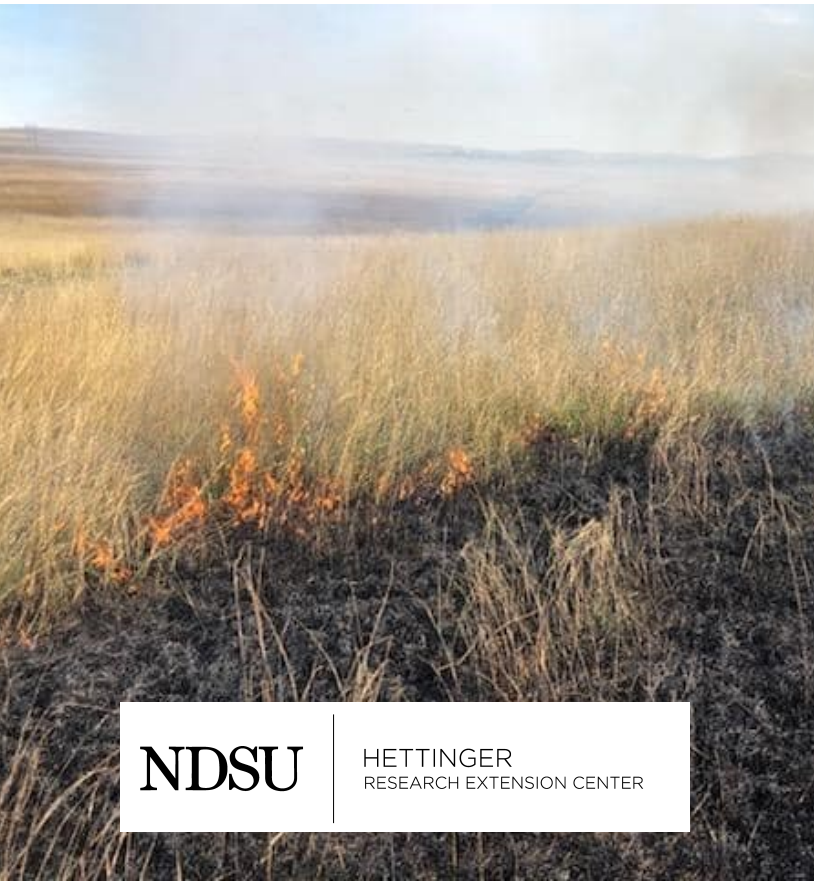
North Dakota State University

Hettinger Research Extension Center

2019 Annual Report



NDSU | HETTINGER RESEARCH EXTENSION CENTER

NORTH DAKOTA **AGRICULTURE EXPERIMENT STATION**

Hettinger Research Extension Center

Hettinger REC Research in Brief

- Integrated crops, livestock, and range research and extension
- Variety, herbicide, and crop production research
- Lamb and beef feedlot nutrition and management
- Reproductive management of fall, winter, and spring lambing ewes
- Multiple-land use management including cropping systems, livestock, and wildlife as potential outputs
- Livestock Extension and applied calf backgrounding

Director: Christopher Schauer

Email: NDSU.Hettinger.REC@ndsu.edu

Web address: http://www.ag.ndsu.edu/HettingerREC/

PO Box 1377
102 Hwy 12 W
Hettinger, ND 58639

Tel: 701-567-4323
Fax: 701-567-4327

The Hettinger Research Extension Center (HREC) was established from a gift of 160 acres by the residents of Adams County and the city of Hettinger in 1909. Currently, the HREC owns or rents nearly 5,000 acres of land, primarily in Adams County, ND, for the purpose of research in weed science, agronomy, range and wildlife science, and animal science. The HREC also lambs over 1,000 sheep and calves close to 100 cows. Currently, we have 13 full-time employees including 4 PhD and 1 M.S. level scientists and extension specialists, 3 research technicians, and 5 support staff.

Research at HREC involves the disciplines of animal science, range and wildlife science agronomy, and weed science. Collaboration is with Main Station scientists, Branch Station scientists, U.S. Forest Service, grazing associations, university scientists from WY, SD, and MT, and USDA research entities in these research disciplines to improve the productivity of livestock and cropping systems and economic development of the region. Through these efforts, the center's research program has gained a national reputation for its involvement with sheep production systems as well as a strong regional and state reputation for its research in agronomy, multiple-land use, and calf backgrounding.

The HREC annual publishes at least 5 refereed journal articles as well as extension articles and lay reports while brining in over $300,000 in grants and contracts, In the past year, staff have given over 60 invited presentations, and have former graduate students across the nation in multiple universities.

AGRONOMY

- Conducted crop variety and hybrid yield trials for 21 different crops at Hettinger along with off-station small grains trials at 4 locations.
- 12 preliminary yield trials/nurseries for wheat, pulse and canola breeding programs.
- Evaluation of carinata, an oilseed mustard like canola, for adaptation to western ND for use biofuel production. This crop looks promising with yields of carinata being competitive with hybrid canola and having fewer problems with seed shatter.
- 10 agronomic studies, including seed treatments, soybean & duram planting dates, spring wheat nitrogen timing, and spring wheat seeding rate.

WEED SCIENCE

- Evaluation of pre-emergence an post-emergence herbicides for weed control and crop tolerance for SW ND.
- Evaluation of fall-applied herbicides for weed control and crop tolerance.
- Options for post-harvest weed control.
- Management of noxious and troublesome weeds in pasture and rangelands.
- Cover crop tolerance to carryover of herbicides applied to spring wheat.
- Contributed to NDSU Weed Control Guide.
- Publish Crops Day report.

HREC Crops, Weeds, Livestock, and Range

RANGE and LIVESTOCK SCIENCE

- Using annual forages to provide forage for grazers and resources for pollinators and a state-wide assessment of pollinator populations.
- Evaluate the ecological effects of integrating livestock herbivory and annual forages into a winter wheat cropping system.
- Patch-burn and sheep/cattle grazing on post Conservation Reserve Program land.

- Evaluated supplementation strategies during pregnancy and their effect on embryonic death loss, fetal development, and potential feedlot and reproductive performance of offspring.
- Continued research in “Value Added Animal Production”; evaluated mineral injection during receiving of freshly weaned calves.
- Evaluation of feeding and supplementation strategies that impact ram fertility.
- Conduct the Dakota Fall Performance Ram Test; a 140 day Rambouillet Certificate of Merit program, one of three Rambouillet Ram Tests in the nation.

OUTREACH and EXTENSION

- Conduct annually the HREC Beef Day, Sheep School, Shearing School, Wool Classing School, Carcass Ultrasound School, Crops Tours, Crops Day, and Soil Health and Wildlife Workshops.
- Analyze wool samples for fiber diameter using an OFDA Fiber Analyzer
- Bi-weekly radio updates during the growing season.
- Implemented Nitrate QuikTest certification program in 41 ND County Extension Offices.
- Annual delivere over 30 presentation to 800 livestock producers.

HREC Research Faculty

Dr. Christopher Schauer, Director & Animal Scientist
christopher.schauer@ndsu.edu

Mr. John Rickertsen, Agronomist
john.rickertsen@ndsu.edu

Dr. Benjamin Geaumont, Wildlife and Range Scientist
benjamin.geaumont@ndsu.edu

Dr. Caleb Dalley, Research Weed Scientist
caleb.dalley@ndsu.edu

Dr. Janna Block, Area Livestock Extension Specialist
janna.block@ndsu.edu

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Weather Summary - Hettinger

Frost Free Days

	28°F	32°F	50% Probability 32°F
Date of Last Frost	May 9	May 20	May 20
Date of First Frost	September 28	September 28	September 16
Frost Free Days	**142**	**131**	**119**

Precipitation (inches)

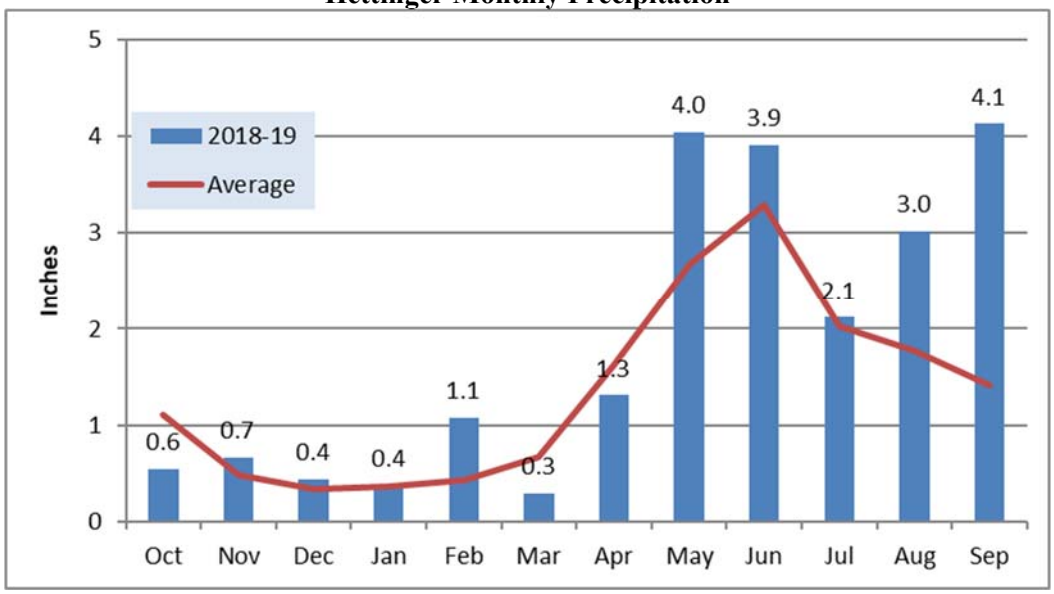
Month	2014-15	2015-16	2016-17	2017-18	2018-19	64 Year Average
October	0.1	2.0	0.9	0.0	0.6	1.1
November	1.0	0.0	0.4	0.2	0.7	0.5
December	0.0	0.5	0.1	0.2	0.4	0.3
January	0.1	0.2	0.6	0.3	0.4	0.4
February	0.0	0.4	0.2	0.6	1.1	0.4
March	0.2	0.2	0.9	0.3	0.3	0.7
April	1.0	3.7	1.2	1.6	1.3	1.6
May	4.0	1.0	0.6	1.7	4.0	2.7
June	5.2	0.9	0.3	3.7	3.9	3.3
July	1.0	1.5	1.7	2.7	2.1	2.0
August	1.9	1.7	1.8	0.9	3.0	1.8
September	0.9	2.3	1.9	1.7	4.1	1.4
April-August	**13.1**	**8.9**	**5.6**	**10.6**	**14.4**	**11.4**
Total	**15.4**	**14.4**	**10.6**	**13.9**	**21.9**	**16.2**

Air Temperature (°F)

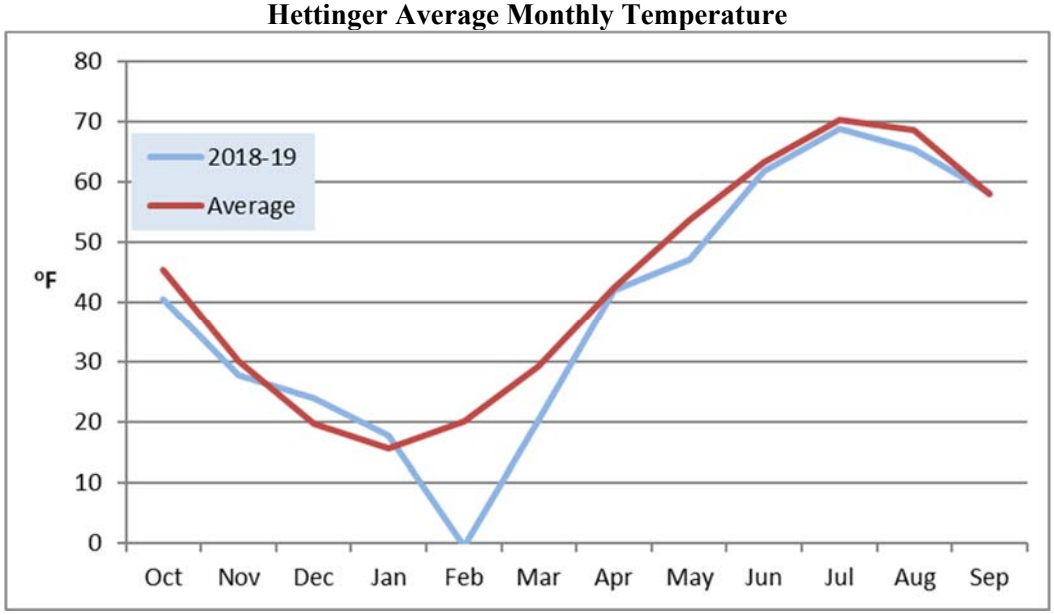
Month	2014-15	2015-16	2016-17	2017-18	2018-19	64 Year Average
October	46.6	48.5	48.1	44.9	40.5	45.5
November	21.3	32.4	39.5	32.4	27.7	30.1
December	23.4	23.9	10.1	19.0	24.0	19.6
January	21.6	20.1	11.8	17.1	17.8	15.6
February	19.1	32.0	24.6	6.0	-0.6	20.0
March	38.0	38.8	34.1	27.4	20.3	29.3
April	43.2	44.2	43.6	35.1	42.0	42.4
May	50.2	54.2	55.2	58.7	47.2	53.7
June	64.6	68.7	66.1	65.4	61.9	63.3
July	70.4	72.0	76.3	69.1	68.8	70.2
August	69.3	69.0	66.8	67.8	65.4	68.6
September	64.1	60.7	58.2	56.3	58.3	58.0
Average	**44.3**	**47.0**	**44.5**	**41.6**	**39.4**	**43.0**

Corn Growing Degree Days (GDD)						
Month	2015	2016	2017	2018	2019	47 Year Average
May	185	298	297	371	154	260
June	444	545	519	467	409	422
July	595	626	699	579	556	587
August	578	568	520	511	529	536
September	462	380	339	321	393	327
Total	**2264**	**2417**	**2374**	**2249**	**2041**	**2132**

Hettinger Monthly Precipitation



Hettinger Average Monthly Temperature



Hard Red Spring Wheat - 2019 **Hettinger, ND**

Variety	Days to Head	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	DAP[1]	inches	0-9[2]	lbs/bu	%	---------- Bushels per acre ----------				
AP Murdock	67	30	0	57.4	14.2	--	--	70.0	--	--
Barlow	66	35	0	58.8	15.1	40.1	40.0	66.3	53.2	48.8
Bolles	68	31	0	56.7	15.8	32.8	25.9	65.1	45.5	41.3
Boost	68	35	0	57.4	14.6	31.2	27.6	67.5	47.6	42.1
CP3504	68	31	0	56.3	13.3	32.7	38.1	70.0	54.1	46.9
CP3530	67	33	0	56.9	14.5	35.9	37.7	66.9	52.3	46.8
CP3616	67	32	0	56.7	15.0	38.7	36.7	62.8	49.8	46.1
CP3888	67	32	0	56.8	14.5	--	36.0	70.6	53.3	--
CP3910	65	30	0	59.0	14.6	--	--	68.4	--	--
CP3915	67	32	0	58.1	15.2	--	--	65.8	--	--
CP3939	67	32	0	56.7	15.6	--	--	65.0	--	--
Dyna-Gro Ambush	66	31	0	58.2	15.4	36.3	39.6	61.6	50.6	45.8
Dyna-Gro Ballistic	67	27	0	56.8	15.1	--	--	57.4	--	--
Dyna-Gro Commander	66	31	0	58.0	14.7	--	--	69.0	--	--
Elgin ND	67	37	0	56.9	15.2	38.4	43.8	68.2	56.0	50.1
Faller	67	35	0	56.9	14.3	41.5	38.2	71.8	55.0	50.5
Glenn	65	34	0	57.3	15.4	32.1	38.9	57.6	48.3	42.9
Lang MN	68	32	0	58.1	14.6	36.3	38.4	68.7	53.6	47.8
Lanning	66	31	0	56.7	16.0	--	45.7	64.5	55.1	--
LCS Breakaway	66	30	0	58.6	15.7	34.8	30.0	67.5	48.8	44.1
LCS Cannon	65	29	0	59.2	15.1	--	36.9	63.5	50.2	--
LCS Rebel	66	33	0	58.0	15.2	36.8	40.0	63.7	51.9	46.8
LCS Trigger	70	32	0	57.9	12.5	44.5	50.3	70.0	60.2	54.9
Linkert	67	29	0	58.3	16.7	34.0	30.3	57.0	43.7	40.4
MN Washburn	67	29	0	57.2	14.5	--	30.1	64.7	47.4	--
Mott	68	38	0	57.2	15.1	36.6	31.5	62.8	47.2	43.6
MS Barracuda	65	30	0	57.7	15.2	--	35.0	66.9	51.0	--
MS Camaro	67	29	0	58.4	15.1	31.4	24.1	63.7	43.9	39.7
MS Chevelle	67	30	0	57.6	13.7	37.5	42.5	71.8	57.2	50.6
ND VitPro	66	31	0	57.3	16.0	31.9	37.9	61.5	49.7	43.8
Prestige	67	31	0	56.3	15.0	32.6	40.1	59.7	49.9	44.1
Redstone	71	33	0	57.2	13.7	38.3	33.7	69.2	51.5	47.1
Shelly	69	30	0	57.0	14.3	43.9	38.2	68.3	53.3	50.1
Surpass	65	31	0	57.0	14.4	36.7	29.1	67.4	48.3	44.4
SY 611 CL2	67	30	0	59.0	13.9	--	33.4	73.8	53.6	--
SY Ingmar	67	31	0	58.8	15.4	39.9	29.0	62.7	45.9	43.9

Table continued on next page

Hard Red Spring Wheat - 2019 **Hettinger, ND**

Variety	Days to Head	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	DAP[1]	inches	0-9[2]	lbs/bu	%	---------- Bushels per acre ----------				
Table continues from previous page										
SY Longmire	67	30	0	58.2	14.4	--	35.0	69.0	52.0	--
SY McCloud	66	31	0	58.2	15.7	--	31.7	62.8	47.3	--
SY Rockford	68	32	0	57.3	14.2	39.3	38.8	70.9	54.9	49.7
SY Soren	67	29	0	58.6	15.3	36.5	31.5	67.9	49.7	45.3
SY Valda	67	29	0	57.4	13.9	35.1	36.7	68.7	52.7	46.8
TCG Climax	72	33	0	58.5	15.6	34.5	37.9	57.0	47.5	43.1
TCG Heartland	66	30	0	58.1	15.6	--	--	65.5	--	--
TCG Spitfire	69	33	0	56.5	14.1	37.6	38.9	69.4	54.2	48.6
TCG Stalwart	66	32	0	56.0	15.4	--	--	59.8	--	--
Trial Mean	67	32	0	57.7	14.9	35.8	35.5	66.0	50.9	46.1
C.V. %	0.7	4.4	--	1.2	3.6	11.4	12.2	7.1	--	--
LSD 5%	0.6	1.9	--	1.0	0.7	5.7	6.1	6.6	--	--
LSD 10%	0.5	1.6	--	0.8	0.6	4.8	5.1	5.5	--	--

[1] Days to Head = the number of days from planting to head emergence from the boot.

[2] 0 = no lodging, 9 = 100% lodged.

Planting Date: April 24

Harvest Date: August 20

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Hard Red Spring Wheat - 2019 **Scranton, ND**

Variety	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	inches	0-9*	lbs/bu	%	---------- Bushels per acre ----------				
Barlow	31	0	55.7	14.9	15.2	33.0	28.3	30.7	25.5
Bolles	31	0	53.8	16.8	12.5	34.4	18.9	26.7	21.9
CP3504	28	0	54.2	14.3	--	--	34.9	--	--
CP3530	32	0	54.6	14.9	14.8	37.0	26.5	31.8	26.1
CP3616	29	0	53.5	15.7	--	35.4	26.0	30.7	--
DynaGro Ambush	30	0	56.0	14.6	--	36.3	26.7	31.5	--
Elgin-ND	33	0	52.6	15.1	16.4	44.0	30.2	37.1	30.2
Glenn	31	0	52.1	14.8	16.1	33.7	21.2	27.5	23.7
Lang-MN	32	0	56.1	15.2	16.4	44.0	29.5	36.8	30.0
Lanning	30	0	51.2	15.8	--	--	25.0	--	--
LCS Cannon	28	0	56.7	13.8	--	--	27.8	--	--
LCS Rebel	32	0	56.7	14.6	--	33.9	25.8	29.9	--
LCS Trigger	32	0	53.7	13.1	13.8	57.0	39.1	48.1	36.6
MN Washburn	29	0	54.0	14.1	--	--	29.0	--	--
Mott	34	0	52.9	15.5	15.4	37.2	25.6	31.4	26.1
MS Chevelle	29	0	53.7	13.6	13.5	37.1	26.7	31.9	25.8
ND VitPro	29	0	54.1	15.3	13.7	35.4	24.1	29.8	24.4
Shelly	28	0	53.5	14.2	18.9	44.2	26.0	35.1	29.7
SY Ingmar	27	0	54.8	14.9	14.1	37.0	28.0	32.5	26.4
SY Longmire	28	0	53.1	14.7	--	--	35.7	--	--
SY Rockford	30	0	53.7	14.9	--	41.1	29.5	35.3	--
SY Soren	27	0	51.9	15.1	18.1	37.2	28.0	32.6	27.8
SY Valda	28	0	56.7	14.6	13.8	35.5	30.7	33.1	26.7
TCG Climax	30	0	56.7	16.4	--	45.1	32.5	38.8	--
TCG Spitfire	30	0	54.4	14.2	17.8	46.7	36.0	41.4	33.5
Trial Mean	30	0	54.3	14.9	15.6	39.9	28.1	33.2	27.2
C.V. %	4.9	--	3.4	3.2	16.5	5.3	16.8	--	--
LSD 5%	2.0	NS	2.6	0.7	3.6	3.0	6.6	--	--
LSD 10%	1.7	NS	2.2	0.6	3.0	2.5	5.6	--	--

* 0 = no lodging, 9 = 100% lodged.

Planting Date: May 15

Harvest Date: September 4

Scranton suffered from hail damage in 2019.

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Hard Red Spring Wheat - 2019 **Regent, ND**

Variety	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	inches	0-9*	lbs/bu	%	---------- Bushels per acre ----------				
Barlow	31	0	55.3	14.6	17.7	45.1	40.9	43.0	34.6
Bolles	28	0	55.2	16.3	15.5	45.2	41.5	43.4	34.1
CP3504	27	0	55.0	14.1	--	--	44.3	--	--
CP3530	32	0	54.6	14.5	14.5	49.9	39.7	44.8	34.7
CP3616	28	0	55.3	15.1	--	--	42.9	--	--
DynaGro Ambush	28	4	56.3	14.4	--	45.4	41.5	43.5	--
Elgin-ND	32	0	55.2	14.7	18.8	48.6	48.7	48.7	38.7
Glenn	30	0	54.0	14.7	17.2	46.3	39.0	42.7	34.2
Lang-MN	31	0	56.8	14.7	19.4	53.4	47.7	50.6	40.2
Lanning	29	0	52.5	15.0	--	--	46.0	--	--
LCS Cannon	26	0	55.5	13.8	--	--	37.5	--	--
LCS Rebel	30	0	56.3	14.7	--	48.8	42.7	45.8	--
LCS Trigger	29	0	56.7	12.4	20.7	52.9	58.8	55.9	44.1
MN Washburn	26	0	55.0	13.7	--	--	44.6	--	--
Mott	33	0	55.6	14.6	16.7	46.8	49.4	48.1	37.6
MS Chevelle	28	0	55.0	13.4	21.3	46.3	37.6	42.0	35.1
ND VitPro	29	0	53.3	14.6	16.9	48.3	38.0	43.2	34.4
Shelly	26	0	55.6	13.2	18.9	51.6	44.3	48.0	38.3
SY Ingmar	26	0	56.9	14.8	19.8	44.3	42.3	43.3	35.5
SY Longmire	27	0	54.6	14.2	--	--	49.6	--	--
SY Rockford	29	0	53.8	14.6	--	51.3	44.0	47.7	--
SY Soren	27	0	56.5	14.9	15.4	47.3	44.1	45.7	35.6
SY Valda	27	0	54.7	14.5	18.7	51.4	43.7	47.6	37.9
TCG Climax	28	0	56.9	15.9	--	44.8	47.3	46.1	--
TCG Spitfire	28	0	54.7	13.9	16.7	48.9	51.9	50.4	39.2
Trial Mean	29	0	55.3	14.5	17.7	48.1	44.2	46.3	36.9
C.V. %	4.8	69.2	1.6	1.9	13.5	6.3	6.9	--	--
LSD 5%	2.0	0.1	1.2	0.4	3.4	4.3	4.3	--	--
LSD 10%	1.7	0.1	1.0	0.3	2.8	3.6	3.6	--	--

* 0 = no lodging, 9 = 100% lodged.

Planting Date: May 15

Harvest Date: September 4

Hard Red Spring Wheat - 2019 **Mandan, ND**

Variety	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	inches	0-9*	lbs/bu	%	---------- Bushels per acre ----------				
AP Murdock	26	0	56.6	11.2	--	--	40.6	--	--
Barlow	31	0	57.0	12.5	16.0	46.2	34.4	40.3	32.2
Bolles	29	0	56.3	12.8	7.5	48.6	35.6	42.1	30.6
Boost	31	0	56.9	12.3	16.0	50.5	34.8	42.7	33.8
CP3504	27	0	56.4	11.3	--	46.2	43.7	45.0	--
CP3530	33	0	56.7	12.3	18.3	48.2	38.8	43.5	35.1
CP3616	28	0	55.4	13.3	--	46.5	36.8	41.7	--
CP3888	28	0	55.9	12.3	--	51.5	40.0	45.8	--
CP3910	25	0	55.9	12.7	--	--	33.6	--	--
CP3915	28	0	55.4	12.2	--	--	36.2	--	--
CP3939	28	0	54.8	13.0	--	--	34.0	--	--
DynaGro Ambush	27	0	57.3	12.4	--	50.5	36.2	43.4	--
DynaGro Ballistic	24	0	54.8	14.2	--	--	31.9	--	--
DynaGro Commander	29	0	55.7	12.9	--	--	35.0	--	--
Elgin-ND	31	0	56.4	12.4	17.4	48.9	38.7	43.8	35.0
Faller	31	0	56.1	11.5	--	45.6	42.1	43.9	--
Glenn	32	0	56.3	12.3	11.1	56.0	34.8	45.4	34.0
Lang-MN	32	0	56.8	13.1	21.1	51.3	40.0	45.7	37.5
Lanning	28	0	54.1	13.0	--	46.3	36.7	41.5	--
LCS Breakaway	27	0	56.5	12.6	--	49.6	34.1	41.9	--
LCS Cannon	27	0	56.8	11.7	--	50.0	37.1	43.6	--
LCS Rebel	31	0	56.5	13.1	--	52.0	36.8	44.4	--
LCS Trigger	29	0	57.5	10.5	28.7	43.5	41.7	42.6	38.0
Linkert	26	0	56.5	13.8	--	45.9	35.5	40.7	--
MN Washburn	28	0	54.5	12.5	--	52.4	35.4	43.9	--
Mott	33	0	56.8	12.4	18.2	45.1	40.0	42.6	34.4
MS Barracuda	26	0	55.8	12.0	--	50.2	34.7	42.5	--
MS Camaro	26	0	55.9	13.5	--	51.6	31.9	41.8	--
MS Chevelle	28	0	55.7	11.6	22.6	49.8	36.3	43.1	36.2
ND VitPro	28	0	54.4	13.0	16.2	47.1	36.9	42.0	33.4
Prestige	28	0	56.3	12.4	--	46.5	25.7	36.1	--
Redstone	29	0	57.2	10.6	22.3	44.7	34.4	39.6	33.8
Shelly	28	0	55.4	11.9	15.0	51.8	37.2	44.5	34.7
Surpass	31	0	56.4	11.2	17.4	51.4	41.9	46.7	36.9
SY 611 CL2	28	0	57.4	11.7	--	45.3	40.7	43.0	--
SY Ingmar	27	0	56.2	13.3	20.5	55.4	33.0	44.2	36.3

Table continued on next page

Hard Red Spring Wheat - 2019 **Mandan, ND**

Variety	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	inches	0-9*	lbs/bu	%	---------- Bushels per acre ----------				
Table continues from previous page									
SY Longmire	28	0	54.4	12.8	--	52.6	32.6	42.6	--
SY McCloud	29	0	56.8	13.2	--	45.8	32.5	39.2	--
SY Rockford	29	0	55.3	12.3	--	46.0	38.2	42.1	--
SY Soren	26	0	55.5	13.0	18.3	48.0	30.4	39.2	32.2
SY Valda	26	0	57.1	11.8	19.1	46.0	41.5	43.8	35.5
TCG Climax	27	0	59.2	13.1	--	54.8	36.2	45.5	--
TCG Heartland	26	0	54.9	13.1	--	--	30.9	--	--
TCG Sptifire	28	0	55.1	11.8	23.2	49.2	38.5	43.9	37.0
TCG Stalwart	27	0	51.1	14.0	--	--	26.6	--	--
Trial Mean	29	0	56.2	12.5	18.5	49.3	36.1	43.2	34.5
C.V. %	4.9	--	1.7	4.0	15.7	12.2	7.6	--	--
LSD 5%	2.0	--	1.3	0.7	4.1	8.4	3.8	--	--
LSD 10%	1.7	--	1.1	0.6	3.4	7.0	3.2	--	--

* 0 = no lodging, 9 = 100% lodged.

Planting Date: May 16

Harvest Date: September 5

Hard Red Winter Wheat - 2019 **Hettinger, ND**

Variety	Heading Date	Plant Height	Plant Lodge	Test Weight	Grain Protein	---- Grain Yield ---- 2017	2018	2019	Average Yield 2 yr	3 yr
	Julian	inches	0-9[1]	lbs/bu	%	---------- Bushels per acre ----------				
AC Emerson	177	33	0	61.4	12.4	70.6	30.6	60.9	45.8	54.0
Decade-Fhb1	172	29	0	59.5	12.1	76.2	19.5	65.4	42.5	53.7
Ideal	175	29	0	58.8	11.6	88.2	26.6	66.0	46.3	60.3
Jerry	175	36	0	59.9	12.3	76.1	29.7	64.8	47.3	56.9
Keldin	176	31	0	59.9	11.7	101.2	37.2	70.6	53.9	69.7
Loma	179	27	0	59.2	12.4	71.5	36.5	58.4	47.5	55.5
Northern	176	31	0	60.2	12.2	78.9	33.7	74.5	54.1	62.4
Oahe	173	33	0	61.2	12.1	83.1	28.2	69.5	48.9	60.3
Overland-Fhb1	173	29	0	57.4	11.9	90.9	26.9	53.3	40.1	57.0
Peregrine	177	37	0	61.0	11.0	81.1	38.0	66.0	52.0	61.7
SY Monument	173	29	0	58.3	11.4	99.6	27.6	71.6	49.6	66.3
SY Sunrise	172	24	0	60.4	12.0	85.6	20.4	64.5	42.5	56.8
SY Wolf	174	28	0	59.6	13.2	93.9	24.3	63.8	44.1	60.7
SY Wolverine	171	25	0	58.5	12.9	--	--	62.1	--	--
TCG-Boomlock	174	32	0	61.4	12.3	--	--	65.3	--	--
Thompson	174	32	0	58.6	12.1	--	33.0	64.9	49.0	--
WB4462	170	30	0	60.6	11.6	--	20.1	69.4	44.8	--
WB4595	174	29	0	63.1	11.9	--	--	71.2	--	--
Trial Mean	174	30	0.0	59.9	12.2	82.2	30.3	65.4	47.2	59.6
C.V. %	0.6	3.9	--	2.0	5.2	9.4	18.3	6.0	--	--
LSD 0.05	1.5	1.7	NS	1.7	0.9	10.8	7.8	5.6	--	--
LSD 0.10	1.2	1.4	NS	1.4	0.7	9.1	6.5	4.7	--	--

[1] 0 = no lodging, 9 = 100% lodged.

Previous Crop: Oats

Planting Date: September 28

Harvest Date: August 6

Winter Rye - 2019 **Hettinger, ND**

Variety	Spring Stand	Heading Date	Plant Height	Plant Lodge	Test Weight	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	%		inches	0-9[1]	lbs/bu	---------- Bushels per acre ----------				
Aroostok	90	6/11	54	5	52.1	53.2	27.6	54.1	40.9	45.0
Bono (hybrid)	90	6/13	39	0	55.5	--	--	98.2	--	--
Brasetto (hybrid)	90	6/13	40	0	53.1	97.8	58.6	89.9	74.3	82.1
Dacold	48	6/14	51	2	47.9	76.6	37.6	43.8	40.7	52.7
ND Dylan	90	6/12	51	7	53.6	74.5	21.6	69.5	45.6	55.2
ND Gardner	90	6/11	51	5	52.9	61.1	28.6	61.7	45.2	50.5
Hancock	68	6/13	53	3	51.0	66.1	29.7	47.0	38.4	47.6
Hazlet	90	6/12	51	2	53.3	84.9	40.2	68.6	54.4	64.6
Rymin	90	6/12	51	4	52.5	85.4	39.6	65.0	52.3	63.3
Spooner	90	6/11	49	4	53.1	61.4	32.6	63.2	47.9	52.4
Wheeler	90	6/12	55	0	52.0	50.8	25.6	27.9	26.8	34.8
Trial Mean	84	6/12	50	3	52.4	70.0	34.2	62.6	46.6	54.8
C.V. %	2.6	0.1	5.9	32.7	2.3	6.7	15.3	6.9	--	--
LSD 0.05	3.1	1.8	4.2	1.3	1.7	6.8	7.6	6.2	--	--
LSD 0.10	2.6	1.5	3.5	1.1	1.4	5.6	6.3	5.2	--	--

[1] 0 = no lodging, 9 = 100% lodged.

Planting Date: September 28

Harvest Date: August 6

Durum Wheat - 2019 **Hettinger, ND**

Variety	Days to Head	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	DAP[1]	inches	0-9[2]	lbs/bu	%	---------- Bushels per acre ----------				
AC Commander	69	30	4	56.8	14.4	38.0	37.3	57.5	47.4	44.3
Alkabo	69	35	2	57.6	13.5	32.6	38.1	73.6	55.9	48.1
Alzada	67	29	6	54.9	14.4	34.0	35.6	48.2	41.9	39.3
Ben	68	36	3	58.0	14.5	35.1	31.9	60.3	46.1	42.4
Carpio	70	36	3	57.5	13.6	36.5	41.9	63.7	52.8	47.4
CDC Verona	69	36	1	57.4	14.6	36.0	36.2	67.7	52.0	46.6
Divide	69	35	3	58.4	13.8	33.5	34.1	70.8	52.5	46.1
Grenora	68	33	2	56.9	14.2	33.3	38.3	67.9	53.1	46.5
Joppa	69	35	3	58.3	12.9	35.7	34.6	66.2	50.4	45.5
Lebsock	68	33	3	58.1	13.4	37.8	33.2	64.8	49.0	45.3
Maier	68	36	2	57.2	14.8	33.5	35.9	62.7	49.3	44.0
Mountrail	68	35	4	57.9	13.2	38.9	37.7	66.9	52.3	47.8
ND Grano	69	36	3	56.9	13.5	35.7	34.6	68.5	51.6	46.3
ND Riveland	69	36	1	58.2	13.4	37.3	36.3	73.0	54.7	48.9
Pierce	68	36	3	59.2	13.8	34.7	32.2	69.6	50.9	45.5
Rugby	67	37	3	57.7	14.1	34.1	31.5	59.8	45.7	41.8
Strongfield	70	36	3	56.9	14.5	38.9	38.8	67.0	52.9	48.2
Tioga	69	36	3	58.0	13.6	33.8	32.1	64.5	48.3	43.5
VT Peak	68	35	2	59.2	14.1	37.2	39.5	72.4	56.0	49.7
Trial Mean	69	36	3	57.8	13.9	36.1	36.7	67.6	51.5	46.1
C.V. %	0.7	4.2	33.9	1.3	4.2	9.7	8.1	7.6	--	--
LSD 5%	0.7	2.1	1.3	1.1	0.8	4.9	4.1	7.2	--	--
LSD 10%	0.6	1.8	1.1	0.9	0.7	4.1	3.5	6.1	--	--

[1] Days to Head = the number of days from planting to head emergence from the boot.

[2] 0 = no lodging, 9 = 100% lodged.

Planting Date: April 24

Harvest Date: August 26

Durum Wheat - 2019 **Scranton, ND**

Variety	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	inches	0-9*	lbs/bu	%	---------- Bushels per acre ----------				
Alkabo	31	0	50.2	12.7	20.2	33.6	23.6	28.6	25.8
Carpio	32	0	52.6	13.5	21.6	36.4	23.3	29.9	27.1
Joppa	31	0	53.4	12.8	24.9	34.9	24.9	29.9	28.2
ND Grano	29	0	52.2	13.3	23.7	32.1	22.0	27.1	25.9
ND Riveland	32	0	53.0	13.3	18.8	36.4	21.6	29.0	25.6
Tioga	32	0	52.1	14.1	19.9	34.0	26.3	30.2	26.7
Trial Mean	31	0	52.2	13.3	21.3	34.6	23.6	29.1	26.6
C.V. %	3.2	--	2.3	2.5	12.3	7.7	14.4	--	--
LSD 5%	1.5	NS	1.8	0.5	3.9	4.0	5.1	--	--
LSD 10%	1.3	NS	1.5	0.4	3.2	3.3	4.2	--	--

* 0 = no lodging, 9 = 100% lodged.

Planting Date: May 15

Harvest Date: September 4

Scranton suffered from hail damage in 2019.

Durum Wheat - 2019 **Regent, ND**

Variety	Plant Height	Plant Lodge	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	inches	0-9*	lbs/bu	%	---------- Bushels per acre ----------				
Alkabo	32	0	52.5	13.8	9.8	52.4	43.8	48.1	35.3
Carpio	33	0	52.2	13.6	12.3	49.3	46.5	47.9	36.0
Joppa	32	0	51.3	13.6	12.9	53.8	38.1	46.0	34.9
ND Grano	30	0	52.8	14.1	14.0	50.2	44.1	47.2	36.1
ND Riveland	32	0	52.9	13.6	14.2	52.0	40.9	46.5	35.7
Tioga	34	0	52.6	14.0	13.1	52.3	45.2	48.8	36.9
Trial Mean	32	0	52.4	13.8	13.3	51.7	43.1	47.4	35.8
C.V. %	4.8	--	2.1	2.1	16.5	5.4	8.0	--	--
LSD 5%	2.3	NS	1.6	0.4	3.2	4.2	5.2	--	--
LSD 10%	1.9	NS	1.4	0.4	2.7	3.4	4.3	--	--

* 0 = no lodging, 9 = 100% lodged.

Planting Date: May 15

Harvest Date: September 4

NDSU Hettinger Research Extension Center

Barley - 2019 **Hettinger, ND**

Variety	Days to Head	Plant Height	Plant Lodge	Plump	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	DAP[1]	inches	0-9[2]	%	lbs/bu	%	---------- Bushels per acre ----------				
TWO ROW											
AAC Connect	67	34	4.5	92	46.7	12.5	--	--	109.8	--	--
AAC Synergy	68	36	3	94	47.2	13.0	41.8	88.6	117.4	103.0	82.6
ABI Balster	69	33	4	90	46.8	13.2	53.0	85.1	113.3	99.2	83.8
Conlon	64	36	6	97	48.1	13.0	24.2	75.5	89.0	82.3	62.9
Explorer	67	30	7	91	46.1	13.1	57.8	95.5	90.1	92.8	81.1
ND Genesis	66	39	3	94	48.2	11.9	40.0	90.3	124.7	107.5	85.0
Pinnacle	67	36	7	93	46.4	12.1	49.4	90.4	80.9	85.7	73.6
SIX ROW											
Lacey	65	37	5	95	47.6	13.8	49.9	70.3	101.7	86.0	74.0
Tradition	66	38	5	94	45.7	13.4	46.3	76.4	113.2	94.8	78.6
Trial Mean	66	35	4	94	46.9	12.6	45.4	82.9	107.6	96.7	80.0
C.V. %	0.9	3.8	24.6	3.1	2.3	4.3	15.0	5.7	4.4	--	--
LSD 5%	0.8	1.9	1.5	3.0	1.4	0.8	9.6	6.7	6.7	--	--
LSD 10%	0.7	1.6	1.3	2.5	1.2	0.6	8.0	5.6	5.6	--	--

[1] Days to Head = the number of days from planting to head emergence from the boot.

[2] 0 = no lodging, 9 = 100% lodged.

Planting Date: April 25

Harvest Date: August 21

Barley - 2019 **Regent, ND**

Variety	Plant Height	Plant Lodge	Plump	Test Weight	Grain Protein	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	inches	0-9*	%	lbs/bu	%	---------- Bushels per acre ----------				
TWO ROW										
ND Genesis	30	0	85	43.8	12.7	19.3	87.0	76.3	81.7	60.9
ABI Balster	27	0	81	44.2	14.7	--	--	78.5	--	--
Explorer	23	0	71	41.9	14.7	--	--	70.9	--	--
Pinnacle	28	0	75	42.2	14.1	19.1	82.5	70.7	76.6	57.4
SIX ROW										
Tradition	27	0	81	44.1	14.0	21.1	85.4	67.6	76.5	58.0
Trial Mean	27	0	79	43.2	14.1	19.3	83.7	72.8	26.3	50.1
C.V. %	6.4	--	5.1	2.4	3.7	27.4	6.7	7.8	--	--
LSD 5%	2.7	NS	2.2	1.6	0.8	8.1	8.6	8.8	--	--
LSD 10%	2.2	NS	1.8	1.3	0.7	6.6	7.0	7.2	--	--

* 0 = no lodging, 9 = 100% lodged.

Planting Date: May 15

Harvest Date: September 4

NDSU Hettinger Research Extension Center

Oat - 2019 **Hettinger, ND**

Variety	Days to Head	Plant Height	Plant Lodge	Test Weight	----- Grain Yield ----- 2017	2018	2019	Average Yield 2 yr	3 yr
	DAP[1]	inches	0-9[2]	lbs/bu	---------- Bushels per acre ----------				
Beach	70	43	7	37.2	50.9	90.9	153.9	122.4	98.6
CS Camden	71	40	3	32.3	73.3	114.1	173.9	144.0	120.4
CDC Dancer	71	43	4	35.7	72.4	98.9	172.9	135.9	114.7
Deon	71	42	6	34.8	70.9	89.8	160.6	125.2	107.1
Hayden	70	43	7	36.7	75.4	105.2	174.1	139.7	118.2
HiFi	71	43	6	35.4	57.5	94.1	161.7	127.9	104.4
Hytest	69	45	4	38.3	63.5	84.3	146.4	115.4	98.1
Jury	71	42	7	33.9	58.0	92.3	162.2	127.3	104.2
Killdeer	70	37	6	34.2	58.2	108.3	150.5	129.4	105.7
Leggett	71	40	7	35.2	65.6	99.7	160.5	130.1	108.6
CDC Minstrel	70	40	5	33.3	66.6	99.6	183.6	141.6	116.6
Newburg	70	45	7	33.3	57.5	95.6	159.1	127.4	104.1
Otana	71	44	7	35.6	67.2	97.1	159.3	128.2	107.9
AC Pinnacle	70	46	8	34.8	79.5	95.5	142.1	118.8	105.7
Rockford	71	43	4	37.3	76.2	112.3	167.7	140.0	118.7
Souris	70	39	6	35.3	74.2	103.6	152.3	128.0	110.0
Stallion	70	43	7	36.4	58.2	96.5	144.9	120.7	99.9
Warrior	69	41	3	32.3	--	--	168.1	--	--
Paul (hull-less)	75	45	3	40.3	39.3	72.7	105.5	89.1	72.5
Trial Mean	71	43	5	35.3	62.3	97.3	157.6	129.5	107.3
C.V. %	0.6	3.6	18.8	4.3	26.0	6.0	7.3	--	--
LSD 5%	0.9	2.2	1.4	2.1	22.7	8.2	16.2	--	--
LSD 10%	0.7	1.8	1.2	1.8	19.0	6.9	13.5	--	--

[1] Days to Head = the number of days from planting to head emergence from the boot.

[2] 0 = no lodging, 9 = 100% lodged.

Planting Date: April 25

Harvest Date: August 22

Oil Type Sunflower - 2019 **Hettinger, ND**

Company/Brand	Hybrid	Oil Type & Traits[1]	Days to Bloom[2]	Plant Height	Lodging	Test Weight	Oil Content	Grain Yield 2019	Grain Yield 2-Year	Grain Yield 3-Year
				inches	%	lbs/bu	%	--------lbs/ac--------		
CROPLAN	CP3845	HO, DM	68	63	0	26.5	41.2	2530	--	--
CROPLAN	CP432E	NS, EX, DM	65	66	0	27.2	31.6	1658	2540	2635
CROPLAN	CP450E	HO, EX, DM	69	67	0	23.9	33.1	1824	--	--
CROPLAN	CP455E	HO, EX, DM	68	70	0	24.9	35.7	1959	2837	2705
CROPLAN	CP4909E	NS, EX, DM	68	63	0	26.1	34.6	1899	--	--
CROPLAN	CP545CL	NS, CL, DM	69	67	0	24.8	35.9	2420	--	--
CROPLAN	CPX57919CLP	NS, CLP, DM	70	72	0	25.4	35.6	2499	--	--
CROPLAN	CPX59619CLP	NS, CLP, DM	71	70	0	24.7	37.2	1590	--	--
Dyna-Gro	H42HO18CL	HO, CL	65	63	0	25.9	39.0	1885	--	--
Dyna-Gro	H44HO12CL	HO, CL	65	65	0	25.6	41.5	2140	--	--
Dyna-Gro	H45HO10EX	HO, EX	68	67	0	23.4	37.8	2027	--	--
Dyna-Gro	H45NS16CL	NS, CL	65	61	0	26.5	38.8	2485	--	--
Dyna-Gro	H48HO15CL	HO, CL	71	69	0	23.5	42.4	2275	--	--
Dyna-Gro	H49HO19CL	HO, CL	69	68	0	24.7	38.9	2567	--	--
Dyna-Gro	H49NS14CL	NS, CL	69	63	0	24.9	35.3	2311	--	--
Dyna-Gro	XH81H52CP	HO, CP	70	68	0	24.2	39.5	2210	--	--
Dyna-Gro	XH91H54CL	HO, CL	67	76	0	25.3	35.5	2206	--	--
Dyna-Gro	XH91H55CL	HO, CL	72	69	0	24.3	38.4	2534	--	--
Dyna-Gro	XH93H75CL	HO, CL	69	67	0	24.2	34.0	2109	--	--
Dyna-Gro	XH93H76CL	HO, CL	68	68	0	25.5	35.8	1698	--	--
Dyna-Gro	XH93H77CL	HO, CL	68	70	0	23.5	31.4	1679	--	--
Dyna-Gro	XH93H78CL	HO, CL	66	64	0	24.9	36.1	1943	--	--
Dyna-Gro	XH93H79CL	HO, CL	71	69	0	24.1	38.4	2675	--	--
FBN	F2FS1	NS,	70	68	0	23.8	38.1	1873	--	--
FBN	F2FS2	NS, EX	70	77	0	23.2	34.2	1949	--	--
FBN	F2FS3	HO,	70	71	0	24.1	33.1	1622	--	--
FBN	F2FS4	NS, EX	73	77	0	22.2	32.2	1526	--	--
Mycogen	MY8H270CL	HO, CL, DM	64	63	0	27.2	37.8	2084	--	--
Mycogen	MY8H400E	HO, EX	69	73	0	25.7	35.5	1697	--	--
Mycogen	MY8H460CP	HO, CP	71	72	0	24.0	40.5	1638	2442	--
Mycogen	MY8H477CL	HO, CL	73	74	0	23.0	37.2	2026	--	--
Mycogen	MY8H131CL	HO, CL	60	58	0	25.4	37.2	1251	--	--
Mycogen	MY8M380E	NS, EX	68	68	0	24.7	33.7	1403	--	--
Nuseed	Camaro II	NS, CL, DMR	67	68	0	26.0	35.9	2591	2748	2573
Nuseed	Falcon	NS, EX	68	67	0	25.7	36.1	2053	2534	2515
Nuseed	Hornet	HO, CL, DMR	71	70	0	24.1	37.1	2372	2895	2857
Nuseed	N4H302 E	HO, EX	68	61	0	23.3	35.6	2022	2281	--
Nuseed	N4H470 CL Plus	HO, CLP, DMR	70	72	0	24.1	39.5	2212	2889	2997
Nuseed	N4H521 CL	HO, CL, DMR	71	66	0	24.8	37.6	2474	2917	--
Nuseed	N4HM354	NS, CL, DMR	66	68	0	25.9	37.5	1909	2339	2406

Table continued on next page

Oil Type Sunflower - 2019 **Hettinger, ND**

Company/Brand	Hybrid	Oil Type & Traits[1]	Days to Bloom[2]	Plant Height	Lodging	Test Weight	Oil Content	Grain Yield 2019	Grain Yield 2-Year	Grain Yield 3-Year
Table continues from previous page										
SunOpta	4415 HO/CLP/DM	HO, CL	68	69	0	25.3	36.3	2454	2722	--
SunOpta	4425CL	NS, CL	68	72	0	24.4	32.6	1979	2493	--
SunOpta	9583CLP	Conv, CL	71	78	0	18.7	21.6	1591	--	--
SunOpta	EXOIL725CL	NS, CL	68	76	0	22.7	36.8	2257	--	--
Mycogen(Check)	8N270CLDM	NS, CL, DM	64	64	0	27.0	37.1	1949	2105	2008
USDA (Check)	894	TR	67	69	0	26.2	35.0	1622	2215	2307
Croplan(Check)	559 CL	NS, CL, DM	68	74	0	26.0	39.7	2500	--	--
Trial Mean			69	69	0	24.6	35.8	1959	2435	2423
C.V. %			1.2	6.4	--	3.9	4.8	13.9	--	--
LSD 5%			1.2	6.2	NS	1.3	2.4	380	--	--
LSD 10%			1.0	5.2	NS	1.1	2.0	318	--	--

[1] Type: TR-Traditonal, NS-NuSun, HO-High Oleic, CL=Clearfield, CLP=Clearfield Plus, EX=ExpressSun, DM=Downy Mildew Resistant

[2] Days after planting.

Planting Date: June 7

Harvest Date: November 21

NDSU Hettinger Research Extension Center

Safflower - 2019 **Hettinger, ND**

Variety	Days to Flower	Plant Height	Test Weight	Oil Content	Grain Yield 2016	Grain Yield 2018	Grain Yield 2019	Average Yield 2-Yr	Average Yield 3-Yr
	DAP[1]	inches	lbs/bu	%	lbs per acre				
Linoleic Types									
Cardinal	87	30	32.0	35.9	1805	1825	1577	1701	1736
Chickadee	88	23	31.9	23.9	--	1497	1299	1398	--
Finch	85	27	30.0	36.7	1669	1335	1456	1396	1487
NutraSaff	90	26	27.5	39.0	1223	1425	555	990	1068
Rubis Red	91	25	30.9	17.0	--	1393	706	1050	--
Oleic Types									
Hybrid 1601	88	29	28.4	29.1	2095	1929	1142	1536	1722
Hybrid 200	89	23	30.5	20.5	1723	1397	1108	1253	1409
Hybrid 446	86	25	31.3	22.5	--	1297	1665	1481	--
MonDak	88	25	31.3	24.0	1559	1680	1668	1674	1636
Montola 2003	89	23	30.5	20.7	1555	1830	851	1341	1412
Trial Mean	88	26	30.4	26.9	1661	1561	1203	1382	1496
C.V. %	1.4	6.0	3.4	6.4	13.6	9.5	15.3	--	--
LSD 5%	1.8	2.2	1.5	2.5	333	215	268	--	--
LSD 10%	1.5	1.8	1.2	2.1	276	179	222	--	--

[1] Days after planting.

Planting Date: May 14

Harvest Date: September 24

Safflower Trial was not harvested in 2017

Very poor seed quality due to a week of wet condtions prior to harvest.

NDSU Hettinger Reserch Extension Center

Canola - Conventional - 2019 **Hettinger, ND**

Brand	Cultivar	Oil Type[1]	Days to Bloom	Bloom Duration	Days to Mature	Plant Height	Lodging	Oil Content	Seed Yield	
									2019	2-Yr. Avg.
			DAP[2]	days	DAP[2]	inches	0 - 9[3]	%	-------lbs/a-------	
Photosyntech	NCC101S	MO	44	21	83	35	0	38.2	1169	679
BrettYoung	6090 RR (RR Check)	TR	47	21	85	44	0	42.4	965	682
Croplan	CP930RR (RR Check)	TR	45	19	82	40	0	46.7	1093	765
NDSU	Experemntal		48	20	85	41	0	41.8	703	--
NDSU	Experemntal		46	20	83	37	0	39.4	987	--
NDSU	Experemntal		46	21	85	40	0	41.5	953	594
NDSU	Experemntal		49	20	87	47	0	43.2	850	524
NDSU	Experemntal		49	21	88	47	0	40.9	524	--
NDSU	Experemntal		45	22	85	44	0	42.7	875	--
NDSU	Experemntal		47	23	88	45	0	42.1	1128	--
Trial Mean			47	21	85	42	0	41.9	1076	708
C.V. %			0.9	3.1	0.6	5.4	--	2.2	11.3	--
LSD 5%			0.6	1.0	8.0	3.3	--	1.4	151	--
LSD 10%			0.5	0.8	0.7	2.7	--	1.1	125	--

[1] Type: TR-Traditional Oil Type, MO-Mid Oleic Type, HO-High Oleic Oil Type.

[2] Days after planting.

[3] Lodging: 0 = none, 9 = lying flat on ground.

Planting Date: May 15

Harvest Date: August 28

Canola - Roundup Ready - 2019 **Hettinger, ND**

Brand	Cultivar	Oil Type[1]	Days to Bloom	Bloom Duration	Days to Mature	Plant Height	Lodging	Shatter	Oil Content	Seed Yield	
										2019[5]	2-Yr. Avg.
			DAP[2]	days	DAP[2]	inches	0 - 9[3]	0 - 9[4]	%	lbs/a	
BrettYoung	4187 RR	TR	48	20	86	46	0	5	43.7	512	631
BrettYoung	6074 RR	TR	46	20	84	44	0	3	43.6	621	624
BrettYoung	6090 RR	TR	47	20	84	46	0	2	43.8	777	640
Canterra Seeds	CS2100	TR	45	20	84	39	0	0	45.1	1221	872
Canterra Seeds	CS2300	TR	47	21	86	47	0	3	43.9	611	648
Canterra Seeds	CS2600 CR-T	TR	46	19	83	45	0	0	45.7	1268	928
Croplan	CP930RR	TR	45	19	82	43	0	0	47.2	1069	808
Croplan	CP955RR	TR	46	19	83	43	0	2	45.9	887	700
Croplan	CP9919RR	TR	44	20	82	34	0	0	42.0	1059	--
Croplan	CP9978TF	TR	45	20	83	40	0	0	44.3	1737	--
Croplan	CP9982RR	TR	46	22	86	46	0	7	40.4	237	--
Proseed	300 MAG	TR	46	21	85	43	0	2	44.2	787	744
Proseed	PS 5000	TR	46	20	84	41	0	2	43.4	779	597
Star Specialty Seed	Star 402	TR	46	19	83	42	0	0	47.8	959	688
Star Specialty Seed	StarFlex	TR	45	20	83	39	0	0	46.0	1341	--
Integra	7389RT	TR	46	20	84	43	0	0	45.3	1271	--
Trial Mean			46	20	84	43	0	1	44.4	905	688
C.V. %			1.0	2.7	0.6	5.8	--	28.1	2.3	12.4	--
LSD 5%			0.6	0.8	0.7	3.5	--	0.5	1.4	160	--
LSD 10%			0.5	0.6	0.6	2.9	--	0.5	1.2	133	--

[1] Type: TR-Traditional Oil Type, HO-High Oleic Oil Type.

[2] Days after planting.

[3] Lodging: 0 = none, 9 = lying flat on ground.

[4] Shatter: 0 = none, 9 = 100% shattered.

[5] Note because wet conditions delayed harvest combined with a severe thuderstorm with high winds just prior to harvest, some cultivars suffered from severe shatter.

Dry Bean - 2019 **Hettinger, ND**

Variety	Type	Plant Height	Plant Lodge	Test Weight	Grain Yield 2017	Grain Yield 2018	Grain Yield 2019	Average Yield 2 yr	Average Yield 3 yr
		inches	0-9[1]	lbs/bu	lbs per acre	lbs per acre	lbs per acre	lbs per acre	lbs per acre
LaPaz	Pinto	30	6	52.2	1507	1691	1441	1566	1546
Lariat	Pinto	29	8	51.3	1140	1375	1245	1310	1253
Monterrey	Pinto	31	5	51.9	1496	1653	1345	1499	1498
ND-Falcon	Pinto	28	6	49.5	--	--	1509	--	--
Palomino	Pinto	31	6	51.5	1282	1536	1611	1574	1476
Stampede	Pinto	27	6	50.4	1415	1609	1797	1703	1607
Torreon	Pinto	28	6	50.8	--	--	1437	--	--
Vibrant	Pinto	29	5	52.5	--	--	1286	--	--
Windbreaker	Pinto	30	6	52.2	1110	1534	1295	1415	1313
Blizzard	Navy	27	4	56.5	--	--	1166	--	--
HMS Medalist	Navy	24	3	56.9	1466	937	1130	1034	1178
T9905	Navy	27	4	56.6	1652	1243	1350	1297	1415
Merlot	Sm Red	26	5	50.7	1449	1011	1757	1384	1406
Viper	Sm Red	25	5	54.2	--	--	1659	--	--
Rosetta	Pink	28	4	53.5	1597	1060	1519	1290	1392
Black Tails	Black	23	5	57.0	--	--	1870	--	--
Eclipse	Black	24	3	57.3	1451	1162	1661	1412	1425
Loreto	Black	22	4	55.9	1298	1006	1618	1312	1307
Zorro	Black	23	3	56.2	1391	1071	1570	1321	1344
ND Pegasus	Great Northern	31	3	52.2	--	--	1811	--	--
Powderhorn	Great Northern	30	4	48.8	1900	1303	1497	1400	1567
Trial Mean		27	5	53.3	1427	1288	1488	1393	1397
C.V. %		13.1	14.6	1.8	13.1	13.0	15.7	--	--
LSD 5%		5.0	1.0	1.4	266	240	330	--	--
LSD 10%		4.2	0.8	1.2	222	200	275	--	--

[1] 0 = no lodging, 9 = lying flat on ground.

Planting Date: May 30

Harvest Date: October 8

Previous Crop: Durum Wheat

NDSU Hettinger Research Extension Center

Chickpea - 2019 **Hettinger, ND**

Variety	Days to Flower	Height	Lodging	-----Seed Size (mm)-----				Seed Size	Test Weight	----- Grain Yield -----			Average Yield	
				<8	8-9	9-10	>10			2016	2018	2019	2 yr	3 yr
	DAP[1]	inches	0 - 9[2]	----------%----------				seed/lb	lb/bu	----------lbs/ac----------				
Kabuli Type														
CDC Frontier	55	27	0	38	46	13	3	2092	46.2	2119	1802	1483	1643	1801
CDC Leader	55	25	0	20	45	26	9	1670	46.3	--	--	2307	--	--
CDC Luna	57	24	0	22	46	23	9	1742	45.3	2054	1589	1850	1720	1831
CDC Orion	55	24	0	17	47	26	9	1709	44.6	--	1456	1918	1687	--
CDC Palmer	55	25	0	6	41	36	17	1320	43.8	--	--	2762	--	--
Sawyer	53	26	0	44	39	14	3	2227	**	1387	1439	662	1051	1163
Sierra	55	26	0	44	34	15	7	2452	**	879	1066	280	673	742
Desi Type														
CDC Anna	55	27	0	91	8	1	0	2813	36.5	2136	1687	1791	1739	1871
MS-19CP1	53	22	0	33	62	5	0	1721	44.3	--	--	2780	--	--
MS-19CP2	56	25	0	50	48	2	0	2074	44.3	--	--	2394	--	--
Mean	55	25	0	37	42	16	6	1982	43.9	1736	1507	1823	1419	1482
C.V. %	5.6	9.7	--	22.2	11.7	29.0	57.1	10.7	4.0	12.7	11.1	13.0	--	--
LSD 5%	4.4	3.5	--	12	7	7	5	310	2.6	324	253	343	--	--
LSD 10%	3.7	2.9	--	10	6	6	4	258	2.1	268	208	284	--	--

[1] Days after planting.

[2] Lodging: 0 = none, 9 = lying flat on ground.

** Not enough sample for a test weight.

Planting Date: May 13

Harvest Date: September 24

NDSU Hettinger Research Extension Center

Field Pea - 2019 **Hettinger, ND**

Variety	Days to Flower	Flower Duration	Days to Mature	Canopy Height	Lodging	Seed Protein	1,000 Seed Wt.	Seeds Lb	Test Weight	Seed Yield 2019	Seed Yield 2-Yr. Avg.	Seed Yield 3-Yr. Avg.
	DAP[1]	days	DAP[1]	inches	0 - 9[2]	%	gm	seeds	lb/bu	bu/a	bu/a	bu/a
Yellow Cotyledon Type												
AAC Asher	52	14	77	28	8	25.8	245	1853	57.7	46.0	--	--
AAC Carver	52	14	77	34	6	24.5	223	2034	58.4	50.4	--	--
AAC Chrome	52	15	78	29	7	25.1	229	1979	58.8	48.5	--	--
AAC Profit	56	12	79	32	7	27.4	218	2094	58.9	50.2	40.1	--
AC Earlystar	51	15	77	32	6	25.0	198	2303	57.7	44.8	--	--
Agassiz	51	16	78	31	7	27.4	220	2059	57.8	48.4	36.8	28.6
Bridger	50	16	77	31	7	26.3	213	2133	58.7	46.5	29.7	24.0
CDC Amarillo	56	11	78	31	6	26.1	216	2099	58.1	44.1	--	--
CDC Inca	54	13	78	33	6	26.5	206	2209	58.5	50.9	--	--
CDC Saffron	54	12	77	30	8	26.4	232	1962	58.7	46.9	--	--
CDC Spectrum	55	13	79	32	7	27.4	208	2186	57.9	46.6	--	--
DL Apollo	52	14	77	33	7	26.6	207	2196	59.2	47.8	--	--
DS Admiral	51	15	77	33	7	25.7	222	2045	58.2	44.0	31.8	25.5
Durwood	52	15	78	34	5	26.6	226	2011	58.3	45.3	33.3	26.8
Hyline	52	15	77	30	7	26.1	228	1991	58.7	45.4	30.4	24.2
Jetset	51	15	78	31	7	26.0	226	2008	58.0	46.0	--	--
Korando	50	17	78	31	7	28.0	246	1845	57.2	41.7	--	--
LG Amigo	51	15	77	30	7	27.2	211	2161	58.3	41.5	29.7	24.4
LG Sunrise	50	17	78	32	6	25.9	217	2097	58.3	45.8	32.5	--
LGPN4909	48	18	77	31	7	27.1	213	2129	57.8	44.2	29.2	24.1
LGPN4913	51	15	77	31	7	27.9	210	2162	58.3	39.1	27.5	--
LGPN4915	50	16	77	31	6	29.4	200	2275	58.1	44.6	34.5	--
N13022-7	50	16	77	32	7	26.9	247	1839	58.2	46.6	--	--
N13029-10	49	17	77	35	7	26.3	235	1937	57.4	49.7	--	--
N13057-4	48	18	77	33	7	27.2	227	2003	58.3	46.8	--	--
N13057-5	51	17	79	34	7	27.5	240	1893	57.2	45.0	--	--
N13068-1	51	16	77	34	7	25.4	245	1860	56.9	47.4	--	--
NDP121587	51	15	77	31	8	24.8	212	2141	57.8	42.7	--	--
Nette 2010	51	15	77	30	7	26.0	205	2220	59.1	45.5	31.8	26.0
Salamanca	53	13	77	32	7	27.2	246	1847	58.3	49.3	34.7	28.0
Spider	54	14	78	33	8	27.1	234	1942	59.0	45.2	36.0	27.5
SW Midas	52	14	77	28	7	25.5	189	2400	58.7	40.5	26.3	22.4
Green Cotyledon Type												
12CP3032	53	14	77	30	8	26.8	237	1917	57.4	44.8	--	--
AAC Comfort	58	9	78	31	8	26.9	230	1975	57.4	40.1	--	--
Arcadia	51	15	77	26	8	25.9	191	2377	58.4	40.5	23.1	19.5
Banner	47	19	77	30	7	24.2	190	2385	57.3	41.4	24.2	--
CDC Greenwater	54	13	78	31	6	25.2	223	2042	58.3	44.2	--	--
CDC Striker	51	15	77	29	9	26.0	192	2370	58.3	43.4	26.4	21.9
Cruiser	51	15	77	31	7	26.4	190	2396	58.7	40.6	27.1	22.4
Empire	54	12	78	34	6	27.6	207	2195	58.7	40.4	--	--
Ginny	51	15	77	28	8	26.1	185	2456	58.2	32.5	22.6	18.6
Hampton	52	14	77	27	9	29.2	200	2266	56.8	32.3	--	--
LG Koda	54	13	77	31	7	25.5	206	2200	59.0	39.9	30.2	24.3
LN1131	50	16	77	30	6	28.1	222	2042	57.9	44.6	--	--
N13073-17	54	13	77	31	8	25.7	220	2066	56.4	44.2	--	--
N13073-19	48	19	78	31	8	26.0	244	1862	57.0	45.2	--	--
Shamrock	54	12	77	31	7	25.7	218	2080	57.3	41.0	29.8	23.6
Viper	50	16	77	32	7	27.8	215	2112	57.3	38.6	25.6	21.5
	52	15	77	31	7	26.5	218	2097	58.0	44.2	30.1	24.1
C.V. %	1.4	5.5	0.6	6.6	9.3	2.2	4.0	4.0	1.0	7.9	--	--
LSD 5%	1.0	1.1	0.6	2.9	0.9	0.8	12	117	0.8	4.9	--	--
LSD 10%	0.8	0.9	0.5	2.4	0.8	0.7	10	98	0.7	4.1	--	--

[1] Days after planting.

[2] Lodging: 0 = none, 9 = lying flat on ground.

Planting Date: May 13

Harvest Date: August 19

NDSU Hettinger Reserach Extension Center

Lentil - 2019 **Hettinger, ND**

Variety	Days to Flower	Height	Lodging	1,000 Seed Wt.	Seeds Lb	Test Weight	----- Grain Yield ----- 2016	2018	2019	Average Yield 2 yr	3 yr
	DAP[1]	inches	0 - 9[2]	gm	seeds	lb/bu	----------lbs/acre----------				
Large Green Type											
CDC Greenland	55	15	8	48	9456	51.5	1219	1028	1823	1426	1357
Pennell	54	14	8	52	8819	52.2	1079	1268	2042	1655	1463
Riveland	51	14	9	53	8631	54.6	1118	951	1404	1177	1158
Medium Green Type											
CDC Richlea	52	15	8	39	11562	51.6	1299	1233	1830	1531	1454
Small Green Type											
CDC Viceroy	52	16	8	30	15304	56.0	1352	1634	2138	1886	1708
ND Eagle	51	15	8	35	12891	54.7	890	1455	2134	1794	1493
French Green Type											
CDC Lemay	56	15	5	36	12790	54.2	598	1334	2038	1686	1323
Small Red Type											
CDC Red Rider	54	13	7	30	15128	57.0	1359	1466	1446	1456	1424
CDC Redberry	54	16	4	37	12183	55.3	902	1258	2117	1687	1426
CDC Rosetown	55	14	6	28	16500	55.2	1304	1557	1745	1651	1535
CDC Rouleau	54	16	6	31	14540	54.6	1157	1180	2316	1748	1551
Trial Mean	53	15	7	38	12528	54.2	1043	1306	1912	1609	1445
C.V. %	2.0	7.3	13.1	4.5	4.3	3.7	11.8	18.9	11.5	--	--
LSD 5%	1.6	1.6	1.3	2.5	772	2.9	174	357	317	--	--
LSD 10%	1.3	1.3	1.1	2.1	642	2.4	145	297	264	--	--

[1] Days after planting.

[2] Lodging: 0 = none, 9 = lying flat on ground.

Planting Date: May 3

Harvest Date: August 27

2017 results not used for milti-year averages because of very low yields.

NDSU Hettinger Research Extension Center

Soybean - Roundup Ready - 2019 **Hettinger, ND**

Company/Brand	Variety	Maturity	Mature Date	Plant Height	Test Weight	Seed Oil	Seed Protein	Seed Yield
				inches	lbs/bu	%	%	Bu/Ac
NDSU	ND18008GT	00.8	9/15	30	54.4	17.1	33.0	34.3
NDSU	ND17009GT	00.9	9/16	30	55.9	17.1	34.0	40.5
Proseed	30-20	0.2	9/20	32	54.7	16.0	34.2	44.0
Proseed	BX 80-35	0.3	9/24	30	55.6	16.3	34.6	42.4
REA Hybrids	RX0330	0.3	9/23	29	54.7	16.4	33.1	36.1
Integra	50309N	0.3	9/22	30	54.8	16.4	32.8	43.0
Proseed	XT 60-40N	0.4	9/23	31	54.6	16.6	33.8	40.1
REA Hybrids	RX0520	0.5	9/26	33	55.3	16.2	33.2	38.5
Integra	50510N	0.5	9/27	30	55.4	16.5	32.5	47.9
MN	M06R-614008GT	0.6	9/21	30	54.5	16.4	33.7	35.4
REA Hybrids	RX0719	0.7	9/22	30	55.4	16.2	34.2	41.9
REA Hybrids	RX0929	0.9	10/1	32	55.9	16.4	32.9	42.9
Trial Mean			9/23	31	55.0	16.4	33.4	40.7
C.V. %			0.5	6.5	1.4	3.2	2.4	10.6
LSD 5%			1.2	2.8	1.1	0.8	1.2	6.1
LSD 10%			1.0	2.3	0.9	0.6	1.0	5.1

Planting Date: May 30
Harvest Date: October 23

Soybean - Roundup Ready - 2019 **Mandan, ND**

Company/Brand	Variety	Maturity	Mature Date	Plant Height	Test Weight	Seed Oil	Seed Protein	Seed Yield
				inches	lbs/bu	%	%	Bu/Ac
Proseed	30-20	0.2			54.6	15.7	33.9	36.2
Proseed	BX 80-35	0.3			55.8	15.8	33.9	43.7
REA Hybrids	RX0330	0.3			55.1	15.2	33.1	42.7
Integra	50309N	0.3			54.8	15.2	33.5	39.8
Proseed	XT 60-40N	0.4			55.2	15.7	33.0	39.7
REA Hybrids	RX0520	0.5			55.1	15.2	33.7	42.6
Integra	50510N	0.5			55.0	16.1	32.0	46.9
MN	M06R-614008GT	0.6			55.7	15.4	34.4	42.2
REA Hybrids	RX0719	0.7			55.0	15.9	33.3	44.8
NDSU	ND15-22873	0.7			55.9	16.4	32.7	43.7
REA Hybrids	RX0929	0.9			55.5	15.8	32.2	40.0
Trial Mean					55.2	15.7	33.0	42.3
C.V. %					0.7	2.0	2.1	8.3
LSD 5%					0.6	0.5	1.0	5.1
LSD 10%					0.5	0.4	0.8	4.2

Planting Date: June 5
Harvest Date: October 24

NDSU Hettinger Reaserch Extension Center

Soybean - Conventional - 2019 **Hettinger, ND**

Company/Brand	Variety	Maturity	Mature Date	Plant Height	Test Weight	Seed Oil	Seed Protein	Seed Yield	Average Yield 2-Yr	Average Yield 3-Yr
				inches	lbs/bu	%	%			
NDSU	ND Benson	0.4	9/27	32	56.0	16.5	33.7	36.5	33.4	30.8
NDSU	ND Stutsman	0.7	9/26	31	55.6	16.8	32.4	42.1	39.5	35.6
MN	MN0810CN	0.8	9/28	35	55.5	15.6	35.0	32.2	--	--
MN	MN0083	00.8	9/13	27	54.2	16.5	34.3	29.2	--	--
Trial Mean			9/27	32	55.6	16.6	32.6	37.5	36.4	33.2
C.V. %			0.7	4.8	0.8	1.7	2.1	10.7	--	--
LSD 5%			1.3	2.3	0.7	0.4	1.0	5.8	--	--
LSD 10%			1.1	1.9	0.5	0.3	0.8	4.8	--	--

Planting Date: May 30
Harvest Date: October 23

NDSU Hettinger Research Extension Center

Corn - 2019 **Hettinger, ND**

Company	Hybrid	Relavtive Maturity[1]	Plant Height	Ear Height	Stalk Lodge	Moisture Content	Test Weight	Grain Yield 2019	Grain Yield 2-Yr
		days	inches	inches	%	%	lbs/bu	------bu/ac------	
Integra	3282	82	101	44	0	17.8	51.4	127.7	119.6
Integra	3537	85	102	45	0	17.9	51.0	134.8	122.8
Integra	3718	87	103	42	0	20.7	47.8	142.6	128.0
Legend Seeds	40J081	81	105	46	0	21.0	53.5	109.0	--
Legend Seeds	LR 9583	83	99	44	0	19.1	52.0	136.0	123.4
Legend Seeds	LR 9983	83	99	44	0	19.4	51.4	132.4	--
Legend Seeds	40J684	84	102	44	0	22.0	49.1	125.5	120.0
Legend Seeds	LR 9886	86	106	44	0	21.2	46.9	128.7	109.4
Proseed	1882	82	100	42	0	19.7	55.1	112.1	--
Proseed	1483	83	98	43	0	18.6	52.0	135.3	126.4
Proseed	1487	87	103	46	0	18.8	48.4	116.6	115.3
Proseed	1787	87	105	42	0	18.5	51.1	129.5	122.5
Trial Mean			102	44	0	19.5	50.8	127.5	120.8
C.V. %			2.6	5.6	--	11.6	5.0	7.9	--
LSD 5%			3.8	3.5	--	3.3	3.6	17.0	--
LSD 10%			3.2	2.9	--	2.7	3.0	14.1	--

[1] Relavtive maturity provided by company.

Planting Date: May 30

Harvest Date: November 19

Industrial Hemp Variety Trial - 2019 **Hettinger, ND**

Variety	Plant Stand	PLSE[1]	Seedling Mortality	Height	Lodging[2]	Test Weight	Oil Content	Seed Yield
	plants/ft^2	%	%	inches	0-9	lbs/bu	%	lbs/ac
CRS-1	9.9	62	38	49	0	*	32.8	210
CFX-1	9.0	56	44	44	0		32.4	157
CFX-2	10.3	65	35	39	0		33.0	214
Grandi	11.3	71	29	42	0		32.4	229
Katani	10.1	63	37	40	0		32.1	191
Picolo	13.8	86	14	38	0		32.4	214
Canda	10.9	68	32	57	0		31.7	229
Joey	12.2	76	24	54	0		31.3	286
X-59	8.5	53	47	45	0		30.9	362
Anka-Trt	9.4	59	41	59	0		32.2	276
Anka-CK	8.5	53	47	65	0		31.9	186
	10.7	67	33	50	0		32.1	232
C.V. %	20.8	20.8	42.1	11.1	--		2.0	47.4
LSD 5%	3.2	20	20	8.0	--		0.9	159
LSD 10%	2.7	17	17	6.6	--		0.8	132

[1] Pure live seed emergence.

[2] Lodging: 0 = none, 9 = lying flat on ground.

* Not enough sample to obtain a test weight.

Planting Date: June 3

Harvest Date: September 25

Trial suffered from significant bird feeding which greatly reduced yields before harvest.

Hettinger Soybean Seeding Rate Study

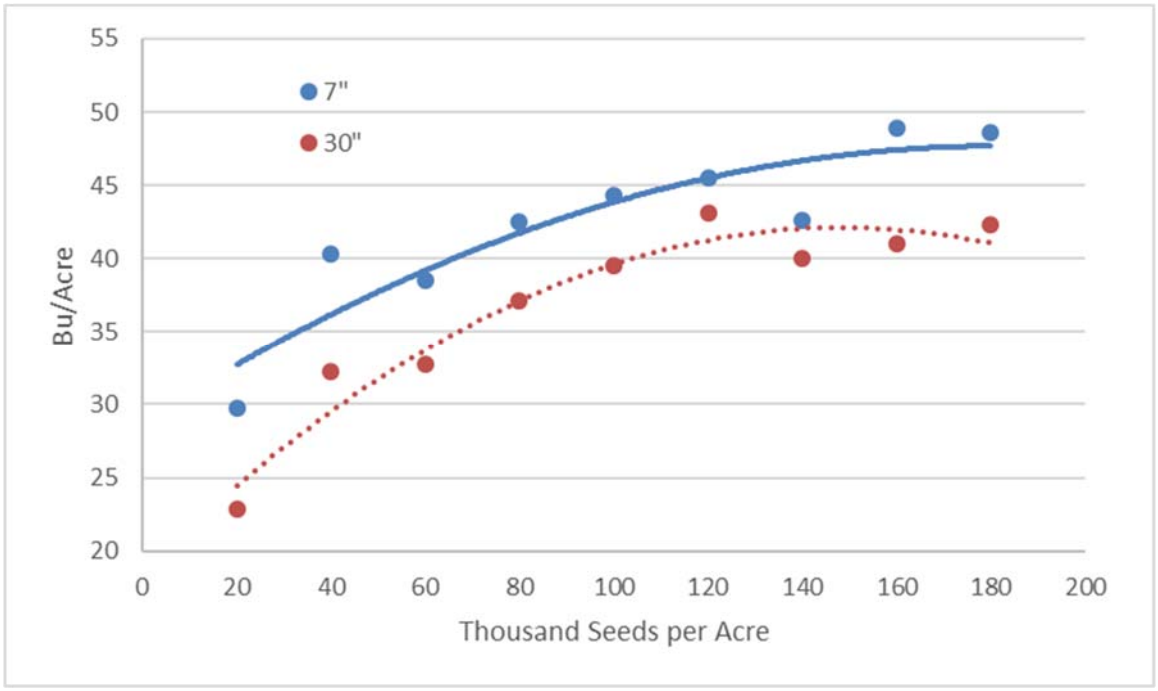
John Rickertsen & Michael Wells, Hettinger Research Extension Center, 2019

Over the past decade soybean seeding rate recommendations in the corn-soybean belt have been reduced from 180,00 - 240,000 seeds per acre to 125,000 - 170,000. Much of this is due to increasing cost of soybean seed and soybeans tremendous ability to compensate for lower densities with increased branching and pod number. Yield per acre for soybeans remains relatively constant across population. This is because the number of seeds produced per plant is inversely related to the number of plants per acre. In general, numerous studies in the Midwest have shown 100,000 relatively uniformly spaced plants at harvest will produce the maximum economic return under most conditions. There have been many studies on soybean seeding rates in the Midwest, but there is little information on seeding rates for dryland soybeans in the semi-arid high plains.

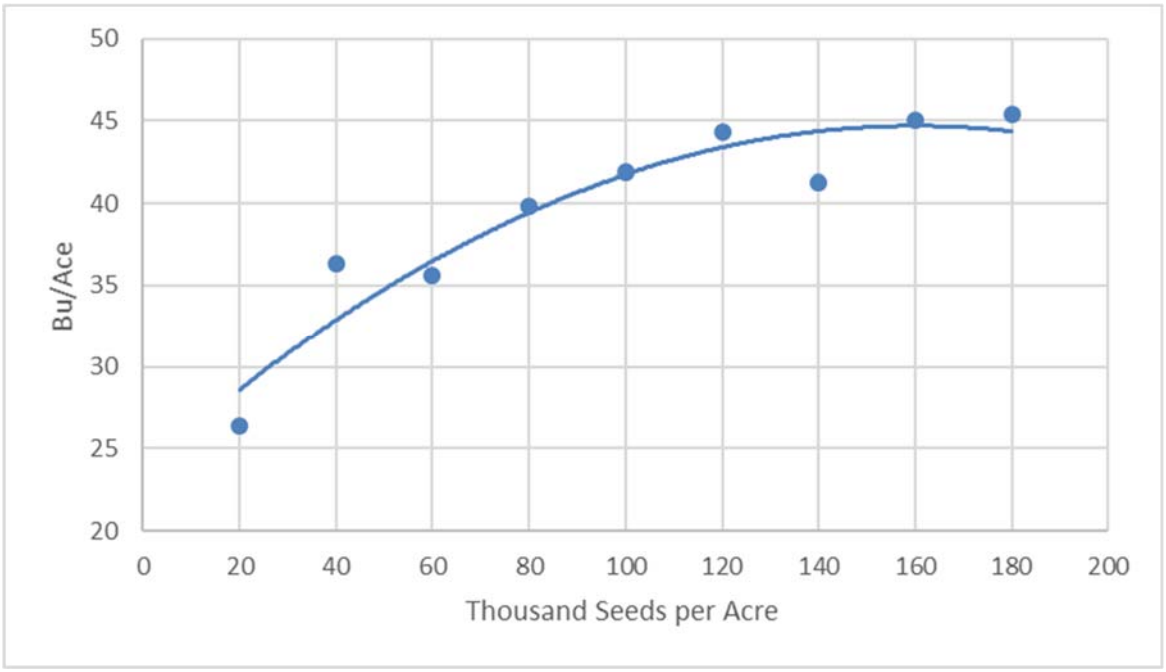
A study was initiated at Hettinger, ND in 2018 with nine seeding rates, 20,000 to 180,000 in 20,000 increments in both drilled (7”) and row (30”) configurations. In 2019 the Hettinger trial was planted on May 30. At Mandan, ND a trial with 30” rows with the same seeding rates was planted on June 5. The soybean variety Proseed 30-20 at Hettinger and REA RX0719 Mandan were no-till planted with a 7 row plot drill equipped with Acra Plant ADU double disk openers and a two row planter equipped with John Deere 1700 row units. Weed control was obtained by a pre-emergence herbicide application of BroadAxe and post-emergence application of glyphosate. The trials were harvested with a Kincaid 8XP small plot combine on October 23 at Hettinger and October 24 at Mandan. Data was recorded on flowering, height, maturity date, yield, test weight, seed size, seed protein and seed oil content.

The results in the following graphs and table show that seeding rates of 100,000 – 180,000 were not significantly different in yield and even the extremely low rate of 20,000 yielded 61% of the 100,000 - 180,000 seeding rates. For seed protein and oil content, as seeding rate increased, oil content decreased and protein increased. At the very lowest populations, seed size increased and test weight decreased, but there was no significant difference in the 100,000 to 180,000 rates for seed size and no significant difference in 40,000 to 180,000 rates for test weight. In 2019 7” rows yielded 5.5 Bu/Acre higher than 30” rows, unlike 2018 were there was no difference in yield between 7” and 30” rows. Over the past two years the 120,000 seeding rate was has looked like the best seeding rate at Hettinger.

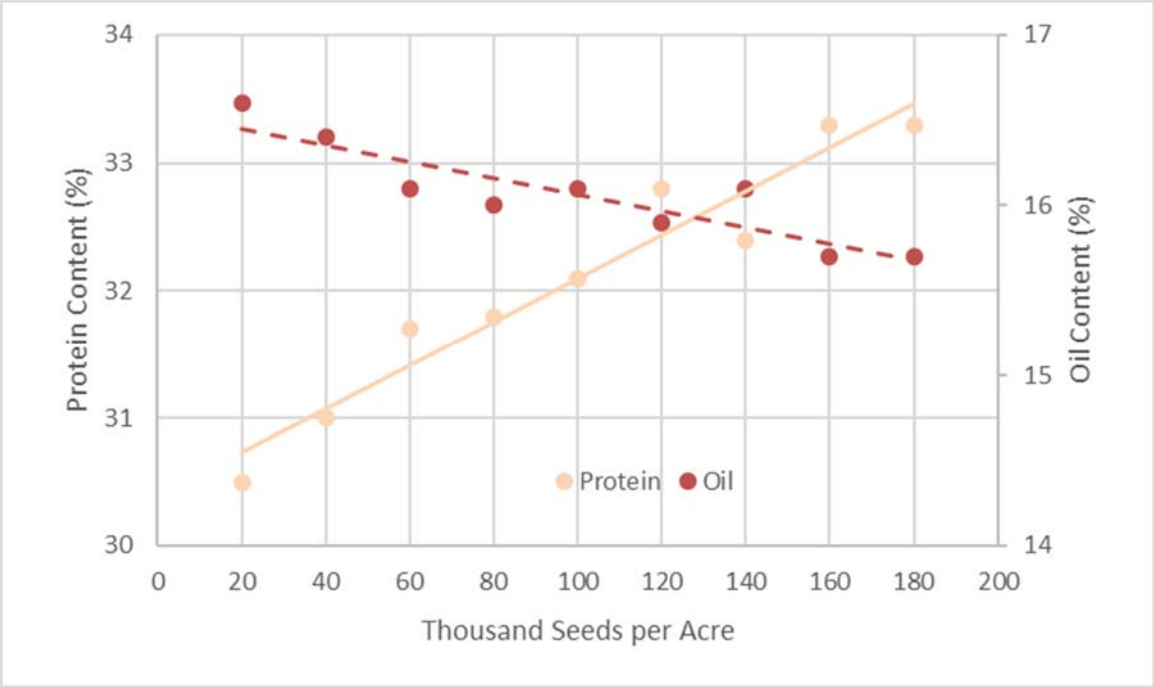
Soybean Seeding Rate Study Yields by Seeding Rate at Hettinger, ND.



Soybean Seeding Rate Study Yields by Seeding Rate at Mandan, ND.



Soybean Seeding Rate Study Protein and Oil Content by Seeding Rate at Mandan, ND.



Soybean Seeding Rate Study - 2019 **Mandan, ND**

Treatment	Mature Date	Plant Height	Seeds Lb	Test Weight	Seed Oil	Seed Protein	Grain Yield
		inches	seeds	lbs/bu	%	%	bu/ac
30" - 20,000		31	3201	54.8	16.6	30.5	15.7
30" - 40,000		34	3129	54.9	16.4	31.0	26.8
30" - 60,000		37	3093	55.1	16.1	31.7	28.8
30" - 80,000		35	3176	55.0	16.0	31.8	32.1
30" - 100,000		37	3060	55.5	16.1	32.1	33.9
30" - 120,000		36	3010	55.1	15.9	32.8	35.9
30" - 140,000		35	3036	55.4	16.1	32.4	37.0
30" - 160,000		36	3000	55.3	15.7	33.3	39.1
30" - 180,000		37	3020	55.3	15.7	33.3	35.8
Trial Mean		35	3081	55.1	16.1	32.1	31.7
LSD 5%		2	114	0.4	0.5	0.9	5.6
C.V. %		3.2	2.5	0.5	2.1	2.0	12.0

Soybean Seeding Rate Study - 2019 **Hettinger, ND**

Treatment	Mature Date	Plant Height	Seeds Lb	Test Weight	Seed Oil	Seed Protein	Grain Yield
		inches	seeds	lbs/bu	%	%	bu/ac
Row Spacing							
7" Rows	9/22	29	3441	54.7	16.3	33.5	42.3
30" Rows	9/21	33	3195	53.8	16.1	33.9	36.8
LSD 5%	NS	1	69	0.2	0.1	0.3	1.8
Population							
20,000	9/26	31	2924	53.8	16.5	32.9	26.4
40,000	9/23	33	3266	54.8	16.4	33.3	36.3
60,000	9/22	31	3268	54.1	16.5	33.1	35.6
80,000	9/22	32	3285	54.7	16.4	34.0	39.8
100,000	9/20	30	3400	54.4	16.3	33.9	41.9
120,000	9/21	31	3390	54.4	15.9	34.1	44.3
140,000	9/20	29	3433	54.2	16.0	34.0	41.3
160,000	9/19	30	3417	53.9	15.9	33.7	45.0
180,000	9/20	30	3480	54.0	15.9	34.2	45.4
LSD 5%	0.3	2	112	0.4	0.3	0.5	3.8
Row Spacing X Population							
7" - 20,000	9/27	30	2843	54.4	16.5	33.0	29.8
7" - 40,000	9/23	31	3275	55.1	16.7	33.3	40.3
7" - 60,000	9/23	29	3323	54.7	16.8	32.8	38.5
7" - 80,000	9/24	30	3314	55.0	16.6	34.1	42.5
7" - 100,000	9/21	27	3624	54.8	16.3	33.1	44.3
7" - 120,000	9/21	28	3613	55.0	16.0	33.7	45.5
7" - 140,000	9/20	27	3674	54.7	16.0	33.8	42.6
7" - 160,000	9/20	27	3656	54.2	15.8	33.4	48.9
7" - 180,000	9/19	28	3649	54.4	15.9	33.8	48.6
30" - 20,000	9/25	32	3005	53.1	16.4	32.9	22.9
30" - 40,000	9/22	34	3256	54.5	16.2	33.4	32.2
30" - 60,000	9/21	32	3212	53.5	16.1	33.4	32.7
30" - 80,000	9/20	34	3257	54.4	16.1	34.0	37.1
30" - 100,000	9/20	33	3176	53.9	16.3	34.7	39.5
30" - 120,000	9/21	33	3168	53.8	15.8	34.4	43.1
30" - 140,000	9/19	32	3192	53.7	16.1	34.2	40.0
30" - 160,000	9/19	33	3178	53.5	16.1	34.0	41.0
30" - 180,000	9/20	32	3311	53.6	16.0	34.5	42.3
Trial Mean	9/21	31	3318	54.2	16.2	33.7	39.6
LSD 5%	1.4	2	174	0.5	0.4	0.7	4.5
C.V. %	0.1	5.1	4.4	0.8	1.9	1.6	9.6

Soybean Seeding Rate Study - 2018 **Hettinger, ND**

Treatment	Mature Date	Plant Height	Seeds Lb	Test Weight	Seed Oil	Seed Protein	Grain Yield
		inches	seeds	lbs/bu	%	%	bu/ac
Row Spacing							
7" Rows	9/30	26	3727	54.4	15.4	34.2	34.6
30" Rows	9/30	25	3535	54.3	15.7	34.1	35.2
LSD 5%	NS	NS	53	NS	0.1	NS	NS
Population							
20,000	10/2	25	3497	53.4	15.9	33.6	26.2
40,000	10/1	25	3603	54.2	15.8	33.5	31.2
60,000	9/30	26	3607	54.1	15.8	33.8	33.2
80,000	9/30	26	3608	54.6	15.6	34.3	35.6
100,000	9/30	26	3757	54.4	15.4	34.3	36.7
120,000	9/30	25	3676	54.4	15.4	34.4	37.4
140,000	9/30	26	3685	54.7	15.4	34.5	38.7
160,000	9/30	26	3655	54.5	15.3	34.5	37.5
180,000	9/30	26	3589	54.6	15.1	34.9	37.5
LSD 5%	0.3	NS	112	0.4	0.3	0.5	3.7
Row Spacing X Population							
7" - 20,000	10/2	25	3470	53.1	15.6	33.6	25.3
7" - 40,000	10/2	26	3742	54.2	15.7	33.7	31.0
7" - 60,000	9/30	27	3743	54.2	15.7	33.8	32.2
7" - 80,000	9/30	27	3705	54.7	15.5	34.3	35.8
7" - 100,000	9/30	26	3919	54.6	15.1	34.5	37.9
7" - 120,000	9/30	25	3758	54.7	15.2	34.5	37.0
7" - 140,000	9/30	26	3751	55.0	15.2	34.5	38.9
7" - 160,000	9/30	26	3797	54.5	15.3	34.4	37.2
7" - 180,000	9/30	26	3656	54.8	14.9	35.0	36.0
30" - 20,000	10/2	25	3524	53.8	16.1	33.5	27.2
30" - 40,000	10/1	25	3463	54.3	15.9	33.4	31.3
30" - 60,000	9/30	25	3471	54.0	15.9	33.8	34.2
30" - 80,000	9/30	25	3511	54.5	15.7	34.3	35.5
30" - 100,000	9/30	26	3595	54.2	15.7	34.1	35.5
30" - 120,000	9/30	25	3594	54.2	15.6	34.2	37.8
30" - 140,000	9/30	26	3619	54.5	15.6	34.4	38.6
30" - 160,000	9/30	27	3512	54.5	15.4	34.6	37.9
30" - 180,000	9/30	26	3522	54.4	15.3	34.8	38.9
Trial Mean	9/30	26	3631	54.3	15.5	34.2	34.9
LSD 5%	0.3	NS	158	0.5	NS	NS	NS
C.V. %	0.1	4.9	3.1	0.7	1.8	1.3	10.6

Sunflower Response to Preemergence Herbicides
Hettinger Research Extension Center

Sunflower was planted at a seeding rate of 18,000 seeds/acre on June 7, 2019 using a John Deere planter in 30 inch rows and at a depth of 1.5 inches. Preemergence herbicide treatments were applied on June 10 using a tractor-mounted research sprayer at a spray volume of 10 gallons per acre. Glyphosate (Roundup PowerMax was included with all treatments, including the untreated control, to control weeds that had emerged prior to planting. Preemergence treatments included Authority Supreme (sulfentrazone + pyroxysulfone), Authority Elite (sulfentrazone + metolachlor), Spartan Charge (carfentrazone + sulfentrazone), Anthem Flex (carfentrazone + pyroxasulfone), and Zidua SC (pyroxasulfone). Sunflower emerged on June 17. In the week following application adequate rainfall occurred for activation of preemergence herbicides. At 7 days after sunflower emergence, slight injury in the form of bronzing of the cotyledon leaves was noticed for many of the herbicide treatments that contained the active ingredient sulfentrazone. This injury was not observed on any of the later true leaves. Control of green foxtail and tumble pigweed was evaluated. Green foxtail control was less in the Spartan Charge treatment than any other herbicide treatment. This was not unexpected as Spartan Charge does not contain any herbicide that is known to provide good control of green foxtail. Tumble pigweed was also controlled at 90% or more with all herbicide treatments. Sunflower were harvested on November 21, 2019 using a small plot combine with a 5 foot all-crop header. Sunflower yield was less in the untreated control, but there was no difference in yield when comparing herbicide treatments. Of the herbicide treatments, sunflower yield was lowest in the Spartan Charge treatment, which was not statistically greater than the untreated control This was likely due to poor grass control in this treatment. And although yield was still good in the untreated control, weeds that were left uncontrolled produced seed that will need to be controlled in future crops.

Table. Comparison of preemergence herbicide treatments for weed control and sunflower yield at Hettinger ND.

			Green foxtail			Tumble pigweed			Sunflower
Treatment	Rate	7 DAE[1]	16 DAE	23 DAE	39 DAE	16 DAE	23 DAE	39 DAE	Yield
	oz/A	% injury	——————% control——————						lbs/acre
1 Untreated		0 b	0 c	0 c	0 c	0 b	0 b	0 b	2214 b
2 Authority Supreme	8	6 a	95 a	89 a	86 a	100 a	100 a	100 a	2662 a
3 Authority Elite	24	8 a	98 a	91 a	88 a	100 a	98 a	100 a	2705 a
4 Spartan Charge	5.1	6 a	73 b	73 b	45 b	100 a	95 a	95 a	2432 ab
5 Anthem Flex	4.5	1 b	95 a	94 a	89 a	100 a	99 a	100 a	2552 a
6 Zidua SC	5	0 b	93 a	91 a	82 a	100 a	100 a	98 a	2636 a
LSD P=.05		3.1	6.3	6.1	9	0.6	4.7	3.9	318
Standard Deviation		2.6	5.3	5.2	7.6	0.5	4.0	3.3	268
Treatment Probability (F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

[1] DAE, days after emergence.

Spring Wheat Response to Pre-Plant Burndown Herbicides
Hettinger Research Extension Center

A trial was conducted to evaluate herbicides that can be applied preplant in wheat to control existing weeds and to see if there is any residual control of weeds from these herbicides. Herbicide treatments were applied on May 13, 2019. Weeds present at time of application included downy brome, prickly lettuce, shepherds purse, tansy mustard, kochia, and common lambsquarters. Green foxtail emerged later. Wheat 'Elgin' was planted on May 15 using a no-till drill at a seeding rate of 120 lbs/acre and at a depth of 2 inches. Wheat emerged on May 29. Downy brome was controlled 100% by all treatments containing Gramoxone (paraquat) or Roundup PowerMax (glyphosate), but only 78 to 87% with Section Three (clethodim). Shepherds purse was control 99 to 100% with glyphosate alone or with glyphosate tank mixes. Paraquat alone or with 2,4-D controlled shepherds purse 89 and 91%, respectively, with 99% control with tank-mixed with Sharpen (saflufencil). Control of flixweed was 90% or better with all treatments, however tank-mixes with clethodim provided lower control than other treatments. Prickly lettuce was controlled 100% by all treatments except tank-mixes containing clethodim. Kochia control was best (98%) with the tank mix of glyphosate plus Anthem Flex (carfentrazone + pyroxasulfone). Other treatments provided only fair control of kochia. Similar to kochia, common lambsquarters control was best (95%) with the tank mix of glyphosate + carfentrazone + pyroxasulfone. Green foxtail was controlled only by the tank mix of glyphosate + carfentrazone + pyroxasulfone. This was due to the ingredient pyroxasulfone in the tank-mix which provides residual control of grasses and some small-seeded broadleaf weeds. Pyroxasulfone works best when there is a minimum of one-half inch of rainfall in the week following application. At Hettinger, 2.9 inches of rainfall occurred in the week following treatment application. There was no significant difference in yield in this trial due to herbicide treatment. Weed populations were light and growing conditions in Hettinger were good so that the presence of weeds did not cause significant yield losses. Although, yield in the untreated plot was the lowest of all treatments.

Table. Comparison of pre-plant burndown herbicide treatments for weed control and wheat yield at Hettinger ND.

Treatment[1]	Rate	Downy brome	Shepherds purse	Flixweed	Prickly lettuce	Kochia	Lambs quarters	Green foxtail	Wheat Yield
	oz/A	% control[2]							bu/acre
1 Untreated		0 d	0 d	0 d	0 d	0 f	0 f	0 b	34
2 Gramoxone SL 2.0	32	100 a	89 b	100 a	100 a	69 de	61 de	0 b	47
3 Gramoxone SL 2.0 + 2,4-D LV6	32+16	100 a	91 b	98 ab	100 a	65 cd	65 cd	0 b	47
4 Gramoxone SL 2.0 + Sharpen	32+2	100 a	99 a	99 a	100 a	77 bc	78 bc	0 b	52
5 Roundup PowerMax	24	100 a	100 a	100 a	100 a	71 bcd	70 bcd	0 b	46
6 Roundup PowerMax + 2,4-D LV6	24+16	100 a	100 a	100 a	100 a	65 bcd	68 bcd	0 b	50
7 Roundup PowerMax + Sharpen	24+2	100 a	99 a	100 a	100 a	78 b	80 b	0 b	47
8 Roundup PowerMax + Aim	24+2	100 a	100 a	100 a	100 a	71 bc	62 de	0 b	44
9 Roundup PowerMax + Anthem Flex	24+4	100 a	100 a	100 a	100 a	98 a	95 a	93 a	48
10 Roundup PowerMax + Quelex	24+0.75	100 a	100 a	100 a	100 a	78 bcd	66 b	0 b	47
11 Roundup PowerMax + Elevore	24+1	100 a	100 a	100 a	100 a	63 bcd	68 bcd	0 b	47
12 Roundup PowerMax + Starane Ultra + Elevore	24+4.5+1	100 a	100 a	100 a	100 a	75 de	60 b	0 b	45
13 Section Three + Elevore	5.3+1	87 b	76 c	90 c	37 c	56 de	59 cd	0 b	42
14 Section Three + Starane Ultra + Elevore	5.3+4.5+1	78 c	78 c	93 bc	83 b	66 bc	79 bc	0 b	46
LSD P=.05		3.3	6.3	6.0	9.1	16.2	14.5	0.9	9.6
Standard Deviation		2.75	5.3	5.1	7.7	13.6	12.2	0.8	8.0
Treatment Probability (F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.4811

[1] NIS (0.5% v/v) was added to treatments 2 and 3; MSO (1% v/v) was added to treatments 4, and 7-14; AMS (17 lbs/100 gal) was added to treatments 5-14.

[2] Downy brome, shepherds purse, flixweed, and prickly lettuce were evaluated 18 days after treatment. Kochia, common lambsquarters, and green foxtail were evaluated 31 days after treatment.

Flax Response to Preemergence Herbicides
Hettinger Research Extension Center

Flax "Carter" was planted at a seeding rate of 40 lbs/acre on May 6, 2019 using a no-till planter to a depth of 1.5 inches. Preemergence herbicide treatments were applied immediately after planting using a tractor-mounted research sprayer at a spray volume of 10 gallons per acre. In the week following application 0.44 inches of rainfall occurred. Flax emerged on May 23. In the period between planting and flax emergence 3.3 inches of rainfall occurred. Rainfall was more than adequate to move the herbicides into the soil for activation. At 12 days after flax emergence, injury was apparent from nearly all herbicides. Although most herbicides caused minor injury, the herbicides Fierce and Valor, which contain the active ingredient flumioxazin, caused major damage to the flax (84%) mostly related to reduction in flax stand. At 33 days after flax emergence, Zidua and Spartan + Zidua, caused low to moderate injury to flax (8 and 18%). At 48 days after emergence, injury was observed only with Fierce and Valor. This injury was apparent in flax stand counts, which were reduced 50% compared to the untreated control. Flax height was not reduced by herbicide treatments, indicating that herbicides were more active during the germination and emergence growth stages and did not cause continued injury following crop emergence. Control of wild buckwheat, common mallow, and kochia were also evaluated. Wild buckwheat was control best with Zidua, Spartan + Zidua, BroadAxe + Dual, Fierce, Prowl, and Valor. Common mallow was control best following application of Zidua, Spartan + Zidua, BroadAxe + Dual, Fierce, and Valor. Kochia was controlled 88 to 100% by all herbicide treatments except Warrant (70%) and Dual II Magnum (63%). Application of Fierce reduced flax yield by 46%, but yield was reduced by just 22% following application of Valor. All other treatments yielded similarly to the untreated control. At Hettinger, growing conditions were cool and wet with nearly 20 inches of rainfall during the growing season and only one day where temperature exceeded 90 F. These conditions were ideal for testing flax herbicide tolerance to preemergence herbicides, but they also allowed the flax to recover somewhat, which reduced yield losses.

Note: the vast majority of the treatments listed in this trial are experimental and are not labelled for use in flax. Only use herbicides that have been labelled for use in flax crop.

Table. Comparison of preemergence herbicides applied to flax. Flax 'Carter' was evaluated for injury from herbicide treatments and resulting yield. Weed control was also evaluated.

Treatment	Rate	12 DAE[1]	33 DAE	48 DAE	Flax Stand	Flax Height	Wild buckwheat	Common mallow	Kochia	Flax Yield
	oz/A	————% injury————			plants/m	cm	————% control————			lbs/acre
1 Untreated		0 d	0 d	0 b	29 a	57.8 -	0 e	0 e	0 d	1495 ab
2 Zidua	3	10 bc	8 c	0 b	34 a	59.8 -	80 a	79 ab	90 a	1506 ab
3 Spartan + Zidua	4 +1.5	15 b	18 b	1.3 b	32 a	58.8 -	76 ab	85 a	96 a	1645 ab
4 Warrant	48	1.3 cd	3.8 cd	0 b	34 a	57.3 -	55 d	59 d	70 bc	1430 b
5 Dual II Magnum	24	7.5 bcd	4.3 cd	0 b	27 a	58.2 -	63 cd	64 cd	63 c	1445 ab
6 BroadAxe + Dual	22.8 + 5.2	8 bcd	1.3 d	0 b	30 a	58.6 -	80 a	91 a	100 a	1692 a
7 Fierce	3	84 a	79 a	68 a	14 b	58.1 -	73 ab	90 a	100 a	812 d
8 Prowl H2O	24	7 bcd	1.3 d	1.3 b	32 a	57.6 -	75 ab	68 bcd	96 a	1451 ab
9 Valor	2	84 a	78 a	68 a	15 b	59.3 -	75 ab	78 abc	94 a	1165 c
10 Outlook	18	3.8 cd	0 d	0 b	30 a	59.4 -	68 bc	55 d	88 ab	1391 bc
LSD P=.05		9.06	5.80	3.48	82.85	2.36	9.96	13.96	19	255.87
Standard Deviation		6.24	4.00	2.40	57.11	1.63	6.86	9.62	13.1	176.36
Treatment Probability (F)		0.0001	0.0001	0.0001	0.0001	0.4528	0.0001	0.0001	0.0001	0.0001

[1] DAE, days after emergence.

Flax Response to Postemergence Herbicides
Hettinger Research Extension Center

Flax "Carter" was seeded at a rate of 40 lbs/acre on May 6, 2019 using a no-till drill to a depth of 1.5 inches. Flax emerged on May 23. Postemergence herbicide treatments were applied on June 6 using a tractor-mounted research sprayer at a spray volume of 10 gallons per acre. Rainfall totaling 0.45 inches occurred on June 7, with rainfall beginning 38 hours after application, which should not have had any impact on herbicides applied. Flax was evaluated for injury at 8, 15, and 34 days after treatment (DAT). Talinor was excessively injurious to flax causing bleaching and necrosis of leaves. Armezon also caused bleaching injury, but was only moderate to minor injury. This injury was hardly noticeable at 15 DAT and not detected at 34 DAT. Bison caused minor injury in the form of leaf burn. Armezon + Bison was more injurious than either alone. Basagran caused little or no injury to flax. Raptor alone resulted in stunting and yellowing of flax. When Raptor was combined with Basagran this injury was reduced. Even with the observed injury, flax height was not measurably reduced 42 DAT. Wild buckwheat was best controlled with Talinor at 18.2 oz/acre, Bison, Bison + Armezon, and Raptor. However, none of the treatments provided good control of wild buckwheat. Common mallow was best controlled with Raptor or Raptor + Basagran. Even with the serious visual injury caused by the application of Raptor, flax yield was greatest with this treatment. Also yielding similar to Raptor alone was Basagran alone and Armezon + Bison. These yields were in part due to improved weed control that resulted from these treatments. However, it is remarkable at how well flax is able to overcome severe visual injury, especially under good growing conditions.

Note: the vast majority of the treatments listed in this trial are experimental and are not labelled for use in flax. Only use herbicides that have been labelled for use in flax or any other crop.

Table. Comparison of postemergence applied herbicides in flax. Flax 'Carter' was evaluated for injury and resulting yield from herbicide treatments and weed control was also evaluated.

Treatment	Rate	8 DAT[1]	15 DAT	34 DAT	Flax Height	Wild buckwheat	Common mallow	Flax Yield
	oz/A	————% injury————			cm	——%control——		lbs/acre
1 Untreated		0 d	0 c	0 d	58 -	0 e	0 f	899 f
2 Talinor	13.7	49 a	48 a	33 a	55 -	59 c	50 d	986 def
3 Talinor	18.2	58 a	40 a	19 b	59 -	75 ab	73 bc	1119 cdef
4 Armezon	0.5	5.5 d	2.5 c	0 d	58 -	0 e	0 f	934 ef
5 Armezon	0.75	11 cd	2.8 c	0 d	58 -	0 e	0 f	778 f
6 Bison	16	8.8 d	1.3 c	0 d	60 -	75 ab	54 cd	1367 bcd
7 Armezon+Bison	0.75 + 16	25 b	21.3 b	9 bcd	60 -	78 a	82 ab	1640 ab
8 Basagran	16	2 d	0 c	0 d	59 -	39 d	28 e	1478 abc
9 Raptor	4	23 bc	39 a	11 bc	59 -	75 ab	93 a	1804 a
10 Basagran + Raptor	16 + 4	9 d	7.5 c	2.5 cd	58 -	65 bc	92 a	1344 bcde
LSD P=.05		12.01	11.82	10.28	3.69	19.49	10.58	424.6
Standard Deviation		8.33	8.21	7.14	2.56	13.53	7.34	295.14
Treatment Prob(F)		0.0001	0.0001	0.0001	0.3217	0.0001	0.0001	0.0001

[1] DAE, days after emergence.

Timing of glyphosate application in Roundup Ready Canola
Hettinger Research Extension Center

A trial comparing different timings for glyphosate application to Roundup Ready Canola was conducted at the Hettinger Research Extension Center. A single application of glyphosate (Roundup PowerMax) was applied prior to planting, at planting, at the 1-2 leaf stage, or at the 3-4 leaf stage. Sequential applications of glyphosate were also evaluated and included the following combinations: prior to planting and at the 3 to 4 leaf stage, prior to planting and at the 5-6 leaf stage, just after planting and at the 3-4 leaf stage, and just after planting and at the 5 to 6 leaf stage. Weeds present at time of application were controlled regardless of application timing. Canola was harvested on August 23 using a plot combine with a 5 foot header. With a single application of glyphosate, timing was important and the 1 to 2 leaf stage of canola had the highest yield when using a single application. A single application just before planting or just after planting yielded 26 to 33% less than when applied at the 1-2 leaf stage. Canola yield was not statistically greater with sequential applications, compared with a single application at the 1 to 2 leaf stage.

Table. Comparison of glyphosate application timing on canola yield at the Hettinger Research Extension Center.

	Treatment[1]	Rate	Timing	Canola Yield
		oz/A		
1	Untreated			342 d
2	Roundup PowerMax	22	0-3 days before planting	927 bc
3	Roundup PowerMax	22	0-3 days before planting	1439 a
	Roundup PowerMax	15	3 to 4 leaf stage	
4	Roundup PowerMax	22	0-3 days before planting	1309 a
	Roundup PowerMax	15	5 to 6 leaf stage	
5	Roundup PowerMax	22	0 to 3 days after planting	838 c
6	Roundup PowerMax	22	0 to 3 days after planting	1372 a
	Roundup PowerMax	15	3 to 4 leaf stage	
7	Roundup PowerMax	22	0 to 3 days after planting	1170 ab
	Roundup PowerMax	15	5 to 6 leaf stage	
8	Roundup PowerMax	15	1 to 2 leaf stage	1254 a
9	Roundup PowerMax	15	1 to 2 leaf stage	1209 ab
	Roundup PowerMax	15	5 to 6 leaf stage	
10	Roundup PowerMax	15	3 to 4 leaf stage	1207 ab
LSD P=.05				281
Standard Deviation				192
Treatment Prob(F)				0.0001

[1] Ammonium Sulfate (AMS) was included with all glyphosate treatments at a rate of 17 lbs per 100 gallons of spray solution.

Comparison of Fall versus Spring Preemergence Herbicide Application in Field Pea
Hettinger Research Extension Center

Preemergence herbicides sulfentrazone and metolachlor were applied in the fall or in the spring to compare weed control and field pea response. The fall application occurred on October 17, 2018. Spring application occurred just after planting on May 6, 2019. Field pea 'Salamanca' was seeded at a rate of 146 lbs/acre at a depth of 2 inches using a no-till drill. Peas emerged on May 25. All preemergence herbicides were tank mixed with glyphosate (Cornerstone Plus at 32 oz/A). Peas were evaluated for visible injury due to herbicide treatments and no injury was observed during any evaluation. Fall applications were very effective at controlling downy brome resulting in 90% or better control 3 days before planting. Spring applications were also very effective at controlling downy brome with control being greater than 90% at 25 days after treatment (DAT), with the fall application of glyphosate alone being the only treatment with reduced downy brome control (85%). Wild buckwheat was control fairly well BroadAxe treatments with spring applications providing better control than fall. This was especially apparent at 39 DAT. However fall applied BroadAxe controlled wild buckwheat much better than fall applications of Dual or glyphosate alone. Kochia control 25 DAT was fairly similar comparing fall with spring applications of BroadAxe. However, at 39 DAT, it was apparent that fall applied herbicides were losing their effectiveness and control was less than spring applications in most cases. All herbicide treatments increased yield compared with the untreated control. However, spring applications generally resulted in greater yield compare with fall applications. The benefit of fall application is that fields have fewer weeds in the spring at planting reducing need for herbicide application prior to planting. The benefit is even greater under dry spring conditions where activity of spring herbicides is reduced due to lack of rainfall. In this trial, more than adequate rainfall occurred for activity of spring applied herbicides, reducing the benefit of fall application. Further, the high amount of rainfall that occurred likely reduced weed control from fall applied preemergence herbicides through dilution in the soil.

Table. Comparison of fall and spring applied preemergence herbicides for weed control in field peas at the Hettinger Research Extension Center.

Treatment	Rate	Timing[2]	Downy Brome		Wild buckwheat		Kochia		Common mallow	Pea Yield
			-3 DAT[1]	25 DAT	25 DAT	39 DAT	25 DAT	39DAT	53 DAT	
	oz/A		%control							bu/acre
1 Untreated			0 d	0 c	0 d	0 f	0 c	0 f	0 f	35 f
2 BroadAxe	19	Fall	97 ab	91 ab	84 ab	70 bc	95 a	79 ab	60 bc	49 bc
3 BroadAxe	25	Fall	99 ab	94 ab	88 a	71 bc	89 a	75 bc	76 ab	42 def
4 BroadAxe + Dual	19 + 10	Fall	100 a	91 ab	67 b	48 de	86 a	63 cd	64 bc	48 bcd
5 BroadAxe + Dual	19 + 26	Fall	100 a	93 ab	70 b	35 e	85 a	48 e	71 ab	47 bcde
6 Dual	32	Fall	100 a	94 a	36 c	8 f	34 b	9 f	6 ef	46 bcde
7 Glyphosate	32	Fall	96 b	85 b	10 d	0 f	15 c	0 f	0 f	41 ef
8 Glyphosate	32	Fall+Spring	90 c	96 a	91 a	60 cd	93 a	63 cd	21 de	52 ab
9 BroadAxe	19	Spring	0 d	95 a	97 a	90 a	96 a	91 a	83 a	49 bc
10 BroadAxe	25	Spring	0 d	94 a	96 a	89 a	97 a	89 a	87 a	57 a
11 BroadAxe + Dual	10 + 16	Spring	0 d	94 ab	94 a	79 ab	95 a	82 ab	77 ab	50 abc
12 BroadAxe + Dual	10 + 26	Spring	0 d	96 a	94 a	80 ab	92 a	80 ab	78 ab	45 cde
13 Dual	32	Spring	0 d	98 a	94 a	61 cd	87 a	60 de	51 c	51 abc
14 Glyphosate	32	Spring	0 d	95 a	93 a	63 c	88 a	55 de	28 d	50 abc
LSD P=.05			3.9	8.1	16.1	13.36	17.5	11.8	18.13	6.9
Standard Deviation			2.74	5.65	11.28	9.34	12.21	8.26	12.68	4.85
Treatment Prob(F)			0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002

[1] DAT, days after treatment (spring application on May 6).

[2] Fall treatments were applied on October 17, 2018 and spring treatments were applied on May 6, 2019.

Comparison of Preemergence Herbicides for Weed Control in Field Pea
Hettinger Research Extension Center

Preemergence herbicides were applied in the spring after planting to compare weed control and field pea response. Field pea 'Salamanca' was seeded at a rate of 146 lbs/acre at a depth of 2 inches using a no-till drill on May 6, 2019. Peas emerged on May 25. All preemergence herbicides were tank mixed with glyphosate (Roundup PowerMax at 22 oz/A). Peas were evaluated for visible injury due to herbicide treatments and no injury was observed during any evaluation. All treatments provided good to excellent control of downy brome. At 34 days after crop emergence, most herbicide treatments provided good control of wild buckwheat, with the exception of Anthem Flex (carfentrazone + pyroxasulfone). Kochia was control 84 to 93% with all preemergence herbicide treatments. Common mallow control was fair to good with all herbicide treatments, with the best control following application of Authority Supreme HL (sulfentrazone + pyroxsasulfone), but this treatment was similar in control to all but Sharpen (saflufencil), and Anthem Flex at 3 oz/A. There was no difference is field pea stand, and yield was only reduced in the untreated plots. Herbicide activity in 2019 was aided by higher than normal rainfall. Under lower rainfall conditions, reduced weed control would likely occur. However, under these conditions, field pea showed tolerance to all of the herbicides used in this trial.

Table. Comparison of preemergence herbicides for weed control in field peas at the Hettinger Research Extension Center.

		Downy Brome	Wild buckwheat		Kochia		Common mallow	Field Pea	
Treatment	Rate	10 DAE[1]	10 DAE	34 DAE	10 DAE	34 DAE	34 DAE	Stand	Yield
	oz/A	——————————%control——————————						plants/m^2	bu/acre
1 Untreated		0 f	0 e	0 c	0 b	0 b	0 d	58 -	17 b
2 Authority Supreme	5.8	98 ab	81 bcd	84 a	95 a	92 a	79 ab	72 -	55 a
3 Authority Supreme HL	4.4	99 a	86 ab	83 a	96 a	91 a	83 a	67 -	56 a
4 Spartan Elite	19	91 de	86 ab	87 a	99 a	88 a	76 abc	74 -	54 a
5 Spartan Charge	3.75	91 d	86 ab	81 a	99 a	91 a	76 abc	76 -	55 a
6 Sharpen	2	87 e	91 a	78 a	93 a	84 a	73 bc	75 -	56 a
7 Anthem Flex	3	96 abc	76 cd	66 b	97 a	90 a	68 c	71 -	46 a
8 Anthem Flex	4.5	93 cd	83 abc	66 b	99 a	93 a	82 a	68 -	49 a
9 Dual + Metribuzin	27 + 4	97 abc	73 d	76 ab	100 a	89 a	75 abc	65 -	53 a
10 Roundup PowerMax	22	94 bcd	0 e	0 c	0 b	0 b	0 d	74 -	51 a
LSD P=.05		4.6	4.1	11.0	8.6	16.3	8.4	NS	12.7
Standard Deviation		3.15	2.8	7.6	6.0	11.3	5.8	9.8	8.76
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.2776	0.0001

[1] DAE, days after emergence (field pea planted on May 6; emerged on May 25).

Comparison of Preemergence Herbicides for Weed Control in Lentil
Hettinger Research Extension Center

Preemergence herbicides were applied in the spring after planting to compare weed control and lentil response. Lentil 'Imvincible' was seeded at a rate of 18 seeds/ft^2 at a depth of 2 inches using a no-till drill on May 10, 2019. Lentil emerged on May 21. All preemergence herbicides were tank mixed with glyphosate (Roundup PowerMax at 22 oz/A). Lentil were evaluated for visible injury due to herbicide treatments. At 14 days after emergence, moderate injury of 8 to 19% was observed in many of the treatments in the form of leaf bronzing. This injury diminished over time and was no more than 10% at 42 days after lentil emergence. All treatments provided good to excellent control of downy brome and prickly lettuce. Wild buckwheat control 28 DAE was greatest with Anthem Flex + Metribuzin at 4 +8 oz/A or Anthem Flex at 6 oz/A. Kochia control was improved when Metribuzin was tank mixed with Anthem Flex or when Anthem Flex was applied alone at 6 oz/A. Some treatments had a slight reduction in lentil stand due to herbicide treatment but there was no difference in lentil height. Yield was reduced nearly 100% in the untreated control. With herbicide treatments, lentil yield ranged from 31 to 36 bu/A. Yield with Anthem Flex + Metribuzin at 4+8 oz/A was the lowest of all herbicide treatments at 31 bu/A. Herbicide activity in 2019 was aided by higher than normal rainfall. More than 2.4 inches of rainfall occurred in between planting and crop emergence. Under lower rainfall conditions, reduced weed control would likely occur. Under these conditions, injury to lentil was apparent early in the season but this injury was less noticeable later in the season showing good tolerance to all herbicide treatments. Good growing conditions of higher than normal rainfall and cooler than normal temperatures resulted in high yield for lentil.

Table. Comparison of preemergence herbicides for weed control in lentil at the Hettinger Research Extension Center.

Treatment	Rate	Lentil	Wild buckwheat		Kochia		Wild oat		Lentil	
		14 DAE[1]	14 DAE	28 DAE	28 DAE	42 DAE	42 DAE	Stand	Height	Yield
	oz/A	——————————%control——————————						plants/m^2	cm	bu/acre
1 Untreated		0 g	0 c	0 d	0 b	0 d	0 b	113 f	39 -	0.2 c
2 Anthem Flex	3.5	8 c-f	100 a	85 c	87 d	88 abc	84 a	153 a-e	35 -	35 a
3 Anthem Flex	4	17 ab	99 ab	89 bc	91 cd	85 c	77 a	142 de	34 -	33 ab
4 AF + Metribuzin	3.5+4	13 a-d	99 ab	86 c	95 abc	92 abc	83 a	140 e	35 -	36 a
5 AF + Metribuzin	4+4	12 bcd	100 a	88 c	95 abc	93 ab	79 a	152 a-e	35 -	35 ab
6 AF + Metribuzin	3.5+5.3	3 fg	96 b	85 c	98 ab	91 abc	80 a	150 b-e	35 -	35 ab
7 AF + Metribuzin	4+5.3	19 a	99 ab	89 bc	97 abc	95 a	82 a	148 cde	35 -	36 a
8 AF + Metribuzin	3.5+8	7 def	100 a	91 bc	96 abc	94 a	79 a	161 abc	37 -	36 a
9 AF + Metribuzin	4+8	16 ab	100 a	98 a	99 a	93 ab	80 a	157 a-d	35 -	31 b
10 Anthem Flex	6	13 abc	99 ab	95 ab	96 abc	93 ab	84 a	149 b-e	34 -	33 ab
11 Dual + Metribuzin	27+4	4 efg	98 ab	87 c	92 bcd	87 bc	0 b	166 a	36 -	37 a
LSD P=.05		5.9	3.5	6.3	6.1	6.7	7.1	17.5	NS	4.2
Standard Deviation		4.9	2.9	5.3	5.1	5.6	5.9	14.6	1.7	3.5
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.2776	0.1158	0.0001

[1] DAE, days after emergence lentil planted on May 10; emerged on May 21).

Preemergence Herbicides for Weed Control in Lentil
Hettinger Research Extension Center

Preemergence herbicides were applied in the spring after planting to compare weed control and lentil response. Lentil 'Imvincible' was seeded at a rate of 18 seeds/ft^2 at a depth of 2 inches using a no-till drill on May 10, 2019. Lentil emerged on May 21. All preemergence herbicides were tank mixed with glyphosate (Roundup PowerMax at 22 oz/A). Lentil were evaluated for visible injury due to herbicide treatments. At 9 days after emergence (DAE), 49% injury was observed in the Spartan Charge + Dual (5+27 oz/A) treatment, injury in other treatments was 10% or less. At 22 DAE, Injury was 60% in the Spartan Charg + Dual treatment. Injury in other treatments ranged from 13 to 20%. Injury from these treatments was high due to the high amount of rainfall that occurred after treatments were applied. At 36 DAE, injury was less than at 22 DAE and lentil appeared to be recovering. All treatments provided excellent control of downy brome and prickly lettuce. Kochia control was 85 to 92% at 36 DAE. Wild buckwheat control ranged 86 to 91% in all herbicide treatments at 36 DAE. Lentil were harvested on August 22. Even though injury to lentil was moderate with many of the herbicide treatments, yield was reduced only with the Spartan Charge+Dual (5+27 oz/A) treatment (15 bu/A) or when weeds were not controlled. Yield with other herbicide treatments ranged from 30 to 35 bu/A. Herbicide activity in 2019 was aided by higher than normal rainfall. More than 2.4 inches of rainfall occurred in between planting and crop emergence. Under lower rainfall conditions, reduced weed control would likely occur. Under these conditions, injury to lentil was apparent early in the season but this injury was less noticeable later in the season showing good tolerance to all herbicide treatments except the Spartan Charge treatment. Good growing conditions of higher than normal rainfall and cooler than normal temperatures resulted in high yield for lentil.

Table. Comparison of preemergence herbicides for weed control in lentil at the Hettinger Research Extension Center.

Treatment	Rate	Lentil	Wild buckwheat		Kochia		Lentil	
		22 DAE[1]	22 DAE	36 DAE	28 DAE	42 DAE	Stand	Yield
	oz/A	——————————%control——————————					#/m^2	bu/acre
1 Untreated		0 e	0 c	0 c	0 c	0 d	132 c	5.2 c
2 Sharpen+Outlook+Metribuzin	0.75+2+4	14 d	96 a	91 a	94 a	91 a	156 abc	30 a
3 Anthem Flex+Metribuzin	4+4	19 b	92 a	86 a	94 a	92 a	154 abc	31 a
4 Sharpen+Metribuzin+Prowl H2O	0.75+4+32	10 d	91 ab	86 a	89 ab	88 ab	172 ab	31 a
5 Sharpen+Dual+Metribuzin	0.75+27+4	21 b	91 ab	86 a	91 ab	92 a	175 a	34 a
6 Sharpen+Metribuzin+Zidua SC	0.75+4+3.25	14 cd	94 a	88 a	94 a	91 a	162 ab	33 a
7 Sharpen+Metribuzin+Zidua SC	0.75+4+5	18 bc	92 ab	81 a	92 ab	88 a	149 bc	31 a
8 Spartan Charge+Dual	5+27	60 a	97 a	91 a	95 a	80 b	131 c	15 b
9 Roundup PowerMax	24	0 e	85 b	80 b	73 b	70 c	164 ab	32 a
LSD P=.05		4.1	7.2	7.6	6.7	8.1	25	5.4
Standard Deviation		3.4	6.0	6.3	5.5	6.7	21	4.5
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

[1] DAE, days after emergence lentil planted on May 10; emerged on May 21.

Evaluation of Postemergence Weed Control Options in Soybean in Southwest North Dakota
Hettinger Research Extension Center

A trial comparing different postemergence options for weed control in dicamba tolerant soybean was conducted at the Hettinger Research Extension Center. Soybean 'AsGrow 03X7'were planted at a rate of 180,000 seed per acre on June 8, 2019 using a John Deere planter in 30 inch rows at a depth of 1.5 inches. Prior to planting, weeds were controlled with an application of glyphosate (Roundup PowerMax at 28 oz/A). Nine postemergence herbicide treatments were compared with and untreated control. Treatments were applied on July 8, 2019 using a tractor-mounted research sprayer using a spray volume of 15 gallons per acre using Turbo T-Jet Air Induction (TTI) nozzles. Weed control from burndown treatments was evaluated 16 and 37 days after treatment (DAT). Green foxtail was controlled 92% or more with all treatments except Engenia (dicamba) alone, Pursuit alone, or Engenia + Pursuit. As dicamba does not have any activity on grasses and Pursuit is primarily a broadleaf herbicide, this was not a surprise. Kochia was only control 63% with Roundup PowerMax (RU) at 28 oz/acre. This increased to 82% at the 42 oz/acre rate. RU + Anthem and Pursuit alone provided poor control of kochia. Wild buckwheat was controlled best with RU at 48 oz/A, RU + Engenia, RU + Engenia + Anthem, and Engenia + Pursuit. Field bindweed was controlled 78% at best by the RU + Engenia treatment. Soybean yield was highly variable due to differences in weed competition between plots. All treatments yielded more than the untreated control, but yields with Pursuit alone and Engenia + Pursuit were less than the highest yielding treatment. Rainfall during the summer of 2019 was well above average and temperature was below normal. This reduced the impact of weeds on soybean production. The number of soybean acres is increasing in southwest North Dakota. Controlling weeds will be important for economic production of this crop in this region. This will include a good preplant burndown of weeds prior to planting and will need to be followed with a postemergence herbicide application. Dicamba tolerant soybean may be a good option for controlling difficult weeds, such as kochia and prickly lettuce. As in other regions of the state where soybean are grown, applicators need to be careful not to impact nearby sensitive crops or other sensitive areas (trees, gardens, etc.) when applying dicamba.

Table. Comparison of postemergence herbicides for weed control in soybean at the Hettinger Research Extension Center.

Treatment[1]	Rate	Green foxtail		Kochia		Wild buckwheat		Field bindweed		Soybean
		16 DAT[2]	37 DAT	16 DAT	37 DAT	16 DAT	37 DAT	16 DAT	37 DAT	Yield
	oz/A	%control								bu/acre
1 Untreated		0 d	0 d	0 d	0 e	0 g	0 f	0 d	0 d	7.4 c
2 Roundup PowerMax	28	98 a	92 ab	70 bc	63 c	70 b	71 cd	67 bc	66 b	37 a
3 Roundup PowerMax	42	99 a	96 a	86 a	82 ab	81 ab	77 abc	80 a	74 ab	28 ab
4 Engenia	12.8	0 d	0 c	83 ab	84 ab	81 ab	75 bcd	75 ab	72 ab	30 ab
5 RU[3] + Engenia	28+12.8	100 a	98 a	87 a	88 ab	82 a	82 ab	76 ab	78 a	27 ab
6 RU[3] + Anthem	28+10	98 a	96 a	66 c	55 c	70 b	68 d	68 bc	70 ab	24 ab
7 RU[3] + Engenia + Anthem	28+12.8+10	98 a	98 a	85 ab	84 a	80 ab	79 abc	81 a	76 ab	29 ab
8 Pursuit	3	55 c	83 b	60 c	44 d	55 c	50 e	61 c	54 c	20 bc
9 RU[3] + Pursuit	28+3	100 a	100 a	81 a	77 b	68 bc	78 abc	74 abc	72 ab	30 ab
10 Engenia + Pursuit	12.8+3	72 b	68 c	85 a	88 a	80 ab	85 a	74 abc	71 ab	21 bc
LSD P=.05		12.8	12.7	8.4	9.8	8.5	7.7	11.4	11	14.5
Standard Deviation		8.8	8.7	5.7	6.7	5.9	5.3	7.8	7.5	9.9
Treatment Prob(F)		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0313

[1] Ammonium Sulfate (AMS) was included with treatments 2, 3, and 6; NIS (0.25% v/v) was included in treatments 2, 3, 4, 5, 6, and7; MSO (1.5 pt/A) was included with treatments 8, 9, and 10.
[2] DAT, days after treatment (treatments applied on July 8, soybean planted on June 10).
[3] RU, Roundup PowerMax

Evaluation of Postemergence Weed Control Options in Soybean in Southwest North Dakota
Hettinger Research Extension Center

A trial comparing different postemergence options for weed control in dicamba tolerant soybean was conducted at the Hettinger Research Extension Center. Soybean 'AsGrow 03X7'were planted at a rate of 180,000 seed per acre on June 8, 2019 using a John Deere planter in 30 inch rows at a depth of 1.5 inches. Prior to planting, weeds were controlled with an application of glyphosate (Roundup PowerMax at 28 oz/A). Nine postemergence herbicide treatments were compared with and untreated control. Treatments were applied on July 8, 2019 using a tractor-mounted research sprayer using a spray volume of 15 gallons per acre using Turbo T-Jet Air Induction (TTI) nozzles. Weed control from burndown treatments was evaluated 16 and 37 days after treatment (DAT). Green foxtail was controlled 92% or more with all treatments except Engenia (dicamba) alone, Pursuit alone, or Engenia + Pursuit. As dicamba does not have any activity on grasses and Pursuit is primarily a broadleaf herbicide, this was not a surprise. Kochia was only control 63% with Roundup PowerMax (RU) at 28 oz/acre. This increased to 82% at the 42 oz/acre rate. RU + Anthem and Pursuit alone provided poor control of kochia. Wild buckwheat was controlled best with RU at 48 oz/A, RU + Engenia, RU + Engenia + Anthem, and Engenia + Pursuit. Field bindweed was controlled 78% at best by the RU + Engenia treatment. Soybean yield was highly variable due to differences in weed competition between plots. All treatments yielded more than the untreated control, but yields with Pursuit alone and Engenia + Pursuit were less than the highest yielding treatment. Rainfall during the summer of 2019 was well above average and temperature was below normal. This reduced the impact of weeds on soybean production. The number of soybean acres is increasing in southwest North Dakota. Controlling weeds will be important for economic production of this crop in this region. This will include a good preplant burndown of weeds prior to planting and will need to be followed with a postemergence herbicide application. Dicamba tolerant soybean may be a good option for controlling difficult weeds, such as kochia and prickly lettuce. As in other regions of the state where soybean are grown, applicators need to be careful not to impact nearby sensitive crops or other sensitive areas (trees, gardens, etc.) when applying dicamba.

Table. Comparison of postemergence herbicides for weed control in soybean at the Hettinger Research Extension Center.

Treatment[1]	Rate	Green foxtail		Kochia		Wild buckwheat		Field bindweed		Soybean
		16 DAT[2]	37 DAT	16 DAT	37 DAT	16 DAT	37 DAT	16 DAT	37 DAT	Yield
	oz/A	%control								bu/acre
1 Untreated		0 d	0 d	0 d	0 e	0 g	0 f	0 d	0 d	7.4 c
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LSD P=.05		12.8	12.7	8.4	9.8	8.5	7.7	11.4	11	14.5
Standard Deviation		8.8	8.7	5.7	6.7	5.9	5.3	7.8	7.5	9.9
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[1] Ammonium Sulfate (AMS) was included with treatments 2, 3, and 6; NIS (0.25% v/v) was included in treatments 2, 3, 4, 5, 6, and7; MSO (1.5 pt/A) was included with treatments 8, 9, and 10.
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Evaluation of Flax Tolerance to Preemergence and Postemergence Herbicide Applications.

Daniel Guimaraes Abe*[1], Caleb D. Dalley[1], Brian Jenks[2]; [1]North Dakota State University, Hettinger, ND, [2]North Dakota State University, Minot, ND (033) 24

Flax is an oil-seed crop grown primarily in North Dakota and in the Canadian Prairie Provinces. In 2018, North Dakota accounted for 85% of flaxseed production in the US with minor plantings in Montana and South Dakota. Few herbicides are registered for weed control in flax seed. Two experiments were conducted in Adams County in southwest North Dakota to evaluate preemergence and postemergence herbicides for flax tolerance and weed control. In the PRE herbicide trial, pyroxasulfone, sulfentrazone + pyroxasulfone, acetochlor, metolachlor, sulfentrazone + metolachlor, flumioxazin + pyroxasulfone, pendimethalin, flumioxazin, and dimethenamid were evaluated. Of these herbicides, injury was observed only after the application of acetochlor, with injury of 8% and 17% at 27 and 58 DAT, respectively. Stand counts and flax height were not affected by any of the applied treatments. Common mallow control was greatest (81% at 27 DAT) with sulfentrazone plus metolachlor, and was similar to sulfentrazone plus pyroxasulfone, flumioxazin plus pyroxasulfone, and pendimethalin (74 to 76%). All other treatments did not control common mallow. In the second trial, bicyclopyrone plus bromoxynil was applied at two rates (37 + 175 g ai ha^{-1} and 49 + 233 g ha^{-1}) PRE and POST (2 weeks after crop emergence). These treatments were compared with POST application of topramezone (12 and 18 g ai ha^{-1}), MCPA + bromoxynil (280 + 208 g ai ha^{-1}), bentazon (560 g ai ha^{-1}), imazamox (35 g ai ha^{-1}), and imazamox + bentazon (35 + 560 g ha^{-1}). POST application of bromoxynil plus bicyclopyrone resulted in severe injury to flax (61 to 81%), and reduced flax yield 38 to 45%, compared with the highest yielding treatment. PRE application of bromoxynil plus bicyclopyrone caused little or no injury. Topramezone caused minor injury to flax, but this injury did not reduce yield. Imazamox alone caused moderate injury to flax (29% at 15 DAT), but when tank-mixed with bentazon, this injury was reduced to 18%. Both treatments provided excellent control of common mallow and fair control of kochia and injury from treatments did not reduce yield. Results from these trials indicate that herbicides should be further explored in order to expand options for weed control in flax.

Evaluation of Flax Tolerance to Preemergence and Postemergence Herbicide Applications

Daniel G. Abe*, Caleb D. Dalley*, Brian Jinks
North Dakota State University, *Hettinger Research Extension Center

INTRODUCTION

Flax (*Linum usitatissumum*) is a purple flowered cool climate crop historically grown as both an oilseed crop (linseed oil) and for its fibrous stem (linen). Flax is grown primarily in North Dakota and in the Canadian Prairie Provinces. According to the USDA National Agricultural Statistic Service report from 2018, North Dakota accounted for 85% of flaxseed production in the US with minor plantings in Montana and South Dakota. In 2016, flax seed crop had one of highest yield at 1400 kg ha^{-1} (24 bu $acre^{-1}$ at 52 lbs bu^{-1}). There are several troublesome weed species across the northern plains that compete with flax production. In order to prevent yield losses, chemical weed control plays important role, particularly in no-till areas. There are few herbicides registered for weed control use in flax seed (2018 North Dakota Weed control guide). Currently, only four products as labelled for preemergence application (trifuralin, sulfentrazone, mesotrione, and carfentrazone) and just six postemergence herbicides are labelled (sethoxydim, quizalofop, clethodim, clopyralid, bromoxynil, and MCPA). Fewer herbicide options limits the scope of weed species controlled, especially for broadleaf weeds. Herbicide trials were conducted to evaluate tolerance of flax to preemergence and postemergence herbicides of interest in order to increase weed control options for flax producers.

OBJECTIVES

Evaluate herbicides and application timing for flax tolerance and weed control.

MATERIAL AND METHODS

- Experiments were conducted at the Hettinger Research Extension Center research farm.
- Prior to planting, on May 4, the entire field was treated with glyphosate (Cornerstone 5 Plus @ 234 ml ha^{-1}) to control winter annual weeds. Urea fertilizer (46-0-0) was applied on May 2 at a rate of 50 kg/ha.
- 'York' flax was planted on May 15, 2018 at a rate of 43 kg/ha, at a depth of 4 cm, and a row spacing of 19 cm using a John Deere 1590 no-till drill.
- Two trials were conducted; one evaluating PRE herbicides (Table 1) and other evaluating primarily POST treatments (Table 2).
- Treatments were arranged in a randomized complete block design with four replications. Plot size was 3 by 12 m.
- Treatments were applied with a tractor sprayer equipped with TeeJet® 8002XR flat fan nozzles calibrated to deliver 94 L ha^{-1} at 262 kPa using CO_2 as a propellant.
- PRE treatments were applied on May 16. Flax emerged on May 24. POST treatments were applied on June 5.
- Flax was evaluated for injury at 27 and 58 days after treatment (DAT) in the PRE trial, and at 7, 15, and 38 DAT in the POST trial. Weed control evaluations were conducted for common mallow, barnyard grass and kochia.
- Stand count and height measurement of flax were measured on June 19 in the PRE trial only.
- Clethodim (Section 3 at 140 g ai ha^{-1}) was sprayed on post emergence trial on 15 June to control grass weeds.
- Both trials were impacted by a severe hailstorm on June 26 resulting in complete defoliation of both flax and weeds. Further evaluations were not taken do to the damage to the plots.
- Flax was harvested on September 28. Plot weights, moisture and test weight of flax seed were recorded.
- Data were subjected to ANOVA.
- Visual ratings were transformed by arcsine square root percent.
- Means separation was performed using Fisher's Protected LSD at P=0.05 when F-test values were < 0.05.

Table 1. Pre emergence herbicides treatments, rates and timing of application utilized to evaluate flax tolerance and weed control.

Trt #	Herbicide	Rate (g ai/ha)	Timing
1	Untreated	-	-
2	Pyroxasulfone	179	PRE
3	Sulfentrozone + Pyroxasulfone	140 + 90	PRE
4	Acetochlor	1,260	PRE
5	S-metolachlor	1,604	PRE
6	Sulfentrozone + S-metolachlor	140 + 1,604	PRE
7	Flumioxazin + Pyroxasulfone	70 + 89	PRE
8	Pendamethalin	1,596	PRE
9	Flumioxazin	71	PRE
10	Dimethenamid-p	945	PRE

Table 2. Post emergence herbicides treatments, rates and timing of application utilized to evaluate flax tolerance and weed control.

Trt #	Herbicide	Rate (g ai/ha)	Timing
1	Untreated	-	-
2	Bromoxynil + Bicyclopyrone	175 + 37	PRE
3	Bromoxynil + Bicyclopyrone	233 + 37	PRE
4	Bromoxynil + Bicyclopyrone	175 + 37	POST
5	Bromoxynil + Bicyclopyrone	233 + 37	POST
6	Topramezone	12	POST
7	Topramezone	18	POST
8	Bromoxynil + MCPA	280 + 280	POST
9	Bentazon	560	POST
10	Imazamox	35	POST
11	Bentazon + Imazamox	446 + 27.9	POST

RESULTS

PRE Trial:

- The only herbicide treatment that caused visual injury to flax was the acetochlor with injury ratings of 8 and 19% 27 and 58 DAT, respectively.
- There was no significant differences among treatments for stand count, flax height or yield. However, flax treated with acetochlor had the lowest height and yield compared to the rest of treatments. Yields ranged from 787 to 1,015 LB/A.
- Common mallow control 27 DAT was greatest (81%) following application of sulfentrazone plus metolachlor, and similar to sulfentrazone plus pyroxasulfone, flumioxazin plus pyroxasulfone and pendamethalin with control ranging from 74 to 76%. All other treatments resulted in poor control of common mallow (Figure 1).
- At 27 DAT, barnyardgrass control was only fair (73 to 79%) following application of metolachlor, sulfentrazone plus metolachlor, flumioxazin plus pyroxasulfone, pendamethalin, and dimethenamid. All other treatments provided poor control of barnyardgrass (Figure 1).
- At 58 DAT, kochia control was only fair (74 to 79%) following application of sulfentrazone plus pyroxasulfone, sulfentrazone plus metolachlor, and dimethenamid (Figure 1).

POST trial:

- POST applications of bromoxynil plus bicyclopyrone provided fair control of both common mallow and kochia. However, it resulted in severe injury to flax, 61 to 81% (Figure 2), and reduced flax yield 38 to 45%, compared with the highest yielding treatment (Figure 3).
- PRE application of bromoxynil plus bicyclopyrone caused little or no injury. However, bromoxynil plus bicyclopyrone acts primarily as a POST herbicide and resulted in little control of either common mallow or kochia.
- Topramezone caused injury (bleaching) to flax with the injury being greater when applied at 0.75 oz/A compared with 0.5 oz/A at 15 DAT. Topramezone in this trial provided only fair control of common mallow or kochia.
- Bromoxynil plus MCPA and bentazon also caused minor injury to flax and provided fair to poor control of common mallow and kochia.
- Imazamox alone caused moderate injury to flax (29% at 15 DAT), but when tank-mixed with bentazon, this injury was reduced to 18%. Both treatments provided excellent control of common mallow and fair control of kochia and injury from treatments did not reduce yield (Figure 2).

DISCUSSION AND IMPLICATIONS

- PRE trial: Results suggest that there are several options that could be pursued for PRE weed control in flax. Although, the herbicide acetochlor may be too injurious to flax. Additional trials should be conducted to further evaluate these herbicides under different environmental conditions.
- POST: Flax yield was reduced by POST bromoxynil plus bicyclopyrone treatments and in the untreated control. Even though moderate injury occurred following imazamox application, flax yield was not reduced. In contrast, thifensulfuron, a different ALS-inhibiting herbicide was shown to injury flax and reduce flax yield (Derksen and Wall, 1996).
- Yield data were confounded by the hail storm that defoliated flax plots. Under these conditions no difference in flax yield was observed in the PRE trial and yield of treatments was not different form the untreated control. Further evaluations under different growing conditions is needed to validate results.
- Results from these trials indicate that herbicides should be further explored in order to expand options for weed control in flax.

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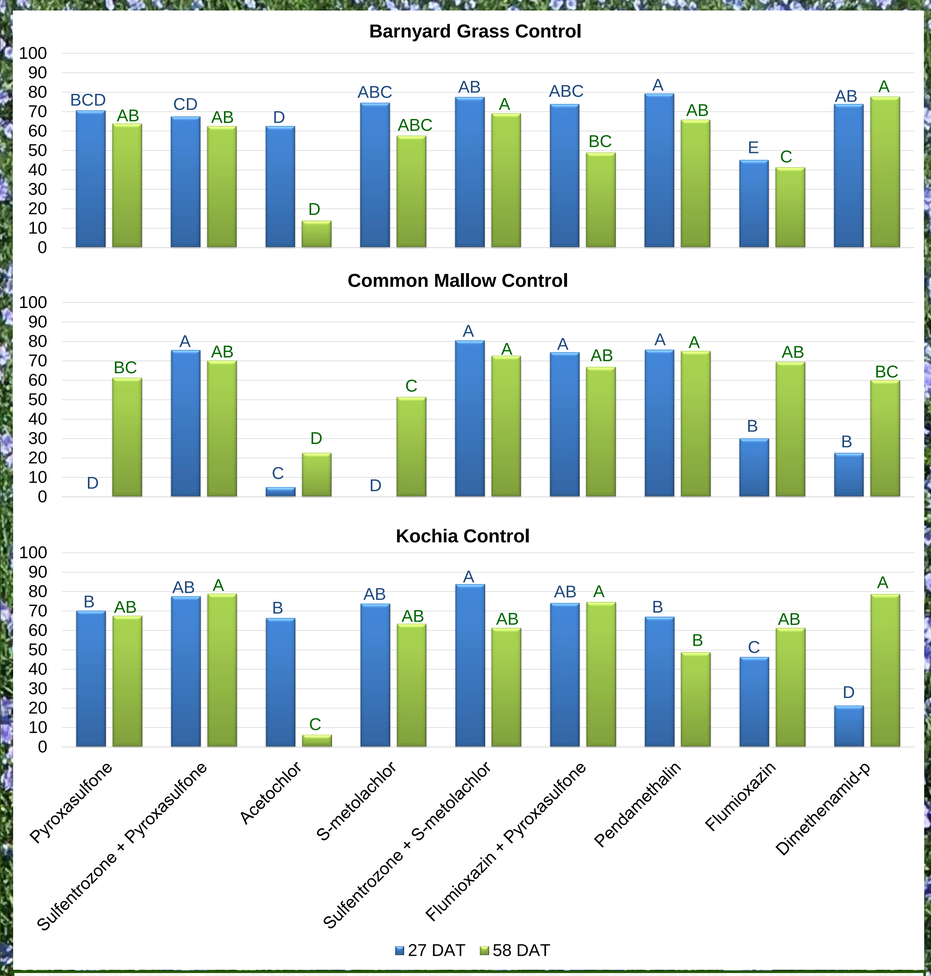

Figure 1. Percent of weed control by pre emergence herbicides treatments.
Treatment means, within evaluation dates, with different letters above the bar are significantly different (0.05). Herbicides rates are shown on Table 1.

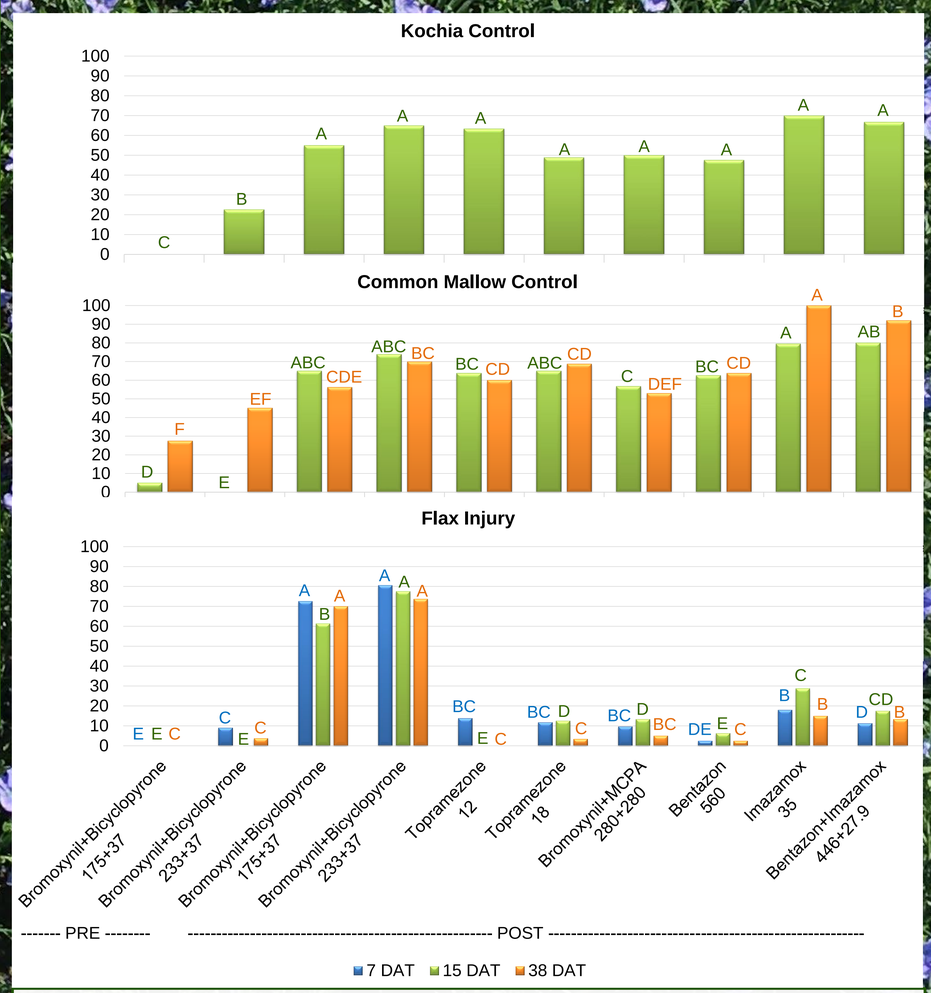

Figure 2. Percent of weed control and flax injury by post emergence herbicides treatments.
Treatment means, within evaluation dates, with different letters above the bar are significantly different (0.05). Herbicides rates are shown on Table 2.

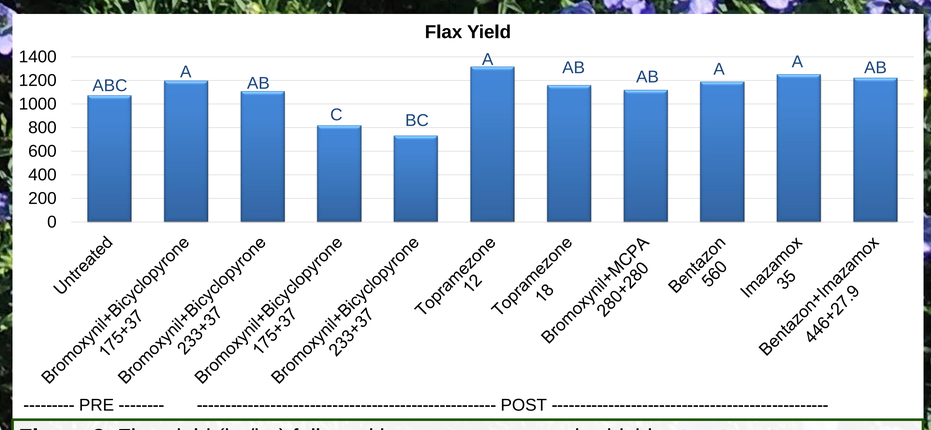

Figure 3. Flax yield (kg/ha) followed by post emergence herbicides treatments.
Treatment means, within evaluation dates, with different letters above the bar are significantly different (0.05). Herbicides rates are shown on Table 2.

Influences of dietary flax on male reproductive traits when supplemented prior to breeding in sheep

Paige P. Anderson[1], Amanda M. Long[1], Ethan R. Schlegel[2], Travis W. Hoffman[3], Kimberly A. Vonnahme[3,4], Jennifer L. Momsen[5], Lauren L. Hulsman Hanna[3], James D. Kirsch[3], Carl R. Dahlen[3], Kacie L. McCarthy[3] and Christopher S. Schauer[1]

The objective of the present study was to examine the influence of flaxseed supplementation on male reproductive traits during a 112-day period leading up to the breeding season. Results indicate that Flaxlic Sheep Tubs did not affect male reproductive traits when supplemented to a basal diet containing soybean hulls, corn and soybean meal.

Summary

Fertility in rams is of critical importance in range sheep operations. Prior to breeding, fertility can be enhanced by improving nutritional management. Fatty acid (FA) supplementation has been shown to improve male reproductive characteristics, such as sperm motility, concentration and morphology. Supplementation with flax prior to breeding is a potential strategy to increase omega-3 FAs in the diet. The objective of this study was to evaluate the effectiveness of flax supplementation on serum testosterone concentration and semen quality. One hundred twenty Rambouillet ram lambs (92.4 ± 6.12 pounds) were assigned randomly to 24 pens (five rams/pen; n = 12) and fed for 112 days. Rams were assigned to receive a Flaxlic® Sheep Tub (**FLX**) or a control (**CON**). Two-day weights were taken on days minus 1 and 0 and days 111 and 112. Serum for testosterone concentration analysis, semen for quality analysis and scrotal circumference measurements were collected on days 83 and 84 and 111 and 112. Average daily gain (**ADG**) for FLX rams was not different from CON ($P = 0.25$). No differences were observed for testosterone concentrations between CON and FLX treatments ($P = 0.70$). We found no differences in scrotal circumference, sperm motility, sperm morphology or sperm concentration ($P \geq 0.15$). These results are in contrast to other research in which flax was fed to rams. Therefore, flaxseed supplementation in a tub form is not recommended to growing ram lambs for the improvement of semen quality when the basal diet consists of soybean hulls, corn and soybean meal.

Introduction

Reproduction is a vital component for any range sheep operation. The male side of reproduction is a component of overall productivity that can be overlooked.

One way to enhance a ram's performance during the breeding season is to improve the nutrients in the ram's diet leading up to breeding. Not only will this help rams regain lost condition from the previous breeding season, but it may stimulate improved spermatogenesis and sperm cell function. Adding extra nutrients to the pre-breeding ration, such as essential fatty acids, has been shown to further improve a male's reproductive efficiency (Baiomy and Mottelib, 2009; Yan et al., 2013; Esmaeili et al., 2014).

Flaxseed provides two essential fatty acids (**FAs**): Alpha-linolenic acid (**ALA**; C18:3 ω-3), an omega-3 (**ω-3**) FA and linoleic acid (**LA**: C18:2 ω-6), an omega-6 (**ω-6**) FA. Flax is approximately 45% oil. Of the total fats in flax oil, about 57% is ALA and 16% percent is LA (Morris, 2007).

Flaxseed in particular has been shown to improve sperm motility and progressive motility in bulls (Moallem et al., 2015). Flaxseed also has been shown to increase levels of the reproductive hormones such as the gonadotropin-releasing hormone, follicle stimulating hormone (Yan et al., 2013), luteinizing hormone (Yan et al., 2013) and testosterone (Baiomy and Mottelib., 2009; Yan et al., 2013; Esmaeili et al., 2014). Supplementing male sheep with flaxseed prior to breeding may be a way to improve semen quality and thereby improve fertility.

Our hypothesis was that the supplementation of flaxseed in the diet for rams would increase testosterone in the blood and therefore improve spermatogenesis and reproductive performance while preventing sperm abnormalities. The objective of the present study was to supplement flaxseed in an applied setting using Flaxlic® Sheep Tubs during a 112-day period leading up to the breeding season.

[1]Hettinger Research Extension Center, NDSU
[2]New Generation Supplements, Belle Fourche, S.D.
[3]Department of Animal Sciences, NDSU
[4]Zoetis, Parsippany, N.J.
[5]Department of Biological Sciences, NDSU

Experimental Procedures

Rambouillet ram lambs (n = 120) were selected from the NDSU Hettinger Research Extension Center flock. Ram lambs (approximately 4 months of age; 92.4 ± 6.12 pounds) were assigned randomly to 24 pens (five rams/pen; 271.25 feet^2/ram), with pen serving as the experimental unit. Rams were fed a basal ration with a Flaxlic® Sheep Tub (**FLX**; n = 12) or a control ration alone (**CON**; n = 12). The basal ration was a total mixed ration (**TMR**) made up of 60% soybean hulls, 10% corn, 15% soybean meal and 15% Market Lamb Supplement (dry matter basis; Southwest Feed Inc.).

Two-day weights and body condition score were taken on days minus 1 and 0 and days 111 and 112, with ram body weight recorded every 28 days to monitor ram health. Ram scrotal circumferences were taken during a two-day period alongside semen collection on days 83 and 84, and again on days 111 and 112.

Blood and semen were collected during a two-day period on days 83 and 84, then again on days 111 and 112. Blood was collected via jugular venipuncture for testosterone analysis. Semen was collected via electro-ejaculation during a two-day period on days 83 and 84, then again on days 111 and 112.

The first successful ejaculate from each ram was evaluated. Sperm morphology and motility traits were analyzed for reproductive efficiency.

Results and Discussion

Performance

Initial and final ram weight or body condition scores (BCS) did not differ between treatments (Table 1; $P \geq 0.25$). As the rams were given free access to feed with or without the addition of the Flaxlic® Sheep Tub, this result was expected.

However, we found a day effect for weight gain ($P < 0.001$), which also was expected due to the growth of a ram lamb into a mature ram. We observed a treatment × day interaction ($P = 0.04$) for average daily gain (**ADG**). Between days 28 and 56, the CON treatment had a higher ADG than the FLX group ($P = 0.04$). The CON treatment gained more through time than the FLX group.

We observed no effect of treatment on daily dry matter intake between CON and FLX treatments ($P = 0.23$). Intake of the Flaxlic® Sheep Tub was 0.09 pound per head-1 per day1, or 2.2% of their total feed intake per day. The gain-to-feed (**G:F**) ratio was not different between CON and FLX treatments ($P = 0.77$)

We observed no treatment × day interactions for scrotal circumference (**SC**; $P = 0.34$). We found a day effect between days 83 and 84 and days 111 and 112 (31.92 and 34.30 centimeters, respectively; $P < 0.001$), as expected of maturing ram lambs (Camela et al., 2018). We also found no treatment effects for overall scrotal circumference (SC) ($P = 0.72$) or on days 83 and 84 (Table 2; $P = 0.56$).

The present study used a less protected form of flax in the tub, made up of flax oil and flaxseed meal. Changes in scrotal circumference are affected by maturity and season. Rams were in the correct season to stimulate changes in SC. Therefore, the lack of change in SC simply may be due to the rams' immaturity.

Testosterone

We observed no treatment × day interactions ($P = 0.99$) for serum testosterone concentrations. Serum testosterone was not different between treatments ($P = 0.99$). A day effect was observed between days 83 and 84 and 111 and 112 ($P = 0.02$). Testosterone increased through time, which is in unison with the observed increase in scrotal circumference.

Sperm Morphological Abnormalities

We found no treatment × day interactions ($P \geq 0.08$) or treatment effects ($P \geq 0.62$) for sperm abnormalities (Table 2). The percentage of bent tails and total abnormalities were affected by day ($P \leq 0.04$). The bent tail percentage and total abnormalities decreased as rams aged, which was expected due to the age of the rams.

Table 1. Influence of Flaxlic® Sheep Tubs on weight and body measurements in Rambouillet ram lambs.

	Treatment[1]			
Item[2]	CON	FLX	SEM	P-Value[3]
Initial weight, lbs.	91.7	92.8	6.12	0.82
Final weight, lbs.	179.5	174.9	6.16	0.25
Initial BCS	3.00	2.99	0.02	0.72
Final BCS	3.62	3.58	0.05	0.65
DM intake, lbs./head^{-1}/day^{-1}	4.20	3.98	0.11	0.23
ADG, lbs./day	0.78	0.73	0.07	0.25
G:F	0.19	0.18	0.10	0.77
SC d 83-84, cm	31.8	32.1	0.29	0.56
SC d 111-112, cm	34.4	34.2	0.33	0.72

[1]FLX = Flaxlic® Sheep Tub-supplemented ewes; CON = control ewes; SEM = Standard error of the mean.
[2]BCS = Body condition score; scale of 1-5; Kenyon et al. (2014); DM = Dry matter; ADG = Average daily gain; G:F = Gain to feed; SC = Scrotal circumference.
[3]P-value across treatments (n=12).

The rams in the present study were fed processed flax oil and flaxseed meal in the form of a tub, in addition to the high levels of omega-6 FAs found in the basal ration. We found no treatment x day interactions ($P \geq 0.15$) for semen volume or concentration.

We also observed no effects of treatment on semen volume, total count or concentration ($P \geq 0.48$). We did find a day effect ($P \leq 0.03$) for ejaculate volume, sperm concentration and total sperm count, with all variables increasing as the rams aged.

Motility

We found no treatment × day effects ($P \geq 0.18$) for any motility measurement. We also observed no effect of treatment ($P \geq 0.42$) for any motility measurement. We found a day effect ($P = 0.05$) for the progressive sperm count, decreasing from 184.85 sperm per milliliter (ml) on days 83 and 84 to 150.75 sperm per ml on days 111 and 112. We are unsure why the progressive sperm count decreased because this value should have increased as the rams aged.

Results and Discussion

These results are in contrast with Pesta and Drouillard (2010), who reported increased ADG and improved feed efficiency between treatments in Flaxlic® Tub-fed bulls ($P < 0.05$). Pesta and Drouillard (2010) conversely reported the control group of bulls had higher feed intakes than Flaxlic® Tub-supplemented bulls. Pesta and Drouillard (2010) also reported improved G:F ratios not found in the present study.

The present study results were opposite to the similar study in bulls, possibly indicating a difference in physiological response to flax between bulls and rams. This may be due to a species-specific response that does not occur in sheep. Another explanation may be the rams were not eating enough of the Flaxlic® Sheep Tub, compared with the intake of the bull. Rambouillet rams may require more flax per pound of bodyweight than bulls.

The lack of change in SC is in agreement with Baiomy and Mottelib (2009), who also found no change in SC between flaxseed-supplemented and control rams, reporting an increase of testosterone in the flax-fed rams versus the control after two months of treatment. These results are in agreement with Pesta and Drouillard (2010), who reported no differences between control and Flaxlic® supplemented bulls for the percent of normal sperm and decreased abnormal sperm in rams supplemented with unprotected flax oil. The addition of a Flaxlic® Sheep Tub did not improve reproductive parameters or influence testosterone concentration level.

Acknowledgments

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Literature Cited

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Table 2. Influence of Flaxlic® Sheep Tub supplementation on semen characteristics in Rambouillet ram lambs.

		Treatment[1]			*P*-Value[2]
Item3	Day	CON	FLX	SEM	TRT
Overall bent tail, %	D112	5.71	5.58	0.58	0.98
Overall distal droplet, %	D112	4.38	4.99	0.40	0.87
Overall proximal droplets, %	D112	25.49	24.12	1.60	0.62
Overall volume, ml	D112	0.75	0.88	0.10	0.87
Overall total sperm count4	D112	431.55	430.05	24.46	0.48
Overall sperm concentration, million cells/ml	D112	1,279.25	1,259.66	136.85	0.67
Overall motile concentration, million cells/ml	D112	620.68	643.34	93.30	0.50
Overall motile sperm count4	D112	195.81	197.38	18.80	0.43
Overall motile sperm, %	D112	43.73	45.68	3.27	0.70
Overall progressive concentration, million cells/ml	D112	478.32	432.79	54.25	0.89
Overall progressive sperm count4	D112	157.48	144.38	12.43	0.94
Overall progressive sperm, %	D112	36.39	35.62	2.78	0.52
Overall static sperm, %	D112	57.07	54.32	3.29	0.34

[1]CON = basal ration; FLX = basal ration with Flaxlic® Sheep Tub; SEM = Standard Error of the Mean.
[2]*P*-values considered significant at $P < 0.05$; TRT = treatment effects.
[3]Concentrations given in million per milliliter of semen; percentages given as % of total sperm.
[4]Count reported as concentration of identified sperm per milliliter multiplied by the total volume of the ejaculate entered initially into the IVOS.

flow associated with the attainment of puberty in Dorper rams raised in a subtropical climate. Reproduction in Domestic Animals.

Esmaeili, V., A.H. Shahverdi, A.R. Alizadeh, H. Alipour and M. Chehrazi. 2014. Saturated, omega-6 and omega-3 dietary fatty acid effects on the characteristics of fresh, frozen-thawed semen and blood parameters in rams. Andrologia. 46:42–49.

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Pesta, A.C., and J.S. Drouillard. 2010. FlaxLic supplementation improves growth performance of Angus bulls. Kansas Agricultural Experiment Station Research Reports. 108–110.

Yan, L., X. Bai, Z. Fang, L. Che, S. Xu and D. Wu. 2013. Effect of different dietary omega-3/omega-6 fatty acid ratios on reproduction in male rats. Lipids in Health and Disease. 12:33.

2019 Presentations, Outreach and Publications

Christopher Schauer, Hettinger REC Director and Animal Scientist

Presentations and Outreach

Rambouillet Ram Test Results.
Ram Test Field Day, Hettinger, ND
March 9, 2019

Governor Bergum tour
July 16, 2019

ND State Fair Sheep Carcass Ultrasound Competition
ND State Fair, Minot, ND
July 23, 2019

ND Legislative Council presentation and tours, Dickinson REC
August 19, 2019

OFDA demonstration
Newell Ram Sale, Newell, SD
September 19-20, 2019

Sheep Nutrition for Beginners
Starter Flock Sheep School, Hettinger, ND
September 21, 2019

Carcass and Reproductive Ultrasound
BSC Animal Science Lab, Bismarck, ND
November 1, 2019

NDSU Shearing School
Hettinger, ND
November 23-25, 2019

NDSU and ASI Wool Classing School
Hettinger, ND
November 23-25, 2019

Publications

David, A.L., **C. Schauer**, W. Stewart, G.M. Becker, K.M. Davenport, and B.M. Murdoch. 2019. Flock54 genotyping panel to explore autosomal mutation for rickets in Rambouillet sheep. J. Anim. Sci. 97(Supp. 2).

Anderson, P.P., A.M. Long, E.R. Schlegel, T.W. Hoffman, J.A. Vonnahme, J.L. Momsen, L.L.

Hulsman-Hanna, J.D. Kirsch, C.R. Dahlen, K.L. McCarthy, and **C.S. Schauer**. 2019. Influences of dietary flax on male reproductive traits when supplemented prior to breeding in sheep. 2019 NDSU Beef and Sheep Report. AS1938:53-56.

Grants

Effects of loin eye muscle depth on accuracy and variation of loin eye area prediction and carcass yield via ultrasound in Rambouillet sheep. ND-SBARE: $5,340. Funded January, 2019. (PI)

Benjamin Geaumont – Wildlife and Range Sciences

Presentations

Cutter, J., T. Hovick, **B. Geaumont**, D. McGranahan, J. Harmon. 2019. Influence of grazer-type on flower and pollinator abundance in former CRP fields managed with patch-burn grazing. Americas Grassland Conference, Bismarck, ND.

Cutter, J., T. Hovick, D. McGranahan, J. Harmon, and **B. Geaumont**. 2019. Influence of herbivore-type on flower and butterfly abundance in former CRP fields managed with patch-burn grazing. Entomological Society Annual Conference, St. Louis, MO.

Geaumont, B.A. and J, Norland. 2019. Diversifying seed mixes, incorporating cover crops, and adjusting planting date to establish native cover in difficult sites. Society for Range Management Annual Meeting, Minneapolis, MN.

Geaumont, B.A. Ring-necked pheasant research and observations. Hettinger County Conservation Meeting. Regent, ND.

Geaumont, B.A. 2019. ND Ring-necks: past, present and future? North Dakota State Pheasant Forever Annual Meeting, Bismarck, ND.

Spiess, J., J. Cutter, D. McGranahan, **B. Geaumont**, T. Hovick. 2019. A hailstorm reduced forage, nesting cover, and floral resources in southwestern North Dakota grasslands. Society for Range Management Annual Meeting, Minneapolis, MN.

Rischette, A., **B. Geaumont**, and T. Hovick. 2019. Disturbance limits utility of unmanned aerial systems for counting sharp-tailed grouse on leks. Society for Range Management Annual Meeting, Minneapolis, MN.

Peer Reviewed Publications

Geaumont, B.A. J. Norland, and J.W. Stackhouse. The influence of species richness and forb seed density on grassland restorations in the badlands of North Dakota, USA. *Ecological Restoration* 37:123-130.

Kral-O'Brien, K.C., K.K. Sedivec, **B.A. Geaumont**, and A.L. Gearhart. 2020. Resiliency of native mixed-grass rangelands and crested wheatgrass pasture lands to spring wildfire. *Rangeland Ecology and Management* 73:119-127.

Duquette, C.A., J.T. Orr, T.J. Hovick, **B.A. Geaumont**, and T.M. Harms. 2019. Secretive marsh bird densities and habitat associations in the prairie pothole region. *Wetlands*. https://doi.org/10.1007/s13157-019-01251-x.

New Grants and Contracts

Geaumont et al. 2019. An Assessment of the importance of shelterbelts as early season nectar and pollen resources for domesticated honeybees. AFRI, Sustainable Agriculture Research and Education, Funded ($199,922).

Geaumont et al. 2019. Using drones to assess floristic resources for honeybees over space and time. Funded by ND Ag. Experiment Station. ($45,000).

Harmon et al. 2019. Managing disturbance for multi-functional rangelands: livestock, plant, and pollinator resource management strategies the differentially use fire and grazing – will be done at CGREC. Funded by AFRI, ($500,000).

Geaumont, B.A. 2019Alternative Land Management on Lands Managed for Wildlife – work with private landowner and Game and Fish. Funded by Game and Fish Department (8,000).

Janna Block, Hettinger REC Extension Livestock Specialist

Presentations and Outreach

Beef Day
Hettinger ND
January 22, 2019

NDSU Extension Feedlot School
Carrington, ND
January 23, 2019

Cattlemen's College – 2019 Cattle Industry Convention and NCBA Trade Show
New Orleans, LA
January 29-30, 2019

Agri-International Trade Show
Bismarck, ND
February 12-13, 2019

Drought Planning Workshop
Minot, ND
February 21, 2019

Dunn County Beef Day
Killdeer, ND
March 7, 2019

Cold Weather Cattle Management Webinar
Live recording available at: https://www.youtube.com/watch?v=B0c4aBzkRxU
March 12, 2019

Nitrate QuikTest Initial Certification Training for Extension Agents
April 23, 2019

Badlands Genetics AI School
Dickinson, ND
April 25, 2019

Beef Cattle Mineral Nutrition Workshop – Part I
Bismarck, ND and Minot, ND
May 14-15 and October 3, 2019

UMN Cattle Reproduction Management Workshop
Oronoco, MN
May 23, 2019

4-H Market Animal Nutrition/Showmanship Workshop
Minot, ND
May 30, 2019

Beef Cattle Mineral Nutrition Workshop – Part II
Hot Springs, SD
June 3, 2019 and September 27, 2019

North Dakota Stockmen's Association Spring Roundup
Killdeer, ND
June 12, 2019

4-H Market Animal Nutrition/Showmanship Workshop
Hettinger, ND
June 18, 2019

Hettinger REC Field Day
Hettinger, ND
July 9, 2019

Ranch visits for Beef Cattle Mineral Nutrition program
Multiple locations across North and South Dakota
July and August, 2019

Grant County Pasture Walk
Elgin, ND
July 25, 2019

NDSU Extension Livestock In-Service Training
Bismarck, ND
September 4-5, 2019

North Dakota Stockmen's Association Annual Convention and Trade Show
Bismarck, ND
September 19-20, 2019

NDSU Extension Fall Conference
Fargo, ND
October 22-24, 2019

Fall Agriculture Challenges Webinar Series
Live recordings available at: https://www.ag.ndsu.edu/livestockextension/2019-ag-challenges-webinar-series
October 29-November 5, 2019

beefSD Webinar presentation
November 6, 2019

Range Beef Cow Symposium
Scottsbluff, NE
November 19-20, 2019

MonDak Ag Research Summit
December 12, 2019

Bowman County Winter Ag Forum
Bowman, ND
December 18, 2019

Stark County Marketing Club Meeting
Belfield, ND
December 18, 2019

Peer-Reviewed Publications

Webb, M. J., **J. J. Block**, R. N. Funston, K. R. Underwood, J. F. Legako, A. A. Harty, R. R. Salverson, K. C. Olson, and A. D. Blair. 2019. Influence of maternal protein restriction in primiparous heifers during mid- and/or late gestation on meat quality and fatty acid profile of progeny. Meat Science 152:31-17.

Popular Press/Media

North Dakota Angus News. January 2019. "Can winter grazing work for you?"

North Dakota Angus News. February 2019. "Is your ration adequate for lactating cows?"

North Dakota Angus News. March 2019. "Understanding pregnancy losses in beef cattle"

NDSU Agriculture Communications. March 11, 2019. "Protect bulls from winter weather"

NDSU Agriculture Communications. March 25, 2019. "Cattle producers should be prepared for wet, muddy conditions and possible flooding this spring"

North Dakota Angus News. April 2019. "Don't stress….and feed your bulls right"

NDSU Agriculture Communications. April 18, 2019. "Make sure rations are adequate for lactating cows"

NDSU Agriculture Communications. June 13, 2019. "Cool weather may decrease forage production, quality"

NDSU Agriculture Communications. June 21, 2019. "Mineral nutrition vital for summer cattle grazing programs"

NDSU Agriculture Communications. June 26, 2019. Now is time for producers to evaluate forage supplies"

American Ag Radio Network Interview. June 27, 2019. "Keep Mineral Nutrition in Mind this Grazing Season"

NDSU Agriculture Communications. July 2, 2019. "Nitrate toxicity poses risk to cattle"

NDSU Agriculture Communications. August 19, 2019. "Rain impacts forage quality"

NDSU Agriculture Communications. September 25, 2019. "NDSU Extension offers fall cattle checklist"

NDSU Agriculture Communications. October 4, 2019. "Consider toxicity issues when fall grazing"

NDSU Agriculture Communications. October 11, 2019. "Wheat still in fields raises concerns"

NDSU Agriculture Communications. October 17, 2019. "NDSU Extension encourages producers to assess forage requirements"

NDSU Agriculture Communications. October 29, 2019. "Unharvested corn can be feed for cattle"

NDSU Agriculture Communications. December 6, 2019. "Stretch limited hay supplies"

KFGO 790 AM 94.1 FM Fargo-Moorhead. December 17, 2019. "NDSU Extension Talks About Stretching the Already Limited Hay Supplies" interview available at: https://kfgo.com/podcasts/ag-news-leader/138190/ndsu-extension-talks-about-stretching-the-already-limited-hay-supplies/

NDSU Agriculture Communications. December 18, 2019. "NDSU Extension offers advice on feeding low-quality forage to cattle"

Red River Farm Network. December 20, 2019. "Extension Expert Offers Tips for Reducing Hay Waste" interview available at: https://www.rrfn.com/2019/12/20/extension-expert-offers-tips-for-reducing-hay-waste/

John Rickertsen, Hettinger REC Research Agronomist

Presentations and Outreach

Seed Treatments: What is Worth the Money
Hettinger County Crop Imp. Asso., New England, ND
February 1, 2019

Pulse Research in Southwest North Dakota
Pulse Crops Working Group, Fargo, ND
February 11-12, 2019

New Varieties Update
West River Breeders, Reeder, ND
February 20, 2019

Barley and Durum Varieties, Soybean Research
Hettinger REC Crop Tour, Hettinger, ND
July 9, 2019

Spring Wheat & Soybean Varieties
USDA-ARS Northern Plains Friends & Neighbors Day, Mandan, ND
July 18, 2019

Small Grain Varieties
Bowman County Crop Tour, Scranton, ND
July 23, 2019

Small Grain Varieties
Hettinger County Crop Tour, Regent, ND
July 25, 2019

Hettinger Agronomy Research Update
Tear Down the Walls, Northern Plains Agronomist Meeting, Sidney, NE
August 15-16, 2019

New Varieties and Research Updates
36th Western Dakota Crops Day, Hettinger, ND
December 19, 2019

Publications

2018 Research Results, Area 4 SCD Cooperative Research Farm & USDA-NGPRL. Spring Wheat, Durum Wheat and Barley Variety Performance Results. In Proc. March 2019.

North Dakota Hard Winter Wheat Variety Trial Results for 2019. September 2018. NDSU Extension Service circular A1196-19.

North Dakota Hard Red Spring Wheat Variety Trial Results for 2019. October 2019. NDSU Extension Service circular A574-19.

North Dakota Dry Pea Variety Trial Results for 2019. October 2019. NDSU Extension Service circular A1469-19.

North Dakota Durum Wheat Variety Trial Results for 2019. October 2019. NDSU Extension Service circular A1067-19.

North Dakota Canola Variety Trial Results for 2019 and Selection Guide - A1124-19. November 2019. NDSU Extension Service circular A1124-19.

North Dakota Dry Bean Variety Trial Results for 2019. December 2019. NDSU Extension Service circular A654-19.

North Dakota Flax Variety Trial Results for 2019. December 2019. NDSU Extension Service circular A1105-19.

North Dakota Barley, Oat and Rye Variety Trial Results for 2019. December 2019. NDSU Extension Service circular A1049-19.

North Dakota Sunflower Hybrid Trial Results for 2019. December 2019. NDSU Extension Service circular A652-19.

North Dakota Soybean Variety Trial Results for 2019. December 2019. NDSU Extension Service circular A843-19.

North Dakota Corn Hybrid Trial Results for 2019. December 2019. NDSU Extension Service circular A793-19.

36th Annual Western Dakota Crops Day Research Report. December 2019. NDSU Hettinger Research Extension Center Ag. Report No. 36.

Grants

Western regional cool season food legume evaluation trials. US Dry Pea and Lentil Council. $3,000.

Evaluation of fungicide seed treatments under different tillage, crop rotations and soil conditions. North Dakota Wheat Commission. $3,110.

Nitrogen relationships of soybean in southwest ND. North Dakota Soybean Council. $6,000.

Management of root rots of field peas with crop rotation. Northern Pulse Growers Asso. $5,890.

Effect of planting date and maturity on foliar and head diseases of durum. ND-SBARE. $2,016.

North Dakota Dry Edible Bean Variety Trials. Northarvest Bean Growers Asso. $2,000

North Dakota Flax Variety Trials. Ameriflax. $1,250.

Evaluation of spring wheat at Hettinger and Rugby. Syngenta Crop Protection. $9,879.

Building a better lentil from the ground up. USDA-SCRI (3 year grant). $37,948.

Development of hard white specialty spring wheat breeding program. Ardent Mills. $36,250.

Contract entries for public variety trials. $36,000.

Caleb Dalley, Hettinger REC Research Weed Scientist

Presentations and Outreach

Research on Downy Brome and Narrowleaf Hawksbeard
North Dakota Weed Control Association Annual Meeting, Bismarck, ND
January 8-10, 2019

Fall vs Spring Application for PRE Weed Control in Field Peas
Wild World of Weeds Workshop, Fargo, ND
January 22, 2019

Kochia Management in North Dakota
Hettinger County Crop Improvement Association, New England, ND
February 1, 2019

Evaluation of Flax Tolerance to Preemergence and Postemergence Herbicide Applications
Western Society of Weed Science, Denver, CO
March 11-14, 2019

Weed Control Research Updates
Hettinger REC Crop Tour, Hettinger, ND
July 9, 2019

Updates in Weed Control
36th Western Dakota Crops Day, Hettinger, ND
December 19, 2019

Publications

Abe, DG, **CD Dalley**, and BM Jenks (2019) Evaluation of flax tolerance to preemergence and postemergence herbicide applications. *In* Proceedings of the Western Society of Weed Science, 72:23 Denver, CO, 11-14 March, 2019.

Jenks, B et al. (2019) North Dakota Weed Control Guide. North Dakota State University Extension Service Publication W-235.

Grants

Date Received	Title of Research Project	Source	Amount
3/15/2019	POST programs with Warrant in Spring-Seeded TruFlex/LL Canola	Monsanto	$4,410
3/15/2019	Warrant tank-mix partners POST in Alfalfa	Monsanto	$5,670
3/19/2019	Evaluation of BAS 8510H for Crop Safety and Weed Efficacy	BASF Corp.	$10,080
05/01/2019	Crop Tolerance to Fall Applied Herbicides	ND Dept of Agriculture	$2,500

05/01/2019	Oat Tolerance to Preemergence Herbicides	ND Dept of Agriculture	$5,000
05/01/2019	Flax Tolerance to Soil Applied and POST herbicides	ND Dept of Agriculture	$5,000
06/01/2019	Evaluation of Sunflower to Fall-applied herbicides	SBARE	$2,500
7/1/2019	Preharvest Options for Desiccation of Crop and Weed Biomass is Wheat	North Dakota Wheat Commission	$2,500
	Other unrestricted grant in aid	Various	$33,500
	Total		**$71,160**

2019 Advisory Board

Hettinger Research Extension Center
Advisory Board Meeting- February 19, 2019

Board members present: Cody Jorgenson, Wade Henderson, Jacki Christman, Ethan Andress, Dustin Laufer, Duaine Marxen, Jeremy Huether, Matt Neiderman and Curt Stanly joined over conference call. **Guests**: Dean Wehri, Tim Faller, Jim Gray, Tessa Keller and Hannah Nordby. **Staff**: Chris Schauer, Ben Geaumont, Janna Block, Caleb Dalley, John Rickertsen and Cassie Dick.

Wade H called the meeting to order at 12:45 pm.

Wade H asked for a motion to approve minutes from previous meeting. Matt N moved to accept the minutes and Dustin L seconded. Motion passed, no opposing.

Wade H asked for a motion to approve agenda. Jeremy H moved to approve, Dustin L seconded. Motion passes, no opposing.

Legislative Update
Dr. Lardy- joined by conference call, cuts for the main station and REC's. Extra deferred maintenance money and Willison REC seed plant. March 20 senate approval hearings. Jim Gray- busy filling County Agent vacancies and looking for SBARE representatives for southwest ND. Tim Faller- Lots of interim positions right now, giving the college a chance to rework some administrative positions. Dean Wehri- SBARE is meeting and working on their plan going forward. They are reworking Administration positions right now with all the interim directors, a chance to tweak the system, who reports to who? Hopefully be able to maintain the budget.

Director's Report- Chris Schauer- handout provided. Will start working on a new 2020-2025 Strategic Plan. Need support for REC's, would like to get back to even budget. Dr. Lardy said to board, even if you do not speak, just showing up and filling a room shows support for the REC's.

Range & Wildlife Report- Ben Geaumont- handout provided. Pollinators is going to keep being a focus. Patch burn fire project are showing potential and generating interest, local producers wondering about doing burns.

Agronomy Report- John Rickertsen- handout provided. Good year despite damaging hail in June and little rain in later summer. Early season crops did better than late season.

Weed Science Report- Caleb Dalley- handout provided. Flax and oat tolerance to PRE and POST applied herbicides. Fall and spring application for field pea. Evaluations of new herbicide for weed control and crop safety for crops in southwest ND.

Animal Science Reports- Chris Schauer- handout provided. Animal science graduate students. Strategic Plan progress. Outreach and Sheep research.

Extension Livestock Systems Specialist Report- Janna Block- handout provided. Programing and Beef Cattle Mineral Nutrition.

Strategic Plan- HREC scientists will meet and start working on 2020-2025 plan. Pollinators will be a new area highlighted. Board is asked to bring ideas to next meeting.

Open Discussion-

Ethan A stated that vets in the clinic are needing to learn about more apiary needs and medicines. Board and Scientist discussion. There needs to be more research studies for beekeepers, vets and everyone involved in the bee business about disease and pesticide effects.

Jacki C asked why there are no corn plots. John R said that he does have a study, not a very big one, as he does not get as many entries for corn as he does other crops. He also stated that he does not keep the corn plots on station ground, where you can see them, as the deer are too bad and destroy the plot. The corn is usually planted on a cooperators plot with sunflower trials.

Election of Officers- Matt N and Jeremy H have served their full term limit on the HREC Advisory Board. They were presented with a plaque for their service from the Hettinger REC. Sean S, Jamie E and Dustin F have completed their first term as of this meeting; they are eligible for reelection to one more term on the board. Wade H asked for discussion from board members, staff and guests on replacement members. Three names were suggested to fill the two open positions: Matt N suggested Bo Beer- farmer/rancher from Keldron, SD. Jeremy H suggested Nathan Thomas- farmer from north of Mott, ND. Tim Faller suggested maybe brining in a scientist from another REC or ARS. Ben G and Chris S suggested Alan Timm, beekeeper from Hettinger, ND, pollinator studies has major interest and Ben G is already working with Alan Timm on projects. Matt N said that another scientist and a bee person would be a good idea, Ethan A does not want to limit the number of ag producers on our board and keeping representatives from the Mott and Morristown/Kendron area is important. There was a suggestion that we could increase the number of members of the board, Wade H said that we do not want too big of a board and do not want to lose those representatives from the area. After discussion, Wade H asked for a motion to nominate the board members. Ethan A nominated that Sean S, Dustin F and Jamie E stay on the board and complete a second term and that Bo Beer and Alan Timm should be asked to be new members of the Advisory Board. Matt N seconded, motion passes, no opposing. Nathan Thomas will be kept in mind for a replacement when Wade H term is complete.

Next meeting: Summer meeting will be held in conjunction with the field crop tours in July.

Executive session: Staff and guests were dismissed

February 19, 2019 Advisory Board Meeting
NDSU-Hettinger Research Extension Center

Director's Report

Legislative Report:

- SBARE Request: hold even budget and raises
    - House has acted on their side of the bill, which included raises, but a cut of approximately 5%. That would put us at a 18.5% cut in 2 bienniums (not including inflation).
        - $2,167,501 in appropriations, approximately $2.8 million in special funds
            - Would be a $108,000 cut/biennium
    - Agribiome and Precision Agriculture are 2 initiatives being talked about.
- Staffing
    - Fully staffed, with the exception of the Livestock Research Specialist

Infrastructure:

- 1000 ewes
- 80 head of cows (McLaughlin project has concluded)
- 110 head of cows at ARS in Mandan (fiscal agent for their cow herd)
- CASE IH rental agreement – 5 tractors, baler, bobcat, self-propelled windrower
- Housing: Utilizing a trailer at the trailer park and the old office by the Agronomy Lab.

Dickinson REC:

- I took on the DREC Interim Director position on January 22. I anticipate spending 1 – 2 days per week in Dickinson.

Strategic Plan: 2015 – 2019

1. Evaluate alternative livestock production systems that increase profitability while maintaining environmental stability (Chris and Janna).
2. Conduct applied research that investigates the compatibility of agriculture and wildlife (Ben).
3. Evaluate weed control methods to increase crop and forage productivity in southwest North Dakota (Caleb).
4. Enhance dryland crop production while maintaining natural resources (John).
5. Integration of Livestock, Wildlife, Agronomy, and Weeds research programs into a farm-scale interdisciplinary research project (All).

2019 Winter Advisory Board Meeting
Wildlife and Range Research Update
Ben Geaumont and Dan Graham

Strategic Plan Aim - **Conduct applied research that investigates the compatibility of agriculture and wildlife**

Graduate Students – Co-Advised

Jonathan Spiess, PhD – Range Sciences, Evaluate livestock selection and fire behavior within patch-burn grazing research (Devan McGranahan).

Jasmine Cutter, M.S. – Range Sciences, Evaluate pollinators in our patch-burn grazing research (Torre Hovick).

Alex Rischette, M.S. – Range Sciences, Evaluate wildlife response to patch-burn grazing on Post-CRP (Torre Hovick).

Additional Graduate Student Committees

Adrienne Antonsen, M.S. – Entomology, Statewide pollinator survey.

Chyna Pei, PhD – Range Sciences, Statewide pollinator survey.

Cameron Duquette, PhD – Range Sciences, Grassland bird response to patch-burn grazing in mixed-grass prairie.

Current Research Projects

1. **The utility of unmanned aerial systems for monitoring sharp-tailed grouse leks** (Hovick, Graham, and Nowatzki).
    a. evaluate the feasibility of using UAS to locate and monitor leks of sharp-tailed grouse.
2. **Restoring disturbance to old Conservation Reserve Program Fields to Promote Ecosystem Services**. (C. Schauer, T. Hovick, R. Limb, and D. McGranahan)
    a. Evaluate the effects of patch-burn grazing in Conservation Reserve Program grasslands on livestock, vegetation, pollinators and wildlife in western North Dakota.
        i. Livestock, birds, vegetation, bees and butterflies
    b. Six, 160 acre pastures
        i. 3 with sheep
        ii. 3 with cow/calf pairs
    c. Six burns completed in October 2018

2a. Evaluate the ability of over seeding native forbs following prescribed fire to enhance habitat for pollinators.

a. Seeded (5), 1 acre plots within each prescribed fire area in mid-March 2018

3. **Annual forage mixes for southwest North Dakota: influence of planting date on forage production and pollinator communities.**
    a. Interested in how incorporating annual forages into food plots for wildlife and forage for livestock may benefit pollinators and other insects.

b. Hammered by hail.

4. **Monitoring native pollinator communities throughout North Dakota: Status and Management considerations for bees and butterflies.** (CO-PIS: R. Limb, T. Hovick, and J. Harmon)
    a. Conducting statewide pollinator surveys. Access land use, floristic resources and pollinator associations. Funded by ND Department of Agriculture.

5. **Evaluate a livestock-crop integrated system using annual forages, winter wheat and sheep. Determine livestock gains, crop production, insect use, and changes to soils.**
    a. Winter wheat was a complete failure
    b. Annual forages were set back by hail

6. **Evaluate the effect of growing annual pollinator plots on kidney bean production in ND.** (Co-PIS: T. Hovick, M. Ostlie, J. Harmon, and R. Limb)

Peer Reviewed Publications

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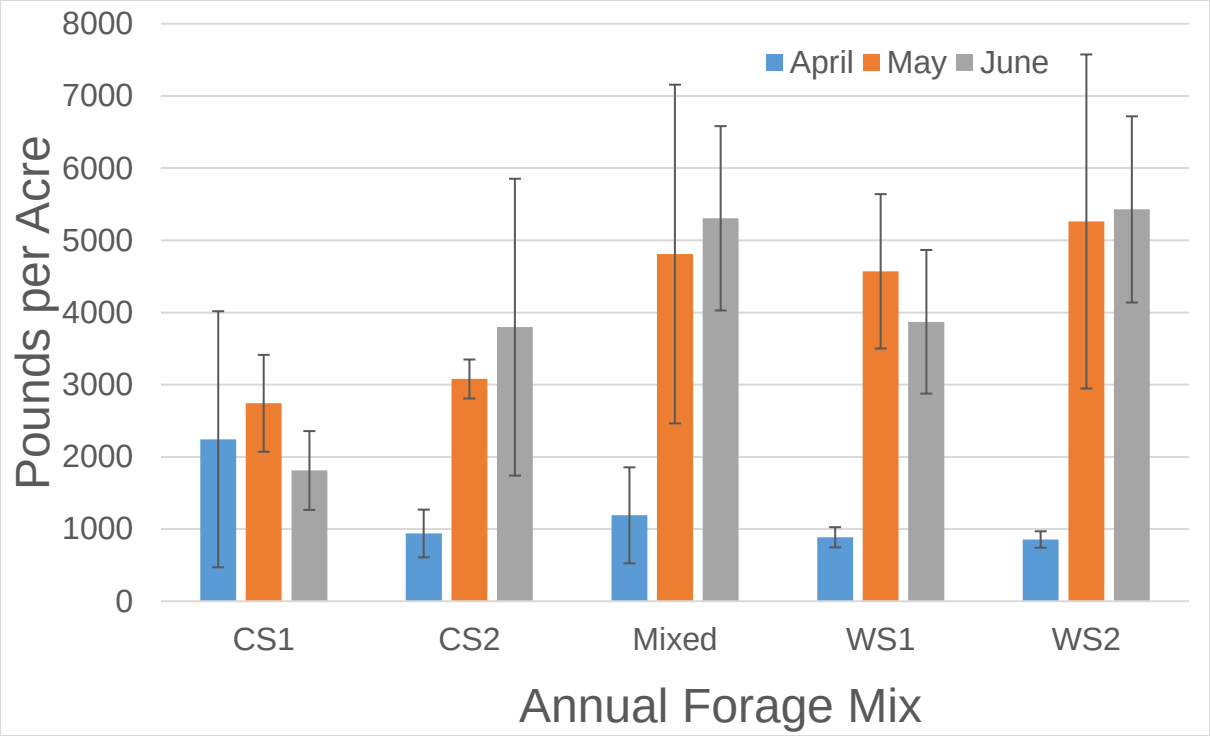
Sustainable Agriculture Research and Education Grant Idea – An Assessment of the importance of shelterbelts as early season nectar and pollen resources for domesticated honeybees.

We submitted a preproposal in October and have been invited to submit a full proposal. As part of the full proposal we will be forming an advisory board to help guide the project. If you are interested, in bees, trees or honey, let’s talk.



Average planted annual forage production from 2016-2018 across five treatments replicated three times each at three different planting dates. Forage production was measured mid-August. Averages do not include biomass attributed to weed species. We designed annual forage mixes to provide biomass for livestock and nectaring resources for pollinators.

CS1 = Cool Season 1 = buckwheat, lentil, flax, oat, barley, radish, safflower, sunflower, turnip

CS2 = Cool Season 2 = buckwheat, pea, flax, millet, barley, radish, safflower, sunflower, turnip

Mixed = buckwheat, lentil, turnip, radish, barley, sorghum-sudan grass

WS1 = Warm Season 1 = flax, radish, sunflower, turnip, proso millet, sorghum-sudan grass, barley

WS2 = Warm Season 2 = buckwheat, lentil sunflower, radish, proso millet, sorghum-sudan grass, flax, safflower

February 20, 2019 Advisory Board Meeting
NDSU-Hettinger Research Extension Center
Agronomy Update – John Rickertsen
2018 Research Projects

Variety/Hybrid Performance Trials:

Twenty two yield trials were conducted on the following crops. (average yield)

Winter Wheat (30 bu)	*Field Pea (17 bu)*	*Canola (550 lb)*	*Safflower (1561)*
Spring Wheat (49 bu)	*Chickpea (1507 lb)*	*Carinata (200 lb)*	*Sunflower (2931 lb)*
Durum Wheat (37 bu)	*Lentil (1306 lb)*	*Flax (23 bu)*	*Corn (110 bu)*
Barley (83 bu)	*Dry Beans (1288 lb)*		
Oats (97 bu)	*Soybean (30 bu)*		

2018 NDSU releases: "ND Hammond" brown seeded flax, "ND18008GT" glyphosate tolerant (RR1) soybean, "ND Eagle" small green lentil. I am currently serving on the NDSU Variety Release Committee as the western REC representative.

Off Station Yield Trials:

Trials were located at Scranton, Regent and Mandan with HRSW, Durum and Barley variety trials. These trials are located with farmer cooperators and with the USDA-ARS Northern Great Plains Lab at Mandan. Crops tested were spring wheat, durum wheat and barley.

Plant Breeding Nurseries:

Nurseries were planted for the following breeding programs.

Program	# of nurseries
NDSU Spring Wheat	5
NDSU Field Pea	2
NDSU Lentil	1
NDSU Canola	1
NDSU RR1 Soybean	1
Syngenta Spring Wheat	1
Regional Spring Wheat	1
Regional Barley	1

Soybean Row Spacing and Population:

A study was initiated at Hettinger, ND in 2018 with nine seeding rates, 20,000 to 180,000 in 20,000 increments in both drilled (7") and row (30") configuration. The results showed that seeding rates of 100,000 – 180,000 were not significantly different in yield and even the extremely low rate of 20,000 yielded 70% of the 100,000 - 180,000 seeding rates. For seed protein and oil content, as seeding rate increased, oil content decreased and protein increased. At the very lowest population, seed size increased and test weight decreased, but there was no significant difference in the 40,000 to 180,000 rates for seed size or test weight. Plant height was not significantly different among any of the treatments. Row spacing showed no effect on yield, test weight or height, but 7" rows had slightly smaller seed size and slightly lower oil content than 30" rows.

Nitrogen Relationships of Soybean in Southwest North Dakota:

In cooperation with Dickinson REC, a study comparing inoculation and nitrogen application on soybeans. Two cultivars were be planted at two populations of 80,000 and 160,000 plants per acre. Four N management strategies used were a control of no inoculant and no N added, no inoculant and 30 lbs of N added through urea, inoculant with no N added, and inoculant with 30 lbs of N added through urea. There were no yield differences among all the treatments, but there was significant differences in nodulation between the inoculant and no inoculant treatments. Funded by ND Soybean Council, applied for funding in 2019.

Management of Fusarium Root Rot of Field Peas and Wheat with Crop Rotation:
This project seeks to evaluate crop rotation strategies as a tool for managing existing problems with Fusarium root rot of peas and for preventing the buildup of Fusarium root rot of peas where the disease is not yet a problem. Findings from the fifth year of this project, demonstrate that the cropping intensity of field peas impacts root rot severity and field pea agronomic performance. At Carrington in a field with a long history of field pea production and documented problems with root rot, rotating out of peas for three years reduced root rot severity by 18 to 27% (incidence 83 to 97%) and increased field pea yield by 9 to 10 bu/ac relative to growing peas every second year. At Hettinger in a field where peas were grown for the first time in 2014 as a part of this study and no previous history of field pea root rot, root rot incidence remained low across all treatments averaging 7 to 10% in 2018 but root rot severity and field pea yield appeared to be influenced by the intensity of broadleaf crop production. Differences in Hettinger were not statistically significant but were observed independently across root rot and yield metrics, increasing the likelihood that they were caused by the crop rotation.

Rotation sequences. Crops for 2018 Crops for 2019
(1) field pea / spring wheat
(2) field pea / spring wheat / spring wheat
(3) field pea / spring wheat / spring wheat / spring wheat
(4) field pea / spring wheat / flax / spring wheat
(5) field pea / spring wheat / canola / spring wheat
(6) field pea / spring wheat / barley / canola / spring wheat / corn

Effect of Planting Date & Maturity on Disease (FHB) of Durum:
Study with plant pathologist at Williston REC looking at four durum varieties at three planting dates (4/27, 5/16, 5/25) for visual fusarium head blight ratings and DON levels in grain. Because of dry conditions, fusarium was not present in 2018. The middle (May 16) date had the highest yields. Funded by SBARE, will continue in 2019.

Other Agronomy Studies:
HRSW seed treatment, barley cover crop/intercrop, carinata seeding rate, carinata planting date.

New Research for 2019:
Hybrid spring wheat seeding rate, funded by Syngenta.
White wheat breeding nurseries for NDSU spring wheat program, five year grant from Ardent Mills.

Presentations and Outreach:
- County Crop Improvement meetings at Reeder, Regent and Taylor. February 2018.
- Western Crop & Pest School, Williston. March 2018.
- Hettinger REC Crop Tour. July 2018.
- Dewey County, SD Crop Tour. July 2018.
- Variety plot tours at Scranton & Regent. July 2018.
- Friends & Neighbors Day, UDSA-ARS Mandan. July 2018.
- Hettinger & Dickinson Cover Crop Tours. October 2018.
- Western Dakota Crops Day. December 2018.

Hettinger REC summer crop tour will be on July 9, 2019

b. Hammered by hail.

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2019 Winter Advisory Board Meeting

Weed Science Research Update
Caleb Dalley and Daniel Abe
February 19, 2019

Research Project Results for 2018:

1) Dicamba and 2,4-D carryover following fall application.
    a. Dicamba applied at 4 and 8 oz/A
    b. 2,4-D (LV-6) applied at 11 and 22 oz/A
    c. Three application timings (Sept 27, Oct 11, Oct 27, 2017)
    d. Trials conducted in Hettinger and Minot
    e. Field pea (May 5), lentils (May 7), chickpeas (May 9), and sunflowers (May 29) were planted in spring to determine if herbicide carryover would cause injury.
    f. Evaluated for injury on June 11
        i. Only injury observed was to lentils from dicamba applied at 8 oz/A, with the greatest injury from the Oct 27 application date.
        ii. Injury to lentil was minor and was only noticeable upon close examination
    g. Hail storm destroyed trial on June 26th.
    h. Trial is being repeated in 2019.
2) Flax tolerance to PRE- and POST-applied Group 27 herbicides (pigment inhibitors)
    a. Herbicides used in other crops primarily for broadleaf weed control
    b. Trials conducted in Minot and Hettinger
    c. Flax was tolerant to PRE application of Talinor but severely injured when Talinor was applied POST
    d. Armezon, Bison, and Basagran lightly injured flax (0 to 14%)
    e. Raptor alone caused more injury to flax than combination of Raptor plus Basagran.
    f. Hailstorm severely damaged plots prior to height and yield measurements.
    g. Trial is being repeated in 2019.

Table 1. Flax response to pre and postemergence herbicides at Hettinger, ND in 2018

Treatment	Timing	Rate	Flax		Mallow		Kochia	Flax Yield
		oz/A	7 DAT	15 DAT	15 DAT	38 DAT	15 DAT	
			Injury (%)		control (%)			lbs/A
Untreated			0 e	0 f	0 d	0 g	0e	937 b
Talinor	PRE	13.7	0 e	0 f	0 d	28 f	0e	1067 ab
Talinor	PRE	18.2	9 d	0 f	0 d	45 e	23d	989 ab
Talinor	POST	13.7	73 b	61 b	65 b	56 cde	55abc	731 c
Talinor	POST	18.2	81 a	78 a	74 a	70 b	66ab	651 c
Armezon	POST	0.5	14 cd	0 f	64 bc	60 bcd	63ab	1174 a
Armezon	POST	0.75	12 d	13 de	65 b	69 bc	42c	1038 ab
Bison	POST	16	10 d	14 d	55 c	53 de	50abc	947 b
Basagran	POST	16	3 e	6 ef	63 bc	64 bcd	48bc	1061 ab
Raptor	POST	4	18 c	29 c	80 a	100 a	70a	1118 ab
Basagran+ Raptor	POST	16+4	11 d	18 d	80 a	92 a	66ab	1094 ab

3) Oat tolerance to PRE and POST applied herbicides
    a. Oats were planted on May 23 and ten preemergence herbicides were planted the next morning.
    b. Rainfall after herbicide application included 0.09 inches on May 28 and 0.33 inches on May 30; Oats emerged on May 30th.
    c. Postemergence application of Armezon (topramezone) was applied to oats with 2 to 3 leaves on June 4 and 4 to 6 leaves on June 14.
    d. No injury from PRE herbicides to oats was observed.
    e. POST application of Armezon at 2-3 leaves caused slight injury that diminished by 25 days after application; Armezon applied at 4-6 leaves caused major injury (46% at 15 DAT).
    f. None of the herbicide treatments resulted in significant yield losses, although yield was lowest following the late application of Armezon and Zidua.

Table 2. Oat response to preemergence and postemergence herbicide application at Hettinger, ND

			18 DAT	26 DAT	36 DAT	50 DAT	Yield
Treatment	Rate	Timing	% control				Bu/A
1Untreated			0b	0c	0b	0b	74
2Zidua	3oz/a	PRE	0b	0c	0b	0b	82
3Warrant	1.5qt/a	PRE	0b	0c	0b	0b	82
4Dual II Magnum	1.67pt/a	PRE	0b	0c	0b	0b	78
5Prowl	3pt/a	PRE	0b	0c	0b	0b	76
6Outlook	18oz/a	PRE	0b	0c	3b	0b	78
7Zidua	3oz/a	EPOST	0b	0c	0b	0b	67
8Warrant	1.5qt/a	EPOST	0b	0c	0b	0b	76
9Dual II Magnum	1.67pt/a	EPOST	0b	0c	0b	0b	83
10Prowl	3pt/a	EPOST	0b	0c	0b	0b	83
11Outlook	18oz/a	EPOST	0b	0c	0b	0b	79
12Armezon	1oz/a	EPOST	14a	9b	0b	3b	77
13Armezon	1oz/a	LPOST	—	28a	46a	30a	67-

4) Fall and spring application of tank-mixes of BroadAxe and Dual with glyphosate were evaluated for control of winter annual weeds including downy brome and shepherd's-purse and control of spring annual weeds kochia, common lambsquarters, and green foxtail. Fall treatments were applied on October 17, 2017 and spring applications were applied on May 5. Field peas were planted on May 3.
    a. No injury to peas was observed from herbicide treatments.
    b. All treatments resulted in excellent control of downy brome and shepherd's-purse although a single application of glyphosate alone resulted in reduced control compared to treatments including Broadaxe or Dual.
    c. Fall application of Broadaxe with or without Dual resulted in 88 to 91% control of kochia in the spring when evaluated 43 days after pea emergence.

d. Spring application of Braodaxe with or without Dual also resulted in excellent control of kochia (93 to 96%), with the exception of when BroadAxe was applied at the reduced rate of 10 oz/A where control was only 80%.
e. Dual or glyphosate alone did not control kochia.
f. Spring applications resulted in better control of green foxtail compared with fall applications; although neither timings resulted in satisfactory control of green foxtail and would require an in-crop application of a POST grass herbicide.
g. Common lambsquarters control was similar to that of kochia, with fall applications resulting in as good as or better control compared with spring applications.
h. Trial to be repeated in 2019.

Table 3. Effect of fall and spring preemergence herbicide treatments for weed control in field peas at Hettinger, ND

			Downy brome	Shepherd's purse	Kochia			Green foxtail		Common lambsquarters	
	Rate		7 DAE	7 DAE	7 DAE	18 DAE	43 DAE	18 DAE	43 DAE	18 DAE	43 DAE
Treatment	oz/A	Timing	% control								
1Untreated		Fall	0c	0d	0c	0.0d	0f	0g	0c	0c	0e
2Glyphosate Broadaxe XC	32 25	Fall	100a	99a	100a	91.3a	91ab	70e	63a	94a	92a
3Glyphosate Broadaxe XC	32 19	Fall	100a	100a	95a	80.0c	90ab	58f	36b	86b	93a
4Glyphosate Broadaxe XC Dual II	32 19 10	Fall	100a	100a	98a	85.0bc	88b	78cd	73a	90ab	95a
5Glyphosate Broadaxe XC Dual II	32 19 16	Fall	100a	100a	96a	85.0bc	91ab	80bcd	74a	93a	88a
6Glyphosate Dual II	32 32	Fall	100a	100a	44b	0.0d	13e	75de	66a	0c	0e
7Glyphosate	32	Fall	96b	90bc	0c	0.0d	0f	0g	0c	0c	0e
8Glyphosate	32	Fall + Spring	100a	99a	95a	0.0d	0f	0g	0c	0c	0e
9Glyphosate Broadaxe XC	32 25	Spring	100a	98a	100a	91.0a	93ab	85a	78a	94a	87ab
10Glyphosate Broadaxe XC	32 19	Spring	100a	96ab	100a	89.1ab	96a	83abc	74a	90ab	90a
11Glyphosate Broadaxe XC Dual II	32 10 16	Spring	100a	99a	98a	86.3ab	80c	77d	75a	86b	75c
12Glyphosate Broadaxe XC Dual II	32 10 23	Spring	100a	94abc	96a	90.0ab	93ab	83ab	78a	86b	78bc
13Glyphosate Dual II	32 32	Spring	99a	98a	95a	0.0d	25d	79bcd	76a	0c	0e
14Glyphosate	32	Spring	100a	89c	98a	0.0d	0f	0g	0c	0c	0e

5) Evaluation of new herbicides for weed control and crop safety for crops grown in southwest North Dakota. The desired outcome is to increase the number of herbicides labelled for use in these crops when data shows treatments are beneficial for weed control and crop production (includes trials described above).
    a. Spring wheat: Ten trials conducted in 2018
    b. Oats: One trial conducted in 2018
    c. Canola: two trials conducted in 2018
    d. Flax: two trials conducted in 2018
    e. Field pea: five trials conducted in 2018
    f. Lentils: three trials conducted in 2018
    g. Chickpea: Two trials conducted in 2018
    h. Safflower: one trial conducted in 2018
    i. Sunflower: one trial conducted in 2018
    j. Dicamba and 2,4-D carryover to peas, lentils, chickpea, and sunflowers
    k. Evaluation of preharvest desiccants for wheat and durum

Presentations and Outreach:

- Wild world on weeds workshop at Fargo, ND. January 2019
- Western Dakota Crops Day at Hettinger, ND. December 2018
- Hettinger County Crop and Livestock Improvement Annual meeting, Feb 1, 2019
- Western Society of Weed Science, Denver, CO March 2019
- 2019 North Dakota Weed Control Guide contributor

February 19, 2019 - Advisory Board Meeting
NDSU-Hettinger Research Extension Center

Animal Science Report

Graduate Students:

- Graduate students and undergrad technicians:
  - Amanda Long – M.S. – Animal Science (Chris Schauer and Travis Hoffman)
    - Graduate in December
  - Paige Anderson – M.S. – Animal Science (Chris Schauer, Travis Hoffman, Dr. Stokka)
  - 2-3 Animal Science internships for the summer

Strategic Plan - Progress towards goals: *Evaluate alternative livestock production systems that increase profitability while maintaining environmental stability*

- Outreach efforts:
  - Fall Ram Test - Field Day March 9, 2019
    - 84 rams from 23 producers: Rambouillet, Columbia, Dorset, Targhee
  - Shearing and Wool Classing School: November 17-19, 2018
    - Shearing School – 15 students from ND, SD, IA, MT, OH, MA, and WY
    - Wool School – 8 students from ND, SD, ZA, NE, MN, OH, and NJ
  - Sheep Schools with Extension Service
    - Beginning sheep school with NDLWPA and starter flock recipients (September)
  - OFDA: Newel Ram Sale, Rapid City Stockshow, processed over 2600 samples from 42 producers
  - Received $27,036 to conduct nation-wide carcass ultrasound training in sheep for certification for the National Sheep Improvement Program
    - Taught schools in ND and TX, organized schools in ID and WI
    - Schools planned for KS and Penn State
  - Getting quotes for a NDSU tartan stadium blanket make out of HREC wool
    - Proceeds to go to Animal Science and Textile Department scholarships
- Sheep Research:
  - ***Impacts of flax on female and male reproductive traits when supplemented prior to breeding in sheep*** (Amanda Long M.S. program)
    - Received $38,000 to fund salary as well as product donation
    - Acquired $20,000 in funds for the ewe and ram trials
      - Trials completed and writing about done.
  - ***Impacts of banamine injection on pain responses of either rubber ring castrated and tail docked or durgically castrated and burdizzo docked lambs***
    - Paige Anderson M.S. program funded by SBARE – project completed, stats and writing
  - New Funding: ***Effects of loin eye muscle depth on accuracy and variation of loin eye area prediction and carcass yield via ultrasound in Rambouillet sheep***
    - Will conduct project this summer and this fall, evaluating feedlot lambs and purebred Rambouillet rams
  - Collaborated with the U of Idaho to determine if there is a genetic marker for "blown legs" in Rambouillet rams

- Cattle Research:
    - Grazing studies with Range and Wildlife program (Integrated project – Strategic Plan #5)
- Publications:
    - Refereed – 1, Extension - 2
- Extension Specialist: Dr. Janna Kincheloe

HREC Advisory Board Meeting Report
February 19, 2019
Janna Block, NDSU Extension Livestock Systems Specialist

- **Published results from post-weaning calf feeding trial data summary and analysis in 2018 North Dakota Beef and Sheep Report** ("Evaluation of the interaction of injectable trace mineral and vaccination protocol on feed intake , performance, and immune response of weaned calves"; available online at: https://www.ag.ndsu.edu/publications/livestock/2018-north-dakota-beef-and-sheep-report-1)
- **2018-2019 fetal programming research trial** – Funding in the amount of ~ $70,000 was received from the South Dakota Beef Industry Council to determine the effect of gestational energy source (full feed forage-based diet vs. limit-fed grain-based diet) on offspring postweaning performance, feed intake and efficiency, carcass ultrasound and evaluation, and meat quality and sensory characteristics. NDSU calves were backgrounded at HREC after weaning until the first part of December, and then shipped to the SDSU Cottonwood Research Center for about 30 days. They are currently on a finishing diet at SDSU in Brookings, SD, with target finish dates in May/June.
- **USDA Beginning Farmer Rancher Development Program (BFRDP) Grant (~$600,000 requested)** – Not funded
- **Planned and facilitated multi-state "Minerals for Livestock Producers" Meetings** – Impact report attached.
- **Educational booth at ND Stockmen's Association Annual Convention/Trade Show** – Sept. 13-15, Bismarck, ND
- **NDSU Extension Livestock In-Service Training** – Sept. 18-19, Rugby, ND – Conducted heifer selection exercise utilizing performance data and phenotypic evaluation with ~ 25 Extension Agents
- **NDSU Extension Backgrounding Series** – Oct. 16-18, McVille, Spiritwood, Napoleon, Granville, New Salem, and Killdeer, ND – Presented seminar on calf weaning management to ~ 100 livestock producers
- **NDSU Extension/Research Fall Conference** – Oct. 22-24, Bismarck, ND – Presented workshop on mineral supplementation for livestock producers and facilitated a brainstorming session with Dr. Schauer focused on strengthening the link between Extension and research in our state.
- **Beef Specialist Search Committee Member –** Helped develop advertising, screen applications, interview applicants, and develop hiring recommendations for NDSU administration for full-time on-campus Extension Beef Specialist (position vacated by Dr. Carl Dahlen in January of 2018)
- **Two manuscripts submitted to peer-reviewed publications** – Meat Science – In Review; J. Anim. Sci. – Rejected (resubmitting to alternate journal)
- **Presentation at Adams County Beef Day –** Jan. 22, Hettinger, ND
- **Presentation at NDSU Extension Feedlot School –** Jan. 23, Carrington, ND
- **Invited speaker at 2019 NCBA Cattlemen's College** – Jan. 29-Feb. 1, New Orleans, LA – Presented information on fetal programming to livestock producers and industry professionals from around the nation (workshop selected as one of three Producer Choice sessions and presented four times during Cattlemen's College).
- **Educational booth at Agri-International Expo., Bismarck, ND** – Feb. 12-13, Bismarck, ND

Beef Cattle Mineral Nutrition

Optimizing livestock mineral supplementation programs

Public Value Statement
Proper mineral supplementation of livestock helps ensure livestock health and performance, which increases production efficiency and helps ensure a stable, high quality food supply.

The Situation

Beef cattle mineral nutrition is a complex issue due to interactions among minerals, variation in mineral content of feed and water, inconsistent consumption of mineral by livestock, and differences in product source and bioavailability. There is increased emphasis on trace mineral supplementation due to health and production concerns that can result from mineral imbalance. Producers want to learn more about factors that impact effectiveness of their mineral programs and strategies for overcoming these challenges.

Extension Response

Extension personnel from North Dakota and South Dakota State Universities worked together to develop a multi-state educational program for livestock producers. This program consisted of two face-to-face workshop sessions per state in addition to individual ranch visits and consultations with participants. Workshops focused on understanding livestock mineral requirements, basic mineral nutrition and product options, and dealing with consumption challenges. Tools for testing forages, feeds, and water for mineral content and tracking mineral consumption were provided to producers. At ranch visits, Extension personnel helped interpret lab results and worked with producers to develop custom recommendations for mineral program management.

Figure 1. Ranch tour and discussion of mineral supplementation with a program participant

Impacts

Participants collected and submitted 30 forage samples, 14 water samples, and 2 mineral supplement samples to a commercial laboratory for analysis. Three livestock operations reported that they have made changes to their previous mineral supplementation program, including improving mineral intake monitoring, adding additional mineral feeders, and changing to an alternate mineral product that better fits their production situation. Other participants have reported that they are planning to make changes pending additional water and forage analysis results.

Feedback

Producers reported improved reproductive performance and less cattle health issues (footrot, pinkeye, etc.) as a result of changing their mineral program. They appreciated the ranch visits and personalized approach to this production issue.

Primary Contact

Janna J. Block, Ph.D.
NDSU Extension Livestock Systems Specialist
Hettinger Research Extension Center
P.O. Box 1377, Hettinger, ND 58639
Phone: 701.567.4323
Email: janna.kincheloe@ndsu.edu

Collaborators

Adele Harty, M.S., and Ken Olson, Ph.D. (SDSU Extension)

Non-Extension Collaborators

Dustin Seuss & Jeff Heldt (Micronutrients); Dustin Elkins & Lance Kennington (CHS Nutrition); Rebecca Kern (Ward Laboratories, Inc.); Pat Guptill (South Dakota Grasslands Coalition)

Hettinger Research Extension Center
Advisory Board Meeting- July 9, 2019

Board members present: Dustin Freitag, Sean Seamands, Alan Timm, Bo Beer, Ashley Sabin, Cody Jorgenson, Wade Henderson, Dave Ollila and Jacki Christman. **Guests**: Dean Wehri, Greg Lardy, Tim Faller, Devan McGranahan, Charlie Stoltenow and Yuri Montanholi. **Staff**: Chris Schauer, Ben Geaumont, John Rickertsen, Caleb Dalley, Janna Block, Cassie Dick, Jon Spiess and Paige Anderson.

Wade H called the meeting to order at 12:45 pm.

Wade H asked for a motion to approve the minutes from the previous meeting. Cody J moved to accept minutes, Jacki C seconded. Motion passes to approve minutes, no opposing.

Wade H asked for a motion to approve the agenda. Janna B asked to add Charlie Stoltenow and Yuri Montanholi to the agenda; Yuri the new NDSU extension beef cattle specialist has a short presentation on his background and studies.

Chris S introduced our two new board members. Bo Beer farms in the Keldron, SD area and Alan Timm is a local honey producer.

Legislative Update & Director's Report
Dr. Greg Lardy said the budgets we received for this biennium are decent. Funds to improve the extension website. Open positions are being filled. Williston received funds for a seed cleaning facility; Oakes irrigation site also received funds. Compensation packages for employees are making for more positive moral. Dean Wehri, SBARE stated that Research and Extension ended up better than he thought when they started out session and was a very promising and successful session compared to the last. REC's received some deferred maintenance funding. Legislators seemed to pay attention to the needs requested. Dr. Greg Lardy told us that the grass-roots effort, by testifying or by contacting local legislators, was well received. Real circumstances from the public where they have been affected positively by research and extension was successful this year and needs to continue. Dean W explained what and how SBARE worked. Wade H testified at the last session and encourages others from the board to volunteer when Chris S askes for members to testify. Chris S said the next session starts in October 2019. Greg L stated that the legislature is increasingly more urban represented, we need to make sure that rural issues continue to be addressed and to stay engaged with your legislators for agriculture and rural issues. Charlie S stated that we need to work together throughout the state.

Chris Schauer- handout provided. 110th anniversary of the station, hopefully will get an article printed in the local papers. The station is doing pretty good, at hold even budgets plus employee raises and extra deferred maintenance funds. Working with scientists for the next 5-year strategic plan.

Scientist Reports
Agronomy report: John Rickertsen- handout provided. New trial this year is hemp. Lots of variety trials this summer.

Weed Science Report: Caleb Dalley- handout provided. A lot of research going on, been here for five field seasons, no two have been alike. Hard to know what an average year would be for comparisons.

Range & Wildlife Report: Ben Geaumont- handout provided. Ph.D. graduate student Jonathan Spiess gave a presentation on the patch-burning project, discussion followed.

Animal Science Report: Chris Schauer- handout provided. M.S. graduate student Paige Anderson gave a presentation on the Banamine injection/pain response in sheep project.

Livestock Extension Specialist report: Janna Block- handout provided. Mineral/nutrition feeding program.

We were introduced to Dr. Yuri Montanholi, new Extension Beef Cattle Specialist, he gave a presentation on his background.

Open Discussion

Dave O- a lot going on, are we meeting the strategic plan goals? Chris S- yes, large scale Ben G's multi-layer project brings everything together for the long-term, so that we can continue to build, it is also diverse enough that most things fit. Looking forward, a cattle/sheep handing facilities for more research diversity. Housing is needed for grad students/summer technicians. Working on pollinators study, that will also tie into many projects.

Alan T- bees are a small industry, most honey producers lease bees, and don't want to travel with them. Alan travel with his bees. Bees are hard to keep alive. There is a need for solid studies, more than just a helpful tip. He said some states have laws as to how close you can put your bees to another person bees, ND does not. You can basically putt your bees right next to another person's bees. He said most of the local producers have an agreement with each other not to crowd each other's hives. But if someone from out of the area wants to put there bees right next you they can, the bees interact and that's how disease can spread. And you have no idea who might own the bees. Dave O- what are the biggest issues we need to support for a pollinators study? There is no specific "bee" person at NDSU. Discussion- Colony collapse, losing 3% a year – Habitat – Economic impact – Vets needing better education – benefits to other industries – Causes of death/loss.

Wade H asked if the board members would be in favor of supporting bee research at the Hettinger REC, all members voted in favor. The Hettinger REC Advisory Board recommends that NDSU strengthens its research and extension efforts in support of the ND apiary industry, recognizing that southwest ND is a center for honey production.

The winter meeting will be planned for February 2020.

Staff dismissed for executive session.

July 9, 2019 Advisory Board Meeting
NDSU-Hettinger Research Extension Center

Director's Report

- ***110th Anniversary this year!***
    - We will be running an article in the newspaper and Ag Week highlighting our history and growth

Legislative Report:

- Ag Administration: Greg Lardy, Tim Faller
- Current Biennium
    - Flat budget plus raises; extra deferred maintenance
        - Looking at concrete parking pad in front of the office if funding allows.
- Staffing
    - Michael Adsero resigned in March, and hired Michael Wells this spring
    - Fully staffed!
- Next Biennium: SBARE testimony will start up this fall
    - Livestock infrastructure may be a theme we pursue

Infrastructure:

- 1000 ewes
- 80 head of cows
- 110 head of cows at ARS in Mandan (fiscal agent for their cow herd); 4 goats
- CASE IH rental agreement – 5 tractors, baler, bobcat, self-propelled windrower
- Housing: 2 trailers at trailer park, old office housing, and 1 trailer stuck in between buildings with no water
    - Roof, siding, and windows may be something we pursue on deferred maintenance this year
- Hail from last June: a couple of doors left to fix, but everything else is done.

Strategic Plan: 2015 – 2019

1. Evaluate alternative livestock production systems that increase profitability while maintaining environmental stability (Chris and Janna).
2. Conduct applied research that investigates the compatibility of agriculture and wildlife (Ben).
3. Evaluate weed control methods to increase crop and forage productivity in southwest North Dakota (Caleb).
4. Enhance dryland crop production while maintaining natural resources (John).
5. Integration of Livestock, Wildlife, Agronomy, and Weeds research programs into a farm-scale interdisciplinary research project (All).

2019 Summer Advisory Board Meeting
Wildlife and Range Research Update
Ben Geaumont and Dan Graham

Strategic Plan Aim - **Conduct applied research that investigates the compatibility of agriculture and wildlife**

Graduate Students – Co-Advised

Derek Klostemeir, M.S. – Natural Resource Management, A study of the relationship between plains sharp-tailed grouse nest site selection and survival and ecological site descriptions in the northern plains. (Kevin Sedivec) Graduated May 2019.

Jonathan Spiess, PhD – Range Sciences, Evaluate livestock selection, vegetation, soils, and fire behavior within patch-burn grazing research (Devan McGranahan).

Jasmine Cutter, M.S. – Range Sciences, Evaluate pollinators in our patch-burn grazing research (Torre Hovick).

Alex Rischette, M.S. – Range Sciences, Evaluate wildlife response to patch-burn grazing on Post-CRP (Torre Hovick).

Additional Graduate Student Committees

Adrienne Antonsen, M.S. – Entomology, Statewide pollinator survey.

Chyna Pei, PhD – Range Sciences, Statewide pollinator survey.

Cameron Duquette, PhD – Range Sciences, Grassland bird response to patch-burn grazing in mixed-grass prairie.

Savannah Adams, MS – Range Sciences, Pollinator use of annual forage plots and pinto beans.

Current Research Projects

1. **The utility of unmanned aerial systems for monitoring sharp-tailed grouse leks** (Hovick, Graham, and Nowatzki) Funded by the Forest Service.
    a. Evaluate the feasibility of using UAS to locate and monitor leks of sharp-tailed grouse.
2. **Restoring disturbance to old Conservation Reserve Program Fields to Promote Ecosystem Services**. (C. Schauer, T. Hovick, R. Limb, and D. McGranahan) Funded by AFRI
    a. Evaluate the effects of patch-burn grazing in Conservation Reserve Program grasslands on livestock, vegetation, pollinators and wildlife in western North Dakota.
        i. Livestock, birds, vegetation, bees and butterflies
    b. Six, 160 acre pastures
        i. 3 with sheep
        ii. 3 with cow/calf pairs
    c. Six burns completed in October 2018

2a. Evaluate the ability of over seeding native forbs following prescribed fire to enhance habitat for pollinators. (Funded by Game and Fish).

a. Seed (5), 1-acre plots within each prescribed fire area in mid-March.

3. **Monitoring native pollinator communities throughout North Dakota: Status and Management considerations for bees and butterflies.** (CO-PIS: R. Limb, T. Hovick, and J. Harmon) Funded by ND Department of Agriculture.
    a. Conducting statewide pollinator surveys. Access land use, floristic resources and pollinator associations.

4. **Evaluate a livestock-crop integrated system using annual forages, winter wheat and sheep. Determine livestock gains, crop production, insect use, and changes to soils.**
    a. Seed annual forage mixture in May to provide forage for sheep and resources for insects.
    b. Graze sheep on annual forage in August.
    c. Plant winter wheat in September.
    d. Graze wheat in April-May.
    e. Harvest wheat in July-August.
    f. Graze wheat stubble.

5. **Can growing pollinator plots in proximity to pinto beans lead to increased yields?** (Co-PIS: T. Hovick, M. Ostlie, J. Rickertsen, J. Harmon, and R. Limb; Work done in Hettinger and Carrington: Funded by ND Department of Agriculture).
    a. Establish 1-acre annual forage plots (consist of 18 flowering plants).
    b. Establish 2-acre bean plots.
    c. Evaluate pollinator use of pollinator and bean plots.

Peer Reviewed Publications

Geaumont, B.A., J. Norland and J.W. Stackhouse. 2019. Influence of seed mixture richness and forb seed density on native plant establishment in the badlands region of North Dakota. *Ecological Restoration* 37:123-130.

Kral-O'Brien, K.C., Sedivec, K.K., **B.A. Geaumont**, and A.L. Gearhart. 20XX. Native mixed-grass rangelands and crested wheatgrass pasture lands resilient to spring wildfire. Rangeland Ecology and Management, first revision.

Potential Projects

Sustainable Agriculture Research and Education Grant Submission – An Assessment of the importance of shelterbelts as early season nectar and pollen resources for domesticated honeybees. – Should hear back by end of July.

Alternative Land Management on Lands Managed for Wildlife – work with private landowner and Game and Fish.

July 9, 2019 Advisory Board Meeting
NDSU-Hettinger Research Extension Center
Agronomy Update – John Rickertsen

2019 Research Projects

Variety/Hybrid Performance Trials:

Winter Wheat	*Winter Rye*	*Soybean*	*Safflower*
Spring Wheat	*Field Pea*	*Canola*	*Sunflower*
Durum Wheat	*Chickpea*	*Flax*	*Corn*
Barley	*Lentil*	*Hemp*	
Oats	*Dry Beans*		

Off Station Yield Trials:
Trials located at Scranton, Regent, and Mandan. These trials are located with farmer cooperators and with the USDA-ARS Northern Great Plains Lab at Mandan. Crops tested are spring wheat, durum wheat, barley and soybean.

Plant Breeding Nurseries & Advanced Trials:
Nurseries & advanced yield trials are planted for the following breeding programs.

NDSU Spring Wheat	NDSU Field Pea
NDSU Winter Wheat	NDSU Lentil
Syngenta Spring Wheat	NDSU Canola
Regional Spring Wheat	Regional Barley
	NDSU Soybean

Agronomy Studies:
- Spring Wheat Seed Treatment.
- Hybrid Spring Wheat Seeding Rate.
- Soybean Population in 30" & 7" rows.
- Soybean Nitrogen & Inoculant Trial.
- Management of Fusarium Root Rot of Field Peas and Wheat with Crop Rotation.
- Durum Wheat Planting Date, Fusarium Head Blight.
- Lentil Fertility
- Lentil Seed Treatment
- Lentil Variety Response to Root Disease

Equipment:
- New plot drill with John Deere 90 Pro series openers is on order, hoping for September delivery.
- New plot combine purchased by spring wheat project to be housed at HREC for white wheat project, will also be housing a plot drill for this project.

July 9, 2019 - Advisory Board Meeting
NDSU-Hettinger Research Extension Center

Animal Science Report

Graduate Students:

- Graduate students and undergrad technicians:
  - Paige Anderson – M.S. – Animal Science (Chris Schauer, Travis Hoffman, Dr. Stokka)
  - 2 Animal Science internships for the summer (1 local high school student, 1 Animal Science major from NDSU)

Strategic Plan - Progress towards goals: ***Evaluate alternative livestock production systems that increase profitability while maintaining environmental stability***

- Outreach efforts:
  - Fall Ram Test - Field Day March 9, 2019
    - 84 rams from 23 producers: Rambouillet, Columbia, Dorset, Targhee
  - Shearing and Wool Classing School: November 17-19, 2018
    - Shearing School – 15 students from ND, SD, IA, MT, OH, MA, and WY
    - Wool School – 8 students from ND, SD, ZA, NE, MN, OH, and NJ
  - Sheep Schools with Extension Service
    - Beginning sheep school with NDLWPA and starter flock recipients (September)
  - OFDA: Newel Ram Sale, Rapid City Stockshow, processed over 2600 samples from 42 producers
  - Received $27,036 to conduct nation-wide carcass ultrasound training in sheep for certification for the National Sheep Improvement Program
    - Taught schools in ND and TX, organized schools in ID and WI
    - Schools planned for KS and Penn State
  - Getting quotes for a NDSU tartan stadium blanket make out of HREC wool
    - Proceeds to go to Animal Science and Textile Department scholarships
- Sheep Research:
  - ***Impacts of flax on female and male reproductive traits when supplemented prior to breeding in sheep*** (Amanda Long M.S. program)
    - Amanda defended her thesis, we are submitting the 2 publications shortly.
  - ***Impacts of banamine injection on pain responses of either rubber ring castrated and tail docked or durgically castrated and burdizzo docked lambs***
    - Paige Anderson M.S. program funded by SBARE – project completed, stats and writing, presentation today
  - New Funding: ***Effects of loin eye muscle depth on accuracy and variation of loin eye area prediction and carcass yield via ultrasound in Rambouillet sheep***
    - Will conduct project this summer and this fall, evaluating feedlot lambs and purebred Rambouillet rams
  - Collaborated with the U of Idaho to determine if there is a genetic marker for "blown legs" in Rambouillet rams
    - Found a "suspect gene" that we will be following chasing grants on
    - This is a an exciting project in that it would be the 1st breed that isolated a gene for a structural deformity.

- Cattle Research:
  - Grazing studies with Range and Wildlife program (Integrated project – Strategic Plan #5)
- Publications: 2018
  - Refereed – 1, Extension - 2
- Extension Specialist: Dr. Janna Kincheloe

HREC Advisory Board Meeting Report
July 9, 2019
Janna Block, NDSU Extension Livestock Systems Specialist

Activities/Events

- Presentation about herd management during drought at Drought Planning Workshop (joint program between NDSU Extension and the National Drought Mitigation Center [NDMC]) – Feb. 21, Minot, ND

- Presentation about post-calving nutrition at Dunn County Beef Day – March 7, Killdeer, ND

- Planned, organized, facilitated, and presented "Cold Weather Cattle Management" webinar in conjunction with other NDSU Extension Specialists – March 12, recording available online at https://www.ag.ndsu.edu/livestockextension/cattle-management-in-cold-weather

- Served on SBARE interview/selection committee – March 25

- Trained new agents to conduct Nitrate QuikTest – April 23

- Presentation about pre-breeding nutrition at Badlands Genetics AI School – April 25, Dickinson

- Planned and facilitated multi-state "Minerals for Livestock Producers" Meetings – May 14-15, Bismarck, ND, and June 3, Hot Springs, SD. This year we added a separate one-day training specifically for Extension Agents that focused on how to work with producers to address mineral issues.

- Served on planning committee and gave presentation about fetal programming at multi-state "Cattle Reproduction Management Workshop" – May 23, Oronoco, MN

- Cow/calf fetal programming manuscript submitted to ANIMAL journal – June 5

- Presentation about basic livestock nutrition at 4-H/FFA Livestock Showmanship and Nutrition Workshops – May 30, Minot, ND and June 18, Hettinger, ND

- Radio interview with American Ag. Network on mineral nutrition for grazing cattle – June 27

Updates

- 2018-2019 fetal programming research trial – All calves were fed to finish at SDSU and harvested at Tyson in Lexington, NE. Individual carcass traits were evaluated, and meat quality analysis is ongoing.

- Beef Industry Tour - Tour being planned for Extension Agents this fall in SD and NE. Stops will include several feedlots, the UNL Gudmundson Sandhills Lab, a packing plant, and a major meat retailer. The goal is to facilitate creative programming ideas between Agriculture and Family Consumer Wellness Extension Agents around topics of beef production and consumer issues.

- Beef Cattle Nutrition & Feeding Management program – I am working closely with Specialists and Agriculture Agents to develop focused, hands-on nutrition programs to be conducted in various counties this fall/winter. Agents will be trained on various topics and then work with small groups of producers to facilitate forage/feed analysis, feed inventory, body condition scoring, ration balancing, etc.

2019 Personnel

Hettinger Research Extension Center

Christopher Schauer	Director and Animal Scientist
Janna Block	Extension Livestock Systems Specialist
Benjamin Geaumont	Research Assistant Professor/Wildlife and Range Science
John Rickertsen	Associate R/E Center Specialist/Agronomy
Caleb Dalley	Research Weed Scientist
Daniel Graham	Wildlife and Range Technician
Daniel Guimaraes Abe	Weed Science Technician
Michael Wells	Agronomy Technician
Terri Lindquist	Finance Paraprofessional
Cassie Dick	Administrative Secretary
Don Stecher	Manager of Ag Operations
David Pearson	Research Technician/Shepherd
Donald Drolc	Research Technician/Livestock
Nicole Hanson	Research Technician/Livestock

Range and Wildlife Graduate Students
Jasmine Cutter, Alex Rischette, Jonathan Spiess
Animal Science Graduate Students
Paige Anderson

The Hettinger Research Extension Center hires individuals on a part-time basis to help in the research effort. Many of these are students as well as local residence. We would like to acknowledge the following people who helped at some time during the past year: Alexandra Fenoff, Elizabeth Urwiller, Justice Anderson, Michelle Witt and Kaden Schauer.

Advisory Board Members

Jacki Christman	Hettinger, ND	Torre Hovick	Fargo, ND
Ethan Andress	Hettinger, ND	Dave Ollila	Rapid City, SD
Dustin Laufer	Hettinger, ND	Alan Timm	Hettinger, ND
Curt Stanley	Bismarck, ND	Bo Beer	Keldron, SD
Duaine Marxen	Mott, ND	Dustin Freitag	Bowman, ND
Ashley Sabin	Elgin, ND	Sean Seamands	Lemmon, SD
Cody Jorgenson	Hettinger, ND	Jamie Enerson	Hettinger, ND
Wade Henderson, Vice Chair	Lodgepole, SD	Dean Wheri, SBARE Rep.	Mott, ND

Hettinger Research Extension Center
102 Hwy 12 W
PO Box 1377
Hettinger, ND 58639

Phone: 701-567-4323
Fax: 701-567-4327
Website: http://www.ag.ndsu.edu/HettingerREC