Yield and Quality of Annual Crop Mixes and Alternative Annual Crops for Forage Production in Alberta

This Project is supported by CAP/RDAR

Non-Technical Summary

Funded by CAP/RDAR, this project was designed to evaluate forage yield and quality of annual crop mixes and non-traditional crops. Separate blocks of twelve spring/winter cereal mixes, twelve cereal/pulse mixes and ten alternative forages were evaluated during the span of the project. Some variation in entries occurred during the course of the trial due to seed availability. A randomized complete block design, with 4 replications of plots measuring 1.4 m by 5 m was used to compare the treatments within each block. All seeding, maintenance and harvest activities were accomplished using CARA's small plot equipment.

The three year study did not identify any annual crop mixes which significantly out-yielded the check crops. However, the addition of pulses to cereals, as well as the spring/winter cereal mixes and some of the alternatives, did provide nutritional benefits over the cereal crops. Protein, total digestible nutrients as well as micro-nutrients calcium, phosphorus, potassium and magnesium tended to be higher in the mixes than the Austenson barley check treatment.

Crops showing the best yield potential within the alternative block were Japanese millet and Sorghum sudan grass. These crops appear to have much better tolerance of drought conditions.

From a nutritional perspective, most of the alternative crops contained higher protein levels at harvest than the millet, however, the millet typically had higher total digestible nutrients. Micro-nutrient levels (calcium, phosphorus, potassium and magnesium) were generally higher than the check.

Cereal/pulse mixes, spring/cereal mixes or alternative annual crops may have a role in specific grazing systems when a higher nutritional level (protein and micro-nutrients) is desired. The spring/winter crop mixes also have potential for extending the grazing season if supported by adequate moisture during the summer and early fall.

Background:

Forage yield and quality of varieties of barley, oats and triticale have been studied at several sites in Alberta for over a decade by applied research associations. The data generated has provided valuable information for cattlemen across the province when selecting annual crops for silage, greenfeed or swath grazing. Less evaluation has been made for alternative, non-traditional crops some of which may produce a higher nutritional value than commonly used annual crops. Mixes of pulse/cereal crops can also produce a higher quality forage, but data for the brown soil zone is limited. Spring/winter combinations may produce not only silage or greenfeed, but can be utilized to extend fall grazing, thus reducing annual cow maintenance costs. This project was designed to evaluate several alternative crops as well as two groups of mixes for both yield and quality. In addition to the trials manage by the Chinook Applied Research Association, the trials have been duplicated by several other applied research associations in Alberta.

CARA's trials during 2018-2022 were located in the brown soil zone within Special Areas 2 and 3. Trials have been affected by drought and heat, especially in 2021 and 2022.

Objectives:

- To provide unbiased, current and comprehensive regional data regarding the establishment, dry matter yield, nutritional quality and economics of:
    - Annual forage crop mixtures (pulse/cereal, spring/fall cereal)
    - Alternative annual forage crops

- To identify nutritional differences between annual crop species and mixtures for livestock production.

Cooperators: Madge Farms, Stanmore NE 20-30-11-W4 (Special Area 2)
Dwayne Smigelski, Oyen NE 16-28-03-W4 (Special Area 3)
Scory Estates, Oyen NW 35-27-04-W4 (Special Area 3)
Rude Farms, Sedalia NE 17-31-06-W4 (Special Area 3)

Project Description:
Crop entries for the trial were determined by consultation with the applied research association partners. All groups assisted with contacting sources, collecting and distributing seed as well as reviewing project protocols.

CARA staff confirmed sites for the trial blocks early each spring based on the previous crop and available space at trial site locations. All sites were within the brown soil zone of Alberta's Special Areas 2 and 3 near the Saskatchewan border. Canola or pea stubble were targeted. Soil samples were collected each spring to establish available soil nutrients at the site. The samples were submitted to A & L Labs for the complete chemical evaluation which includes organic matter, phosphorus, potassium, magnesium, calcium, pH, electrical conductivity, percent base saturation (potassium, magnesium, calcium, hydrogen, phosphorus, sodium, aluminum), sulphur, nitrate, zinc, manganese, iron, copper, boron, aluminum, potassium/magnesium ratio, estimate of nitrogen release and sodium.

Separate blocks were established for each trial (ie. pulse/cereal, spring/winter cereal and alternative forages) and were often situated at different sites. Glyphosate was applied prior to seeding for pre-seed weed control for all blocks. Trial entries for each are listed below. All crops and mixes were seeded into a randomized complete block design, with 4 replications of plots measuring 1.4 m by 5 m. A 3 m border separated replications. All seeding, maintenance and harvest activities were accomplished using CARA's small plot equipment, including a Henderson 500 seed drill, 3 point hitch custom sprayer, a flail type forage harvestor and sickle cutter. The Henderson 500 seeder was used to seed all treatments, placing seed in paired rows with fertilizer applied between and below the seed. Target seeding rate was 18 plants per square foot for the cereals, 8 for the peas and 12 for the lentils. A half rate was used for each annual cereal in mixed treatments. 75% of the pulse rate was used for the peas and lentils mixed with cereal treatments. Seeding depth for the cereals was 2 - 2 ½ inches for cereals and pulses and 1 – 1.5" for the alternatives.

In-crop weed control was managed primarily by hand weeding in the alternative forage block as herbicide selection for the different treatments was difficult. MCPA 600 was applied in-crop in the cereal/pulse mixes. In-crop herbicides used in the spring/winter cereals included MCPA 600 (2020), Bromotril (2021) and Pardner (2022).

Biomass yield from the three interior rows of each plot were collected with a flail type forage cutter targeting soft dough stage for the spring cereals. A sickle cutter was used for the sorghum sudan grass in 2022. Samples were not taken from the Madge site in 2020 due to an intense hail storm in early July. The 2021 growth at the Madge site was challenged by a late flush of kochia so was not harvested. The field wet samples were weighed and a sub-sample was dried and then weighed for yield determination. A portion of the sub-sample was analyzed by A & L Labs for nutritional quality of the biomass on a dry matter basis, including crude and soluble protein, total digestible nutrients, acid detergent fibre, neutral detergent fibre, lignin, starch, fat, ash, net energy (lactation, gain and maintenance), calcium, phosphorus, potassium, magnesium, sodium, sulphur, copper, iron, zinc, manganese, chloride and relative feed value.

Trial Entries:

Cereal/Pulse Block

Cereals: CDC Austenson barley
CDC Baler oats
Taza triticale

Pulses: CDC Meadow peas
DL Delicious peas
Aberdeen peas
CDC Jasper peas
CK Lacrosse peas
DL Tesoro peas
Snowbird fababeans

Spring/Winter Cereal Block

Spring Cereals: CDC Austenson barley
CDC Baler oats
Taza triticale

Winter Cereals: Bobcat, Metzger and Luoma triticale
AAC Wildfire wheat
Prima fall rye

Alternative Forage Block

Japanese millet
Sorghum sudan grass
Red Siberian millet
Pearl millet
Phacelia
Radish
Malwira turnip
Hercules turnip
Double max radish
Plantain
Chicory

Note: not all treatments were present in all years of the trial because of seed availability

Cooperators: Madge Farms, Stanmore NE 29-30-11-W4 or NW 33-30-11-W4 (Special Area 2)
Dwayne Smigelski, Oyen NE 16-28-03-W4 (Special Area 3)
Kuhn Farms, Oyen NW 35-27-04-W4 (Special Area 3)
Rude Farms, Sedalia NE 17-31-06-W4 (Special Area 3)

Table 1 **Site Information Summary**

Alternatives	**2019**	**2020**	**2021 - 1**	**2021 - 2**	**2022**
Location	Smigelski Site			n/a	Smigelski Site
Seed Date	May 29	June 23			June 22
Fertilizer*	140 lb/A 26-18-5-3	150 lb/A 26-18-5-3	150 lb/A 26-18-5-3		150 lb/A 26-18-5-3
Harvest	Aug 26	Sept 8	Aug 1		
Precipitation (May-August)	138.3 mm *203.6 LT avg*	190.8 mm *203.6 LT avg*	131.8 mm *203.6 LT avg*		155.7 mm *203.6 LT avg*

Spring/Fall					
Location	n/a	Madge	Madge	Kuhn	Rude Site
Seed Date		June 3	May 21	June 4	May 17
Fertilizer*		150 lb/A 26-18-5-3	150 lb/A 26-18-5-3	150 lb/A 26-18-5-3	196 lb/A 26-18-5-3
Harvest		Hailed out	Aug 25	Aug 23	Aug 5
Precipitation (May-August)		217.6 mm *226.1 LT avg*	177.4 mm *226.1 LT avg*	203.6 mm *203.6 LT avg*	104.8 mm *207.2 LT avg*

Pulse Mixes					
Location	n/a	Madge	Madge	Kuhn	Madge Site
Seed Date		June 5	May 21	June 7	May 27
Fertilizer*		50 lb/A 11-52-0	50 lb/A 11-52-0	50 lb/A 11-52-0	196 lb/A 26-18-5-3
Harvest		Hailed out	Weed impact	Aug 20	Aug 10
Precipitation (May-August)		217.6 mm 226.1 LT	177.4 mm 226.1 LT	203.6 mm 203.6 LT	206.0 mm 226.1 LT

Results:

It is important to note that yields and nutritional measurements from treatments including three years of data is much more reliable than crops and mixes appearing only once in the trial.

A summary of the Cereal/Pulse Mix yields appears in Table 2. The only cereal/pulse mix to outyield the spring cereals CDC Austenson and CDC Baler was CDC Baler/DL Tesoro which was only tested in 2022. All treatments in the cereal/pulse block were compared as a percent of the check (Austenson barley). Taza triticale had a higher average yield than the Austenson check with an average of 3349 lb/A. 2021 and 2022 average yields of the CDC Baler oats/DL Delicious peas were also comparable to the check (3149 lb/A). Although lower in yield, the majority of cereal/pulse mixes contained higher protein levels than the Austenson check (Table 3). Total digestible nutrient levels in CDC Baler and several of the mixes were comparable to the check. Fibre (acid detergent and neutral detergent) levels were similar to or slightly higher in some of the mixes. Calcium, phosphorus and magnesium levels were higher in most cereal/pea mixes than the barley alone. Potassium levels ranged from 81 percent of check to 156 percent. Starch levels were lower in most mixes than the Austenson barley and fat levels ranged from 146 percent (Austenson/CDC Meadow) down 60 percent with the Taza/Snowbird fababean mix.

Combining spring and winter cereals did not provide a yield advantage over the spring cereals alone (Table 4). Highest greenfeed/silage average yield was very similar between the CDC Austenson barley and the CDC Baler oats at an average of 3394 and 354 lb/A respectively. Protein levels were generally higher from the mixes than in the Austenson check (Table 5). The winter cereal growth would have been vegetative at the time of cutting, which added green leaves to the biomass harvested. Fibre levels were similar to slightly higher. Levels of micro-nutrients (calcium, phosphorus, potassium and magnesium) were typically higher from the mixes as well. Winter cereal re-growth was not sufficient throughout the trial to collect forage samples in the fall. With the right environmental conditions, however, the potential of forage for fall grazing gives the mixes a role in extending forage and grazing systems in east central Alberta.

Low precipitation levels in 2020 and 2021 severely impacted growth and yield of the brassicas and broadleaf's plantain and chicory in the alternative forage block (Table 6). Using Japanese millet as a check, other millets were the only crops to yield higher during 2018 – 2020 duration of the trial. Again, it should be noted the yield of crops with less than 3 years of data should be used with caution. Sorghum sudan grass is the only other crop comparable to the Japanese millet. Height of the sorghum sudan grass is also appealing for harvesting or grazing forage crops in east central Alberta where low moisture levels often result in shorter crop growth.

A summary of the nutritional qualities of the alternative forages appears in Table 7. From a nutritional perspective, most of the alternative crops contained higher protein levels at harvest than the barley, however, the Austenson typically had higher total digestible nutrients. Acid detergent fibre levels were higher in most of the alternatives included in the trial when compared to the barley, although the neutral detergent fibre levels were less which would indicate these crops could be consumed at a higher level than the barley. Micro-nutrient levels (calcium, phosphorus, potassium and magnesium) levels were generally higher than the barley. Starch and fat levels were typically lower.

Cereal/pulse mixes, spring/cereal mixes or alternative annual crops may have a role in specific grazing systems. When a higher nutritional level (protein and micro-nutrients) is desired, they will be a good choice. Millet and sorghum sudan grass also exhibit more drought tolerance than some of the cereal or cereal mixes. When moisture is adequate, the winter cereals will provide some fall grazing which can be very valuable. Full benefits were not realized in this trial due to limiting climatic conditions.

Benefits to Industry

Winter feed is typically the highest cost component for annual maintenance of the beef cow herd. Identification of higher yielding, or more nutritious, forage material can cut the annual feed costs and/or improve animal performance. Longer term benefits from improved health of both the cow and her calf, can be realized from feeding a higher quality feed. Healthy animals have better gains, less disease, improved conception and better over-all performance. Knowledge of nutritional values can also be very important with targeted performance goals – eg. improving milk production.

These trials reduce risk by local producers in crop selection, especially with non-traditional crops which tend to have high seed costs. This trial has demonstrated the drought tolerance of the millets and sorghum sudan grass, but also showed the poor performance of the brassicas under low moisture and high heat.

When environmental conditions are favorable, use of spring/winter mixes for forage can achieve both stored feed goals and also extend the grazing season with late season re-growth of the winter cereal component. Extending the grazing season has many benefits to cattle producers, eg. reducing the volume and therefore cost of harvesting feed, reducing manure accumulation around feed yards which is good from an environmental perspective and can also contribute to over-all health of the cattle with the high quality of the vegetative cereals.

Table 2 **Yield and Height of Pulse Mixes 2019 - 2022**

	Yield (lbs/ac)					Heights (cm)			
	2019	**2021**	**2022**	**Avg Yield**	**% Austenson**	**2019**	**2021**	**2022**	**Avg Height**
CDC Austenson	4549	982	3915	3149	100	67	34	n/a	51
CDC Baler	3461	1065	4239	2922	97 (3)	81	53		67
Taza	4673	1012	4361	3349	106 (3)	85	57		71
CDC Austenson	4106	599		2353	76 (2)	64	37		50.5
CDC Meadow						60	24		42
CDC Austenson		893	3624	2259	92 (2)		38		38
DL Delicious							23		23
CDC Baler	3858	852		2355	86 (2)	72	55		63.5
CDC Meadow						65	25		45
CDC Baler		948	4046	2497	100 (2)		53		53
DL Delicious							34		34
Taza	4163	758		2461	85 (2)	72	59		65.5
CDC Meadow						69	20		44.5
Taza		992	3656	2324	97 (1)		62		62
DL Delicious							29		29
CDC Austenson			3579	3579	91 (1)				
Aberdeen									
CDC Austenson	4342			4342	95 (1)	63			63
CDC Jasper						54			54
CDC Austenson		818		818	83 (1)		36		36
CL Lacross							30		30
CDC Austenson			3187	3187	81 (1)				
DL Tesoro									
CDC Austenson		971		971	99 (1)		36		36
Snowbird							6		6
CDC Baler			3213	3213	82 (1)				
Aberdeen									
CDC Baler	3147			3147	69 (1)	72			72
CDC Jasper						61			61
CDC Baler		738		738	75 (1)		53		53
CL Lacross							31		31
CDC Baler			4349	4349	111 (1)				
DL Tesoro									
CDC Baler		950		950	97 (1)		54		54
Snowbird							0		0
Taza			3678	3678	94 (1)				
Aberdeen									
Taza	4030			4030	89 (1)	72			72
CDC Jasper						60			60
Taza		828		828	84 (1)		56		56
CL Lacross							25		25
Taza			3874	3874	99 (1)				
DL Tesoro									
Taza		864		864	88 (1)		61		61
Snowbird							3		3

Table 3 **Pulse Mix Nutritional Qualities**

		Average Feed Values (%)									
		CP	**TDN**	**ADF**	**NDF**	**Ca**	**P**	**K**	**Mg**	**Starch**	**Fat**
CDC Austenson	*Avg*	*9.64*	*63.55*	*36.73*	*52.82*	*0.27*	*0.15*	*1.99*	*0.21*	*4.45*	*2.42*
CDC Baler	*Avg (3)*	*12.02*	*65.37*	*34.32*	*49.54*	*0.41*	*0.19*	*2.28*	*0.27*	*3.96*	*2.49*
	% Check	*124*	*103*	*93*	*94*	*153*	*128*	*115*	*130*	*89*	*103*
Taza	*Avg (3)*	*10.65*	*58.74*	*38.39*	*59.34*	*0.30*	*0.16*	*1.89*	*0.17*	*4.23*	*2.27*
	% Check	*111*	*92*	*105*	*112*	*114*	*109*	*95*	*82*	*95*	*94*
Austenson	*Avg (2)*	*10.33*	*60.35*	*38.25*	*53.87*	*0.57*	*0.16*	*1.85*	*0.29*	*4.55*	*2.69*
CDC Meadow	*% Check*	*107*	*96*	*106*	*100*	*199*	*116*	*95*	*122*	*95*	*146*
Austenson	*Avg (2)*	*12.18*	*61.34*	*38.24*	*52.30*	*0.66*	*0.22*	*1.84*	*0.26*	*2.97*	*1.84*
DL Delicious	*% Check*	*126*	*98*	*107*	*97*	*240*	*160*	*100*	*111*	*64*	*99*
CDC Baler	*Avg (2)*	*12.46*	*61.07*	*37.25*	*51.80*	*0.73*	*0.17*	*2.18*	*0.32*	*3.77*	*2.62*
CDC Meadow	*% Check*	*130*	*97*	*104*	*96*	*258*	*128*	*113*	*134*	*79*	*95*
CDC Baler	*Avg (2)*	*13.79*	*62.44*	*35.88*	*50.95*	*0.55*	*0.23*	*1.78*	*0.28*	*3.12*	*1.75*
DL Delicious	*% Check*	*145*	*100*	*102*	*95*	*197*	*175*	*95*	*119*	*68*	*74*
Taza	*Avg (2)*	*7.48*	*46.20*	*48.89*	*72.36*	*0.28*	*0.07*	*1.56*	*0.12*	*3.49*	*1.46*
CDC Meadow	*% Check*	*96*	*89*	*110*	*115*	*123*	*64*	*83*	*68*	*92*	*91*
Taza	*Avg (2)*	*10.31*	*66.28*	*34.96*	*49.61*	*0.31*	*0.28*	*1.96*	*0.19*	*3.37*	*1.71*
DL Delicious	*% Check*	*101*	*94*	*114*	*106*	*120*	*157*	*92*	*77*	*73*	*68*
Austenson	Avg (1)	15.16	67.43	30.99	46.48	0.33	0.29	2.4	0.22	3.36	1.9
Aberdeen	*% Check*	*158*	*103*	*82*	*92*	*143*	*181*	*114*	*138*	*88*	*98*
Austenson	Avg (1)	11.66	64.81	30.93	50.26	0.45	0.17	2.05	0.26	5.27	3.55
Jasper	*% Check*	*111*	*102*	*95*	*92*	*167*	*106*	*96*	*108*	*99*	*101*
Austenson	Avg (1)	9.12	58.43	42.43	56.39	0.51	0.16	1.40	0.25	3.86	1.74
CL Lacross	*% Check*	*104*	*94*	*107*	*106*	*171*	*139*	*82*	*109*	*92*	*96*
Austenson	Avg (1)	9.49	67.04	35.9	49.83	0.23	0.2	2.08	0.17	4.06	2.03
DL Tesoro	*% Check*	*99*	*103*	*95*	*99*	*100*	*125*	*99*	*106*	*106*	*105*
Austenson	Avg (1)	9.24	62.84	39.39	52.06	0.32	0.16	1.62	0.24	3.94	1.84
Snowbird	*% Check*	*88*	*100*	*101*	*99*	*78*	*103*	*86*	*81*	*106*	*96*
CDC Baler	Avg (1)	11.6	64.17	36.87	50.2	0.31	0.22	2.36	0.2	2.99	1.74
Aberdeen	*% Check*	*121*	*98*	*97*	*99*	*135*	*138*	*112*	*125*	*78*	*90*
CDC Baler	Avg (1)	15.11	64.53	31.29	48.19	0.68	0.21	2.8	0.34	4.25	3.36
CDC Jasper	*% Check*	*144*	*102*	*96*	*88*	*252*	*131*	*131*	*142*	*80*	*95*
CDC Baler	Avg (1)	12.01	60.82	39.13	52.97	0.54	0.19	1.58	0.28	3.09	1.78
CL Lacross	*% Check*	*137*	*98*	*99*	*100*	*181*	*161*	*92*	*124*	*74*	*98*
CDC Baler	Avg (1)	13.08	67.87	34.19	46.08	0.27	0.29	3.29	0.22	3.09	2.11
DL Tesoro	*% Check*	*136*	*104*	*90*	*91*	*117*	*181*	*156*	*138*	*81*	*109*
CDC Baler	Avg (1)	11.41	62.95	37.83	50.82	0.39	0.18	1.81	0.28	3.43	1.80
Snowbird	*% Check*	*130*	*102*	*96*	*95*	*131*	*152*	*106*	*124*	*82*	*99*
Taza	Avg (1)	10.35	63.44	37.7	52.78	0.22	0.25	2.01	0.16	3.14	1.62
Aberdeen	*% Check*	*108*	*97*	*99*	*104*	*96*	*156*	*95*	*100*	*82*	*84*
Taza	Avg (1)	11.54	61.46	35.23	55.9	0.48	0.18	2.01	0.21	4.99	3.36
CDC Jasper	*% Check*	*110*	*97*	*108*	*102*	*178*	*113*	*94*	*88*	*93*	*95*
Taza	Avg (1)	8.43	48.74	46.42	66.91	0.31	0.14	1.67	0.14	3.45	1.41
CL Lacross	*% Check*	*96*	*79*	*117*	*126*	*105*	*117*	*97*	*60*	*83*	*78*
Taza	Avg (1)	12.72	66.72	35.53	47.12	0.33	0.29	3.02	0.22	3.09	2.04
DL Tesoro	*% Check*	*133*	*102*	*94*	*93*	*143*	*181*	*143*	*138*	*81*	*106*
Snowbird	Avg (1)	7.13	48.71	47.71	68.7	0.24	0.08	1.61	0.11	3.72	1.46
Fababean	*% Check*	*74*	*77*	*130*	*130*	*91*	*55*	*81*	*52*	*84*	*60*

Table 4 **Spring and Winter Cereal Mix Yield and Heights**

	Yield (lbs/ac)						**Height (cm)**					
Crop	**2020**	**2021 Madge**	**2021 Jkuhn**	**2022**	**Avg**	**% Aust**	**2020**	**2021 Madge**	**2021 Jkuhn**	**2022**	**Avg Ht**	**% Aust**
CDC Austenson Barley	6904	2571	829	3271	3394	100 (4)	77	70	32	32	53	
CDC Baler Oats	6921	2741	1070	3431	3541	110 (4)	81	72	44	44	60	113
Taza Triticale	4545	1157	966	4248	2729	90 (4)	92	75	52		73	137
Bobcat Triticale		602			602	23 (1)		32	12		22	42
Metzger Triticale		373			373	15 (1)		32	10		21	40
Austenson AAC Wildfire	7362	1105	438	2262	2792	68 (4)	34 78	34 61	9 30	9 30	22 50	42 94
Austenson Bobcat	5077	1199	364	2608	2312	61 (4)	15 81	36 57	11 29	11 29	18 49	34 93
Austenson Luoma		1080	340		710	42 (2)		32 61	12 29		22 45	42 85
Austenson Metzger		1305	466		886	54 (2)		38 62	11 29		25 46	47 87
Austenson Prima	5802	1577	413	2847	2660	71 (4)	70 85	35 64	12 30		39 60	74 113
Baler AAC Wildfire	5609	2023	502	3387	2880	81 (4)	35 59	35 71	14 41	14 41	25 53	47 100
Baler Bobcat	4331	2406	419	1890	2262	67 (4)	0 77	24 73	9 40	9 40	11 58	21 109
CDC Baler Oats Luoma		1763	441		1102	61 (2)		36 67	12 43		24 55	45 104
Baler Metzger		1893	432		1163	63 (2)		30 62	12 40		21 51	40 96
Baler Prima	4594	3060	389	3040	2771	82 (4)	77 66	34 64	12 42		41 57	77 108
Taza AAC Wildfire	5291	897	545	3847	2645	74 (4)	20 68	37 66	12 51	12 51	20 59	38 111
Taza Bobcat	3567	974	407	3193	2035	59 (4)	42 61	33 67	12 52	12 52	25 58	47 109
Taza Luoma		677	565		621	47 (2)		32 68	12 51		22 60	42 113
Taza Metzger		714	386		550	38 (20		30 71	11 49		21 60	40 113
Taza Prima	4032	708	535	3191	2117	62 (4)	38 84	38 70	12 49		29 68	55 128

Table 5 **Spring and Winter Cereal Mixes Nutritional Values**

		Average Feed Values (%)									
Crop	**Year**	**CP**	**TDN**	**ADF**	**NDF**	**Ca**	**P**	**K**	**Mg**	**Starch**	**Fat**
CDC Austenson	***Avg (4 yr)***	***10.06***	***59.02***	***40.84***	***57.04***	***0.34***	***0.15***	***1.97***	***0.19***	***4.11***	***1.74***
CDC Baler	*Avg (4)*	*11.12*	*60.25*	*40.44*	*54.86*	*0.40*	*0.15*	*2.17*	*0.24*	*4.58*	*1.66*
	% Check	*121*	*104*	*98*	*94*	*124*	*107*	*115*	*129*	*101*	*96*
Taza	*Avg (4)*	*9.03*	*55.97*	*42.25*	*60.83*	*0.27*	*0.17*	*1.72*	*0.15*	*3.47*	*1.55*
Triticale	*% Check*	*95*	*95*	*104*	*107*	*81*	*119*	*83*	*80*	*45*	*90*
Bobcat	*Avg (2)*	*17.10*	*63.51*	*35.53*	*49.10*	*0.31*	*0.30*	*2.93*	*0.19*	*1.64*	*1.81*
W. Triticale	*% Check*	*201*	*114*	*79*	*78*	*124*	*333*	*136*	*136*	*44*	*105*
Metzger	2021 (1)	22.97	67.23	30.11	41.62	0.32	0.26	3.19	0.25	0.52	1.67
W. Triticale	*% Check*	*270*	*121*	*67*	*66*	*128*	*289*	*148*	*179*	*14*	*97*
Austenson	*Avg (4)*	*10.37*	*62.24*	*39.11*	*54.05*	*0.29*	*0.16*	*2.05*	*0.20*	*4.80*	*1.90*
Wildfire	*% Check*	*131*	*102*	*112*	*87*	*89*	*108*	*104*	*105*	*114*	*151*
Austenson	*Avg (4)*	*11.76*	*62.95*	*37.28*	*53.03*	*0.32*	*0.17*	*2.15*	*0.21*	*4.49*	*1.89*
Bobcat	*% Check*	*130*	*92*	*92*	*94*	*96*	*125*	*108*	*110*	*107*	*109*
Austenson	*Avg (2)*	*12.19*	*61.20*	*37.92*	*52.92*	*0.30*	*0.17*	*2.23*	*0.18*	*3.36*	*1.83*
Luoma	*% Check*	*140*	*109*	*88*	*89*	*106*	*167*	*138*	*112*	*86*	*106*
Austenson	*Avg (2)*	*11.99*	*60.78*	*38.15*	*53.93*	*0.31*	*0.14*	*2.12*	*0.18*	*3.44*	*1.86*
Metzger	*% Check*	*137*	*108*	*81*	*91*	*107*	*143*	*109*	*107*	*87*	*107*
Austenson	*Avg (4)*	*10.34*	*61.86*	*39.21*	*54.62*	*0.30*	*0.15*	*2.18*	*0.20*	*4.16*	*1.89*
Prima Rye	*% Check*	*111*	*105*	*98*	*97*	*92*	*119*	*110*	*105*	*101*	*109*
CDC Baler	*Avg (4)*	*11.80*	*62.79*	*38.71*	*52.34*	*0.36*	*0.19*	*2.56*	*0.23*	*4.46*	*1.85*
AAC Wildfire	*% Check*	*124*	*107*	*95*	*92*	*110*	*144*	*134*	*122*	*104*	*107*
CDC Baler	*Avg (4)*	*11.49*	*61.96*	*38.72*	*52.99*	*0.36*	*0.19*	*2.30*	*0.23*	*4.57*	*1.73*
Bobcat	*% Check*	*123*	*105*	*97*	*94*	*110*	*150*	*117*	*122*	*105*	*99*
CDC Baler	Avg (2)	12.26	61.46	37.79	51.68	0.39	0.16	1.79	0.24	2.88	1.65
Luoma	*% Check*	*139*	*110*	*87*	*87*	*136*	*156*	*95*	*146*	*73*	*95*
CDC Baler	Avg (2)	12.33	61.00	38.60	52.33	0.38	0.17	1.69	0.26	2.64	1.58
Metzger	*% Check*	*140*	*108*	*89*	*88*	*132*	*167*	*91*	*156*	*67*	*91*
CDC Baler	Avg (4)	11.81	63.14	37.96	51.85	0.39	0.19	2.19	0.25	4.49	1.81
Prima	*% Check*	*126*	*107*	*94*	*89*	*126*	*148*	*111*	*134*	*105*	*104*
Taza	Avg (4)	12.22	61.02	38.67	53.79	0.26	0.20	2.27	0.17	3.01	1.74
AAC Wildfire	*% Check*	*132*	*103*	*96*	*95*	*81*	*157*	*114*	*92*	*73*	*100*
Taza	Avg (4)	10.17	58.55	40.62	57.47	0.25	0.18	1.89	0.15	3.25	1.57
Bobcat	*% Check*	*108*	*100*	*101*	*102*	*78*	*138*	*96*	*78*	*85*	*91*
Taza	Avg (2)	11.62	55.02	41.50	59.50	0.31	0.15	1.76	0.18	2.70	1.44
Luoma	*% Check*	*134*	*98*	*95*	*100*	*112*	*151*	*93*	*112*	*68*	*83*
Taza	Avg (2)	11.82	56.33	40.43	58.36	0.29	0.17	1.88	0.15	2.74	1.47
Metzger	*% Check*	*136*	*100*	*94*	*98*	*114*	*173*	*98*	*91*	*69*	*85*
Taza	Avg (4)	12.10	58.97	39.08	56.40	0.31	0.18	2.08	0.18	3.07	1.64
Prima	*% Check*	*127*	*100*	*97*	*100*	*96*	*159*	*105*	*100*	*83*	*95*

Table 6 **Alternative Annual Forage Yield and Height**

Crops	Yield (lb/A) 2018	2019	2020	2021	2022	Avg Yield	% Jap Millet	Height 2020	2021	Avg	% Jap Millet
Japanese Millet	1234	2230	1644	3766	464	1868	100 (5)	51	67	59	100 (2)
Sorghum Sudan Grass	1164	2159	748	3697	727	1699	98 (5)	74	125	100	166 (2)
Phacelia	1124	1442	1062	1330	134	1018	57 (5)	54	54	54	94 (2)
Radish	1101	1428	140	0	116	557	47 (4)	0	0	0	
Forage Brassica	370		41	61		157	11 (3)	0	14	7	2 (1)
Plantain	0	590	391	339	0	264	20 (3)	34	30	32	56 (2)
Chicory	0	876	435	174	0	297	23 (3)	24	20	22	39 (2)
Red Siberian Millet	3143		1830			2487	183 (2)	50		50	98 (2)
Proso (crown) Millet	2482	2750				2616	162 (2)				
Forage Turnip	0		33	30	0	16	2 (2)	0	11	6	16 (1)
Forage Kale			169	238		204	8 (2)	36	35	36	62 (2)
Golden German Millet		2614				2614	117 (1)				
Pearl Millet		1633				1633	73 (1)				
Malwira Turnip		269				269	12 (1)				
Hercules Turnip		409				409	18 (1)				
Double Max Radish				225		225	6 (1)		0	0	

Table 7 **Alternate Annual Forage Nutritional Values**

		Average Feed Values (%)									
Crop	**Year**	**CP**	**TDN**	**ADF**	**NDF**	**Ca**	**P**	**K**	**Mg**	**Starch**	**Fat**
Japanese Millet	*Avg (5 yr)*	*8.64*	*62.16*	*34.16*	*57.54*	*0.47*	*0.13*	*1.93*	*0.36*	*3.95*	*2.11*
Sorghum Sudangrass	*Avg (5)*	*8.88*	*61.98*	*34.59*	*59.06*	*0.45*	*0.13*	*2.15*	*0.28*	*3.41*	*2.10*
	% Check	*105*	*99*	*101*	*103*	*112*	*90*	*123*	*85*	*86*	*97*
Phacelia	*Avg (5)*	*11.59*	*56.75*	*42.40*	*49.00*	*2.97*	*0.21*	*2.41*	*1.21*	*2.76*	*1.82*
	% Check	*136*	*91*	*124*	*86*	*673*	*261*	*123*	*357*	*66*	*83*
Radish	*Avg (4)*	*12.01*	*56.56*	*45.63*	*51.70*	*1.11*	*0.22*	*2.42*	*0.51*	*3.51*	*1.47*
	% Check	*144*	*91*	*134*	*88*	*252*	*152*	*121*	*145*	*88*	*74*
Forage Brassica	*Avg (3)*	*12.86*	*58.56*	*43.91*	*53.58*	*1.39*	*0.17*	*2.04*	*0.58*	*2.82*	*1.40*
	% Check	*145*	*96*	*123*	*94*	*357*	*138*	*115*	*173*	*93*	*76*
Plantain	*Avg (3)*	*12.86*	*59.60*	*43.73*	*53.64*	*1.24*	*0.15*	*1.73*	*0.48*	*3.07*	*2.40*
	% Check	*132*	*99*	*127*	*94*	*406*	*138*	*126*	*182*	*63*	*87*
Chicory	*Avg (3)*	*17.81*	*61.34*	*44.45*	*50.99*	*1.38*	*0.14*	*3.02*	*0.50*	*2.22*	*2.23*
	% Check	*180*	*99*	*128*	*89*	*451*	*127*	*221*	*178*	*46*	*76*
Red Siberian Millet	*Avg (2)*	*7.16*	*59.05*	*38.32*	*57.24*	*0.37*	*0.16*	*3.01*	*0.36*	*4.28*	*1.84*
	% Check	*146*	*98*	*105*	*97*	*197*	*143*	*212*	*115*	*85*	*100*
Proso (crown) Millet	*Avg (2)*	*8.215*	*62.84*	*33.45*	*56.39*	*0.34*	*0.17*	*1.79*	*0.31*	*4.39*	*2.79*
	% Check	*141*	*100*	*102*	*104*	*59*	*99*	*98*	*83*	*106*	*102*
Forage Turnip	*Avg (2)*	*8.22*	*51.69*	*47.84*	*63.34*	*0.82*	*0.12*	*1.33*	*0.35*	*2.87*	*1.04*
	% Check	*100*	*91*	*136*	*107*	*265*	*110*	*71*	*112*	*89*	*76*
Forage Kale	*Avg (2)*	*14.76*	*54.64*	*49.64*	*58.11*	*1.47*	*0.19*	*1.85*	*0.63*	*1.58*	*1.05*
	% Check	*185*	*90*	*139*	*100*	*515*	*206*	*122*	*235*	*49*	*60*
Golden German Millet	*Avg (1)*	*7.8*	*62.48*	*33.92*	*58.07*	*0.30*	*0.15*	*2.61*	*0.22*	*5.69*	*3.82*
	% Check	*102*	*97*	*108*	*106*	*81*	*107*	*218*	*81*	*99*	*106*
Pearl Millet	*Avg (1)*	*7.8*	*62.48*	*33.92*	*58.07*	*0.30*	*0.15*	*2.61*	*0.22*	*5.69*	*3.82*
	% Check	*146*	*98*	*105*	*97*	*197*	*143*	*212*	*115*	*85*	*100*
Malwira Turnip	*Avg (1)*	*10.34*	*69.68*	*24.67*	*28.79*	*0.92*	*0.21*	*1.71*	*0.40*	*5.79*	*3.23*
	% Check	*135*	*108*	*78*	*53*	*249*	*150*	*143*	*148*	*101*	*89*
Hercules Turnip	*Avg (1)*	*11.35*	*70.07*	*24.17*	*23.99*	*1.28*	*0.20*	*1.71*	*0.44*	*5.72*	*3.35*
	% Check	*148*	*109*	*77*	*44*	*346*	*143*	*143*	*163*	*99*	*93*
Double Max Radish	*Avg (1)*	*14.99*	*49.54*	*50.53*	*59.43*	*1.51*	*0.21*	*2.17*	*0.86*		
	% Check	*173*	*81*	*143*	*112*	*521*	*233*	*176*	*287*		