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Crop Rotation Benefits of Annual Forages Preceding Spring Cereals

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Progress Report

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2020 Progress Report

Abstract

In the spring of 2020 a trial was established titled, "Crop Rotation Benefits of Annual Forages preceding Spring Cereals." This project consisted of a 4-replicate RCBD demonstration with 7 different treatments made up of a barley monoculture, and 6 multispecies mixes. In the second year of the trial, spring wheat will be seeded into the existing plots to complete the rotation. This demonstration is designed to provide producers an opportunity to see how these polyculture crops establish in their own region compared to the barley check and improve soil rotational health benefits for a monoculture in the following year. Potential yields and forage quality were closely related to environmental growing conditions at each location, as the trial took place at Swift Current, Melfort and Outlook and 2021 will determine if specific mixtures are better suited to aiding spring wheat the following year. This trial was brought to the attention of multiple small group tours throughout 2020 and was also promoted on a CKSW radio program titled, "Walk the Plots" which is broadcasted on a weekly basis throughout the summer. Year one preliminary results were presented by Amber Wall at a Saskatchewan Ministry of Agriculture Planning Meeting on September 22, 2020 in Humboldt, SK.

Project Objectives

This demonstration is designed to provide producers an opportunity to see how these crops establish in their own region and to introduce options for improving soil health by adding annual forages into their rotation, specifically preceding a cereal year.

Project Rationale

This project is based on work demonstrated at AAFC in Swift Current, by Dr. Jillian Bainard[1]. Most recently, research has addressed environmental stability by exploring ways to reduce herbicide and fertilizer inputs, improve forage and feed grains by assessing the nutritive value of these mixtures and determining the economic and agronomic impact of incorporating annual forage mixtures into a cropping system. Results from past and ongoing projects have found that creating polyculture mixtures (more than one species) with annual crops can result in high quality forage, increased biomass production, enhanced weed suppression, greater microbial activity and diversity, and increased soil nutrients.[2][3]

Nitrogen is commonly provided through chemical fertilizer, or by the introduction of nitrogen fixing plants, such as legumes. Although legume species were shown to vary in the amount of N they can fix, they can have a significant impact on the amount of N fertilizer needed to reach maximum crop productivity. At AAFC, Dr. Jillian Bainard is looking at mixtures where the addition of these legumes in grass-legume mixtures can improve forage quality in terms of protein content and digestibility. Multiple studies have found that as the proportion of legumes in a mixture increases, so does the forage yield and quality, and the yield of subsequent cereal crops.[4]

The inclusion of brassica species will also impact nutrient cycling as they have the potential to take up excess nitrates in the soil and store them in plant tissues. The breakdown of these tissues over time can replenish soil N levels and increase the efficiency of N cycling. Brassica species are being tested as forage crops as they provide a source of high-quality feed, as well as show considerable weed control through competition. Although forage brassicas do come with a risk, as N fertility is important to maximize forage brassica production, the timing and rate of fertilizer application can lead to levels of nitrates and sulfates in the plants, high enough to be toxic to animals.

Many producers are looking to improve soil rotational health and effects in order to create environmental stability that allows for a reduction in herbicides and fertilizers, higher quality forages, and provides multiple benefits for a monoculture in the following year. Benefits to improving soil health includes the integration of larger, and more stable aggregates occurring in soils after annual forage polycultures are grown, indicating increased microbial activity and overall soil quality compared to single seeded monoculture **(Control)**, such as barley or oats.

Although mixtures are not likely to maintain fertility over multiple years without additional inputs, legume species such as Persian Clover, Hairy Vetch, and Forage Pea **(Nitrogen- Fixing Mix)** may

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[1] Schellenberg, M.P., Bainard, J., Ren, L., Lamb, E. August 2017. Determination of appropriate species for diverse annual plantings based on their contribution to forage yield and soil improvement

[2] AAFC Swift Current, Dr. Jillian Bainard; Ongoing SK Cattlemen's Association Project – Development of best management practices for residue and fertility management of annual polycultures

[3] AAFC Swift Current, Dr. Jillian Bainard; Ongoing BCRC Project - Assessing the impact of grazing annual forage cover crops in an integrated crop-livestock system

[4] Lithourgidis, A. & Dordas, Christos & Damalas, Christos & Vlachostergios, D. (2011). Annual intercrops: An alternative pathway for sustainable agriculture. Australian Journal of Crop Science. 5. 396-410.

allow for a low input fertilizer application to be applied in both crop years due to the N fixation occurring in the soil.

Weed suppression in a cereal crop after incorporating forages into a rotation has shown to be significantly higher**.** Mixtures with higher amounts of root crops/brassica species such as Groundhog Radish, Tillage Radish and Winfred Radish, **(Weed Control Mix)** may account for some weed control, with the possibility of reducing herbicide applications in the following cereal year. Care must be taken to create a mix in which the proportion of brassica species to cereals and legumes is not too high, as brassicas are shown to contain nitrates and sulfates that can be toxic to animals at high enough levels.

Polyculture mixes are shown to create higher quality forages compared to a single monocrop. It is important to pick mixes that provide high crude protein, low non-digestible fibre (NDF) with high digestibility. As many producers are creating their own mix, they may prefer to produce something simple that will still accomplish a range of tasks, therefore includes a balance of legumes, cereals, and brassicas **(Balanced Mix)**. Another option is a balanced mix with an additional cereal species to increase biomass **(Simple Balanced Mix).** Others may be willing, or have the means to produce a more complicated polyculture that includes more species. The more species included, the higher the likelihood to improving biomass yield and increasing the nutritional value of the forage **(Complex Balanced Mix).**

Having a cover crop that can accomplish a range of tasks, including weed control, improved forage nutrition and biomass, as well as nitrogen fixation for the following years crop will result in a number of benefits for overall soil rotational health and effects **(Complex Soil Amendment Mix).** As for a cereal monoculture in the following year, grain yield increases are shown when annual forages precede cereal crops in a rotation, especially when mixtures that include N- fixing legumes are included allowing a low input fertility system.

Methods

- Locations: Swift Current (WCA), Outlook (ICDC) and Melfort (NARF).
- No-till, continuous cropping system, harvested for forage biomass.
- Previous crop, seed and harvest dates varied by location (Table 1).
- All plots received a base fertility of side-banded 45 lbs. N per acre.
- A pre-seed herbicide to ensure a clean seed bed.
- 7 treatments including a cereal monoculture (control), and 6 polyculture mixes seeded with 4 replications (Table 2).
- Treatments were seeded at the same target plant stand at each location. Advantage barley was seeded as the control at 100 lbs/ac. Polyculture seeding rates were calculated so that

the sum of the proportional rates exceeded one hundred percent, while also taking seed size and growth pattern into consideration.[5]

- Plant species selected are adapted to grow in the agricultural region with 3-4 species being from each of the legumes (nitrogen fixing), cereals, and brassicas (root crops). These functional groups represent variation in plant traits and growth form, and consequently vary in their contribution to the agroecosystem and to forage quality.
- The following spring (2021) one spring wheat variety will be seeded into each plot using low amounts of fertility, consistent across treatments, also utilizing the residual N fixed in the previous year. All fertilizer will be side-banded and spring wheat will be harvested for grain yield.
- In-crop herbicides applied in second year after a weed control rating is done.
- Each site was statistically analyzed individually using JMP and $p<0.05$.

Table 1. Other agronomic information

	Swift Current	**Melfort**	**Outlook**
Previous Crop	Durum	Canola	Canola
Seeding date	May 15, 2020	May 23, 2020	May 28, 2020
Harvest Date	August 5, 2020	August 6, 2020	August 13, 2020

Table 2. Treatment List

Year One (2020) L=Legume, C=Cereal, B=Brassica									Year Two (2021)
TRT #	# of species	Proportion	Purpose of treatment	Species	lb/ac in mix				Species
1	Monoculture	1C	Control	C: Advantage Barley	100				Spring Wheat
2	3 species	1L:1C:1B	Balanced Mix	L: Persian Clover	5				Spring Wheat
				C: Advantage Barley	30				
				B: Groundhog Radish	4				
3	3 species	3L	N-Fixing Mix	L: Persian Clover, Hairy Vetch, Forage Pea (Leroy)	4	6	70		Spring Wheat
4	4 species	1L:2C:1B	Simple Balanced Mix	L: Persian Clover	4				Spring Wheat
				C: Advantage Barley, Haymaker Oats	30	26			
				B: Groundhog Radish	2				
5	6 species	1L:2C:3B	Weed Control Mix	L: Persian Clover	1.5				Spring Wheat
				C: Advantage Barley, Haymaker Oats	30	26			
				B: Groundhog Radish, Tillage Radish, Winfred Radish	1	1.2	1		
6	6 species	2L:2C:2B	Complex Balanced Mix	L: Persian Clover, Hairy Vetch	3	2			Spring Wheat
				C: Advantage Barley, Haymaker Oat	26	30			
				B: Groundhog Radish, Winfred Radish	1	0.5			
7	8 species	2L:4C:2B	Complex Soil Amendment Mix	L: Persian Clover, Hairy Vetch	1.5	2			Spring Wheat
				C: Advantage, Haymaker Oat, Corn, Millet	17	20	3	3	
				B: Groundhog Radish, Winfred Radish	1.5	0.8			

Data Collection:

Year 1 (2020)

- Soil Sample to determine stored soil nutrients (0- 6”, 6-24”)
- Crop Establishment – using the line intercept method
- Visual Weed Control Rating (1=no control, 5=control)
- Forage Biomass Yield

[5] http://northeastcovercrops.com/wp-content/uploads/2018/03/NH-340-Cover-Crop-Planting-Specification-Guide-2.pdf

- Feed Analysis (Central Testing Laboratories)

Year 2 (2021)

- Residual soil nutrients & qualities – composite soil sample bulked by treatment (0- 6", 6-24") submitted to Agvise to see the accumulative effect of each mixture.
- Spring Wheat Emergence – 2 x 1m rows
- Visual Weed Control Ratings – 1. Prior to in-crop application and 2. Prior to harvest.
- Plant Height – record average height at front and back of plot
- Grain Yield – Corrected for dockage and to 14.5% seed moisture content

General Site Conditions

Table 3. Mean monthly temperatures and precipitation amounts for the 2020 growing season at each location.

Location	Year	May	June	July	August	Avg. / Total
		------------------------------Mean Temperature (°C) --------------------				
Swift Current	2020	10.9	16.6	18.2	19.5	16.3
	Long-term	**10.9**	**15.3**	**18.2**	**17.6**	**15.5**
Outlook	2020	11.3	15.9	19.1	18.8	16.3
	Long-term	**11.5**	**16.1**	**18.9**	**18**	**16.1**
Melfort	2020	10.1	14.3	18.8	17.6	15.2
	Long-term	**10.7**	**15.9**	**17.5**	**16.8**	**15.2**
		-------------------------------- Precipitation (mm) ---------------------				
Swift Current	2020	36.3	80	62.5	6.5	185.3
	Long-term	**51.2**	**77.1**	**60.1**	**47.4**	**235.8**
Outlook	2020	27.8	79.2	29.6	19.0	155.6
	Long-term	**42.6**	**63.9**	**56.1**	**42.8**	**205.4**
Melfort	2020	26.7	103.7	52.4	18.5	201.3
	Long-term	**42.9**	**54.3**	**76.7**	**52.4**	**226.3**

Results and Discussion

Monoculture

In year one, polycultures were compared to a single seeded monoculture (control), Advantage barley. As expected, the more common barley monocrop had the best establishment compared to polyculture mixtures, although was not significantly different than mixtures at Outlook (Specific values listed in Tables 4-6). At Swift Current and Melfort the barley monoculture resulted in the greatest weed control, likely due to weeds being having stronger competition in the monoculture compared to other treatments. When analyzing forage quality, the monoculture resulted in the lowest Acid Detergent Fiber (ADF, 28-32%) compared to mixtures. According to the Beef Cattle Research Council (BCRC), high quality grasses range from 30-45% and high ADF would indicate poor digestibility of the feed.[6] The monoculture also had acceptable Neutral Detergent Fiber (NDF), below 70%, at all sites (BCRC). Crude protein at Outlook was 6.4% and below required levels, but the monoculture would still meet the nutritional requirements for feed at each location. Requirements are based on a mature cow at early gestation weighing approximately 1100 lbs. and are determined using the National Research Council's Nutrient Requirements for Beef Cattle, & Alberta Agriculture and Forestry calculator (BCRC). Compared to other treatments, barley resulted in the lowest potassium levels ranging from 1.3-1.9%. Calcium levels were low (0.19-0.30%) and magnesium was adequate, but remained above 0.12% (.15-.17%), therefore would still avoid winter tetany. High potassium, lowered calcium and lowered magnesium can all cause the tetany ratio to increase and predispose animals to winter tetany leading to disease and death among cattle.[7] Barley resulted in the highest Total Digestible Nutrients (TDN) ranging from 64-69%. TDN values below 50% are generally associated with higher fibre and therefore reduce animal intake.[8] Relative feed value (RFV) estimates intake potential and digestibility and values below 80 typically do not meet animal requirements for energy (BCRC). In this trial, the barley monoculture ranged from 115-138 and had the highest value at each location compared to other treatments.

Nitrogen Fixing Mix

Legume species included in this project consist of Persian clover, Hairy vetch, and a forage pea (Nitrogen-Fixing Mix) and may allow for a low input fertilizer application in both crop years because of the N-fixation occurring in the soil. When averaged over all site's establishment of the N-fixing mix was 68.5%. Weed control was significantly different at each site, having the least control at Swift Current and Melfort. Greater weed control at Outlook may be due to the strong crop establishment for all treatments. The N-fixing mix statistically had the highest moisture at harvest, opposite the monoculture for all locations, likely as a result of greater leaf biomass in the legumes compared to stem biomass of the monoculture. The N-fixing mix resulted in levels indicative of poor digestibility, therefore less consumption, as between the 3 locations ADF ranged from 36-38% compared to an acceptable range of 20-35% for legume mixes (BCRC). The N-fixing mix had the significantly highest percentages of crude protein ranging from 14.5-19.3% and had a 39% increase over the next treatment (Complex Soil Amendment Mix). All nutrients, (Ca, Mg, P, K) were adequate, therefore would avoid winter tetany. The N-fixing mix resulted in the lowest NDF, or amount of fibre content in the plant and would not restrict uptake and TDN was above 55% (58-60%) for the N-fixing mix at each location. RFV ranged from 108-112.

Balanced Mix

The balanced mixes included are to determine if the addition of legumes can improve the forage quality of a grass-legume mixture in terms of protein content and digestibility. Multiple studies have found that as the proportion of legumes in a mixture increases, so does the forage yield and quality, and the yield of subsequent cereal crops. Polyculture mixes are to provide high crude protein, low non-digestible fibre (NDF) with high digestibility. Over all sites, establishment for the

[6] https://www.beefresearch.ca/research/feed-value-estimator.cfm
[7] https://www.gov.mb.ca/agriculture/livestock/beef/down-cows-winter-tetany-milk-fever-pregnancy-toxaemia.html
[8] http://peaceforage.bc.ca/forage_facts_pdfs/FF_20_Understanding_Feed_Tests.pdf

Balanced mix (3-species mix) averaged 78%, similar to the 79% and 80% establishment for the Simple Balanced mix and Complex Balanced Mix, respectively. In terms of the 3-species mix at all locations ADF ranged from 34-37%, within the acceptable levels for a grass mix. NDF was below 70% and ranged from 51-53% at Outlook and Melfort, respectively and was slightly higher at Swift Current (55%). This may have been the result of a more mature forage at Swift Current, which can be assumed from the low moisture percentage at harvest compared to other sites (Table 4-6). Crude protein in the Balanced mix was low at Outlook (7.0%) and ranged from 8.0-8.5% at Swift Current and Melfort, but all were significantly higher than the monoculture control at each location. Although most nutrient values resulting from the Balanced mix were acceptable, Calcium was low at Swift Current (0.2%), therefore could be prone to tetany at that location. TDN ranged from 59-62%, above the minimum requirement of 55%. RFV ranged from 106-124.

Simple Balanced Mix

While the 3-species mix may be sufficient, others may be willing, or have the means to produce a more complicated polyculture that includes more species. This Simple Balanced mix is similar to the Balanced mix, but includes an additional cereal species meant to increase biomass. As a result of the additional cereal, ADF increased by 2% (35-39%) and NDF increased by 5% (55-60%) decreasing the digestibility of the feed. Crude protein was significantly reduced at Melfort and Outlook by 0.6% and 1.2%, respectively and was not significantly different at Swift Current. Magnesium was adequate at all locations, but Calcium was low at Swift Current and Outlook. The resulting tetany ratio was high at Swift Current, therefore prone to tetany. However, the additional cereal did significantly increase biomass yield from 8479 kg/ha to 9019 kg/ha (6.4%) at Swift Current, 4977 kg/ha to 6222 kg/ha (25%) at Melfort and 5646 kg/ha to 8207 kg/ha (45.4%) at Outlook. RFV ranged from 95 to 112.

Complex Balanced Mix

The more species included, the higher the productivity to improving biomass yield and increasing the nutritional value of the forage. The Complex Balanced Mix still includes a balance of legumes, cereals, and brassicas, but with twice the amount of species as the 3-species Balanced Mix. The ADF ranged widened 34-39% and NDF values increased, but still remain well below 70%. Crude protein was not significantly different than the Balanced mix at any location, but was significantly higher than the Simple Balanced at Melfort and Outlook and adequate for feed requirements at all locations. Magnesium was adequate at all locations and Calcium was low at Swift Current and Outlook. The resulting tetany ratio was high at Swift Current, therefore prone to causing winter tetany. TDN remained above 55% at all locations. RFV ranged from 89-106.

Weed Control Mix

A mixture with higher amounts of root crops/brassica species such as Groundhog Radish, Tillage Radish and Winfred Radish are all included in a Weed Control mix and may increase weed suppression. In year one, a visual weed rating was not statistically significant. However, there was a tendency for the monoculture barley crop to have the highest weed control, likely due to strong establishment, with the exception of Outlook where the N-fixing treatment resulted in the best weed control. ADF of the weed control mixture ranged from 35-37% and NDF (54-58%) was below 70%, but on the high end compared to other treatments, likely due to difficulties for cattle to digest a high number of Brassicas. Crude protein at Outlook was low (6.5%) and below the required level. This 6-species mix did not amount to a statistical difference in weed control in the first year, but may make a difference in the second, possibly allowing herbicide applications to be reduced. The Swift Current weed control mix had low levels of Magnesium and Calcium and the resulting tetany ratio was high. TDN ranged from 59 -62%, above the minimum requirement. RFV ranged from 92-110.

Complex Soil Amendment Mix

Lastly, the Complex Soil Amendment Mix was established to accomplish a range of tasks, including weed control, high quality forage, biomass and nitrogen fixation for the following crop and ultimately provide a number of benefits to improving overall soil rotational health and effects. The complex soil amendment mix did not establish well at Melfort. However, this did not compromise weed control. Calcium and Magnesium were both inadequate at Swift Current and Melfort and the resulting tetany ratio was high at Swift Current. RFV ranged from 88-104.

Yield

Forage yield greatly varied by location in 2020 (Figure 1). Swift Current resulted in the highest yields, ranging from 8,479 kg/ha to 10,241 kg/ha. The highest yielding treatment at Swift Current was the N-fixing mix followed by the Complex Soil Amendment mix resulting in as much as a 17% increase over the control barley monoculture. At Melfort, yield ranged from 4,977 kg/ha to 6,222 kg/ha. The Simple Balanced mix, which contained the additional cereal, as well as the Weed Control mix out-yielded the monoculture by 3-4%. Lastly, the Complex Balanced mix was the highest yielding at Outlook with 29% increase over the monoculture. Yields at Outlook ranged from 7,214 kg/ha to 9,848 kg/ha.

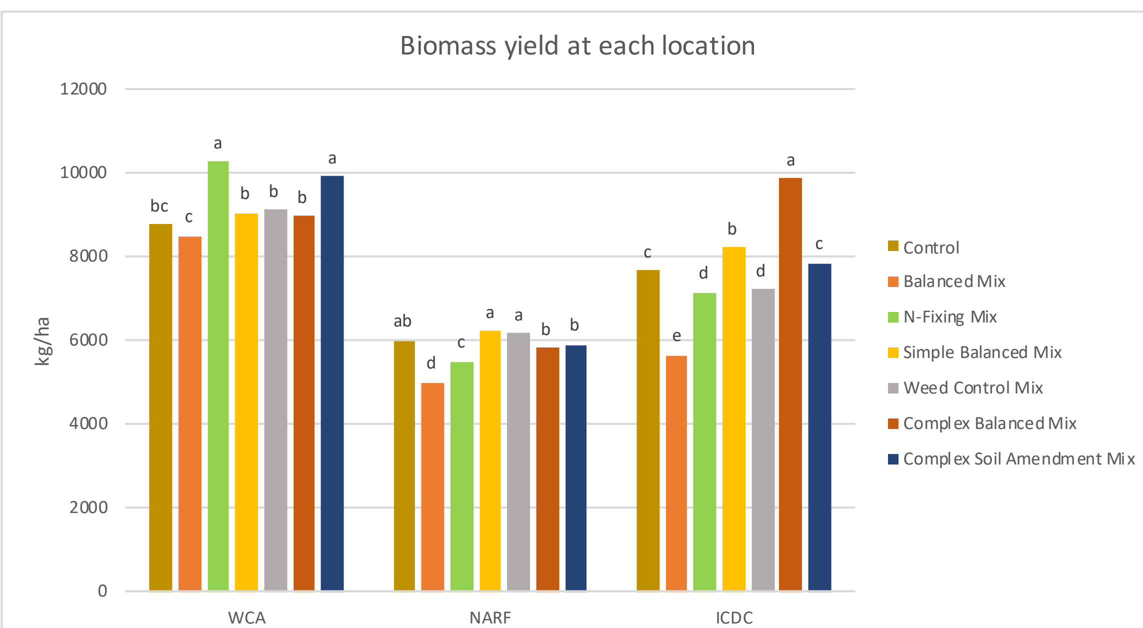

Figure 1. Forage production for the monoculture and each polyculture, grouped by location. Each location is analyzed individually.

This trial was brought to the attention of multiple small group tours throughout 2020 and was also promoted on a CKSW radio program titled, "Walk the Plots" which is broadcasted on a weekly basis throughout the summer. Year one results were also presented by Amber Wall at Saskatchewan Ministry of Agriculture Planning Meeting September 22, 2020 in Humboldt, SK. Results will be also shared locally and a summary can be found on our website at www.wheatlandconservation.ca.

Conclusions and Recommendations

In the first year of this demonstration, producers had an opportunity to see how these crops established in their own region and to introduce options for improving soil health by adding annual forages into their rotation, specifically preceding a cereal year. As expected, the cereal monoculture appeared to have the greatest establishment, but polyculture mixes were successful, ranging in establishment from 69 to 99%. Feed analyses revealed 76% of treatments to be sufficient for cattle requirements, and almost half yielded higher than the monoculture check. Since forage quality is dependent on field conditions and differs year to year according to species, stage of maturity at time of harvesting, weathering, storage conditions, plant disease and many other factors, it is important to test feed annually (BCRC).

As for the spring cereal in the following year, grain yield increases are expected, especially following mixtures where nitrogen fixing legumes are included. However, we can expect low spring wheat yield in the second year to result from the barley monoculture/spring cereal rotation as this treatment did not incorporate a polyculture mixture aimed to improve soil rotational health. Residual nutrients will be determined to evaluate the accumulative effect of each mixture on the soil. There will be a total of two weed control ratings in the second year in order to evaluate whether the weed control mix, or any other treatment had a significant effect on weed suppression in the second year. Spring wheat emergence and height will be measured, as well as the main measurement of grain yield for each location.

Acknowledgements

We thank the Ministry of Agriculture for all ADOPT projects including plot signage and verbal acknowledgement at field days and on PowerPoint slides during presentations. This will continue at each venue where an extension activity occurs. We also thank Shannon Chant with the Saskatchewan Ministry of Agriculture.

Tables 4-6. Individual means for each measurement, as well as feed analysis results from Central Testing Laboratories.

Swift Current (WCA)								
Analysis	**Control**	**Balanced Mix**	**N-Fixing Mix**	**Simple Balanced Mix**	**Weed Control Mix**	**Complex Balanced Mix**	**Complex Soil Amendment Mix**	**CV (%)**
Establishment (%)	98.1	73.8	58.1	92.5	86.9	90.6	85.6	7.6
Visual Weed Control	3.3	1.6	1.0	2.3	2.5	2.8	2.3	27.0
Biomass Yield (kg/ha)	8,739	8,479	10,241	9,019	9,106	8,962	9,889	10.6
Moisture at harvest (%)	49	52	65	54	55	54	58	5.3
Dry Matter (%)	94	94	94	94	94	94	94	0.3
Crude Protein (%)	7.8	8.5	14.5	8.6	8.7	8.4	8.9	7.9
Calcium (%)	0.19	0.20	0.61	0.19	0.17	0.20	0.22	14.1
Phosphorous (%)	0.22	0.23	0.25	0.24	0.24	0.24	0.23	6.9
Magnesium (%)	0.15	0.15	0.25	0.15	0.14	0.17	0.16	6.9
Potassium (%)	1.86	1.99	2.74	2.35	2.26	2.40	2.36	11.5
Sodium (%)	0.14	0.14	0.09	0.21	0.15	0.22	0.19	40.0
Acid Detergent Fibre (%)	32	34	38	35	35	34	37	5.8
Neutral Detergent Fibre (%)	52	55	52	58	55	55	55	4.5
ADI-CP (%)	4.3	3.8	4.1	3.7	3.3	3.6	3.8	10.7
ADIN (% Crude Protein)	55	46	28	44	39	43	42	14.0
Total Digestible Nutrients (%)	64	62	58	61	62	62	59	3.5
Relative Feed Value	115	106	108	98	105	106	102	6.3

Melfort (NARF)								
Analysis	**Control**	**Balanced Mix**	**N-Fixing Mix**	**Simple Balanced Mix**	**Weed Control Mix**	**Complex Balanced Mix**	**Complex Soil Amendment Mix**	**CV (%)**
Establishment (%)	97.5	58.8	47.5	55.5	52.3	44.5	27.3	13.7
Visual Weed Control	4.0	2.5	1.5	3.5	3.8	3.5	3.0	20.0
Biomass Yield (kg/ha)	5,979	4,977	5,492	6,222	6,169	5,805	5,878	9.5
Moisture at harvest (%)	64	73	77	70	69	71	71	2.1
Dry Matter (%)	34	27	19	27	28	26	27	6.7
Crude Protein (%)	7.5	8.3	17.5	7.7	7.6	8.6	8.5	11.0
Calcium (%)	0.30	0.54	1.07	0.35	0.31	0.37	0.33	28.0
Phosphorous (%)	0.26	0.25	0.28	0.26	0.25	0.25	0.26	6.0
Magnesium (%)	0.15	0.19	0.24	0.15	0.14	0.15	0.16	10.0
Potassium (%)	1.32	1.75	2.64	2.11	1.99	2.20	2.16	15.6
Sodium (%)	0.04	0.03	0.03	0.03	0.02	0.02	0.02	50.0
Acid Detergent Fibre (%)	29	36	37	39	37	39	39	4.7
Neutral Detergent Fibre (%)	48	53	46	60	59	62	62	4.5
ADI-CP (%)	4.8	6.1	9.2	4.5	4.6	5.3	4.7	21.6
ADIN (% Crude Protein)	63	72	52	59	61	62	55	18.0
Total Digestible Nutrients (%)	67	60	59	59	57	57	57	3.1
Relative Feed Value	129	121	108	95	92	89	88	5.6

Outlook (ICDC)								
Analysis	**Control**	**Balanced Mix**	**N-Fixing Mix**	**Simple Balanced Mix**	**Weed Control Mix**	**Complex Balanced Mix**	**Complex Soil Amendment Mix**	**CV (%)**
Establishment (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0
Visual Weed Control	1.5	1.0	3.5	1.3	1.0	1.0	1.3	23.4
Biomass Yield (kg/ha)	7,664	5,646	7,135	8,207	7,214	9,848	7,837	9.9
Moisture at harvest (%)	61	78	80	70	73	69	74	3.1
Dry Matter (%)	93	93	93	93	93	93	93	0.5
Crude Protein (%)	6.4	7.0	19.3	5.8	6.5	7.2	7.8	10.4
Calcium (%)	0.24	0.63	1.02	0.23	0.40	0.33	0.50	28.0
Phosphorous (%)	0.22	0.20	0.23	0.20	0.21	0.20	0.20	7.4
Magnesium (%)	0.17	0.29	0.30	0.16	0.22	0.17	0.22	18.5
Potassium (%)	1.39	1.74	2.42	1.72	1.76	1.74	1.99	10.9
Sodium (%)	0.18	0.13	0.12	0.12	0.10	0.10	0.09	30.0
Acid Detergent Fibre (%)	28	37	36	35	36	34	35	8.4
Neutral Detergent Fibre (%)	46	51	46	55	54	53	52	7.0
ADI-CP (%)	3.0	3.2	7.0	2.3	2.7	3.2	3.8	20.1
ADIN (% Crude Protein)	46	47	36	40	42	45	49	18.5
Total Digestible Nutrients (%)	69	62	62	62	60	60	59	5.0
Relative Feed Value	138	124	112	112	110	105	104	10.5