Project Identification

Project Title: Crop Rotation Benefits of Annual Forages Preceding Spring Cereals

Project Number: ADOPT 20190479

Producer Group Sponsoring the Project: Northeast Agriculture Research Foundation

Project Location(s): RM of Star City no. 428 SE 31-44-18 W2

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Objectives and Rationale:

Project Objectives: The demonstration was designed to provide producers an opportunity to see how various annual forage crops establish in their own region, and to introduce options for improving soil health by adding annual forages into crop rotations, specifically preceding a cereal year.

Project Rationale: Current forage and grain crop research has investigated sustainability by finding ways to minimize crop inputs, such as herbicides and fertilizer use, while improving forage and feed grains and determining the agronomic and potential economic impacts of adopting forages into cropping rotations. The results of some current and past research have found that polycultures, or using more than one species of forage with annual crops can provide many benefits, such as enhanced biomass production, enhanced weed control, better soil microbial activity and diversity, increased soil nutrients, and overall higher quality forage. As many producers look to improve soil health and adapt more diverse crop rotations, polycultures may allow for less need for crop inputs and higher quality forage. For instance, legumes are known for their ability to fix nitrogen which allows for greater amounts of nitrogen to be left in the soil. Adding legumes such as persian clover, hairy vetch, and forage pea may allow for lower input fertilizer inputs in both the 1st forage year and the subsequent crop year due to high residual nitrogen. Additionally, using deep rooting crops or brassica species including groundhog radish, tillage radish, and winfred radish may reduce weed pressure when combined with the right ratio of legumes and cereals. This may lead to decreased reliance on herbicides in the following year. Brassicas must be used with caution in forage feed mixes as nitrates and sulfates in brassicas can be toxic to animals when consumed at high enough levels. Finally, cereals are a great option to be used in polycultures to add biomass and provide easily digestible carbohydrates in forage mixtures. This demonstration looks to combine various mixtures of annual forage legumes, cereals, and brassicas to evaluate which mixture resulted in the greatest weed control, biomass and feed quality and the subsequent effects of these annual forage mixtures on a cereal crop in the next growing season.

Methodology and Results

Methodology:

This demonstration was a part of the ADOPT project initiated by the Wheatland Conservation Area with the small plot demonstration located at SE 31-44-18 W2 in the RM of Star City, near Melfort, SK as a secondary site. The trial was arranged as a randomized complete block design with 4 replicates. There were 7 treatments which varied on the number of cereal, legume and brassica species within each mixture (**Table *1***). All treatments were seeded to spring wheat in 2021, the second year of the study.

Table 1: Treatments used in Crop rotation benefits of annual forages preceding spring cereals in Melfort, SK 2021.

		Year one			Year 2
Trt	**# of species**	**Proportion**	**Treatment Purpose**	**Species**	**Species**
1	Monoculture	1C	Control	C: Metcalfe Barley	Spring Wheat
2	3 species	1L:1C:1B	Balanced Mix	L: Persian Clover C: Metcalfe Barley B: Groundhog Radish	Spring Wheat
3	3 species	3L	N-fixing Mix	C: Metcalfe Barley L:Persian Clover B:Groundhog Radish	Spring Wheat
4	4 species	1L:2C:1B	Simple Balanced Mix	L:Persian Clover C:Barley, Oats B: Groundhog Radish	Spring Wheat
5	6 species	1L:2C:3B	Weed Control Mix	L:Persian Clover C: Barley, Oats B: Groundhog Radish, Tillage Radish, Winfred Radish	Spring Wheat
6	6 species	2L:2C:2B	Complex Balanced Mix	L: Persian Clover, Hairy Vetch C: Barley, Oats B: Groundhog Radish, Winfred Radish	Spring Wheat
7	6 species	2L:4C:2B	Complex Soil Amendment Mix	L: Persian Clover, Hairy Vetch C: Barley, Oats B: Groundhog Radish, Winfred Radish	Spring Wheat

C: Cereal, L: Legume, B: Brassica

In Melfort plots were 2-meters wide by 7-meters long. Prior to seeding in both 2020 (Table 2) and 2021 (Table 7) the site was soil sampled for residual nutrient levels. In 2020, all annual forage mixtures were seeded on May 23rd at a 1.3-2.5 cm (0.5-1-inch) depth into canola stubble. All seed was seeded in the seed row with a 6-row Fabro plot seeder on 30 cm row spacing. All seeding rates were corrected for % germination and TKW and were seeded at rates pre-determined by the Wheatland Conservation Area (WCA). All seeding rates were balanced by the correct proportions of legumes, cereals and brassicas needed for each treatment (Table 1). The only fertility applied was 45 lbs/ac of nitrogen in the side-band as 46-0-0. In year two (2021) all treatments were seeded to AAC Brandon wheat on May 11th, 2021. All plots were seeded at a 3.8 cm (1.5-inch) depth into the stubble of the preceding forage mixture using a 6-row Fabro plot seeder on 30 cm row spacing. AAC Brandon was treated with Raxil Pro at 325 mL/100 kg of seed was seeded at 130 kg/ha with a target plant population of 250 seeds/m^2. All treatments received a common fertilizer rate applied at seeding time in 2021 consisting of 93 kg/ha of Nitrogen, 45 kg/ha of Phosphorus, 11 kg/ha of Potassium, and 8 kg/ha of Sulphur. Nitrogen was applied as 46-0-0 in the midrow band. All other nutrients were applied in the side band with phosphorus being applied as 11-52-0, potassium as 0-0-60, and sulphur as 21-0-0-24.

Table 2. Residual soil nutrient levels (0-12") found in Crop rotation benefits of Annual forages preceding spring cereals in Melfort, SK 2020.

Residual Soil Levels			
Nitrogen (lb/ac)	*Phosphorus (ppm)*	*Potassium (ppm)*	*Sulphur (lb/ac)*
54	19	477	48

In 2020, Glyphosate 540 at 1 L/ac was applied on May 24th for pre-emergent weed control. No pre-emergent herbicides, fungicides, or insecticides were applied to the plot area in year 1. All plots were harvested for biomass around the late-milk to early dough stage of the barley and oat crop. All plots were harvested on August 6th, where all 6 crop rows were collected. In 2021, a pre-emergent application of Glyphosate 540 (1L/ac) and Heat LQ (0.59mL/ac) was applied on May 14th, prior to the emergent of the wheat crop. Two applications of in crop herbicide were made with Prestige XC (0.17L/ac A & 0.8L/ac B) applied on June 8th and Axial (0.5L/ac) applied on June 22nd. A foliar fungicide, Caramba (0.4L/ac) was applied on July 9th. No insecticides or desiccants were applied. All wheat plots were harvested on August 18th, with 5 rows harvested per plot.

To assess treatment differences data in 2020 consisted of plant establishment, weed control, biomass yield, and feed analysis. In 2021, or year 2 of the demonstration data collection consisted of plant density, visual weed control, height, and grain yield. Methodology for both site years of data collection is described below. Both site years were analyzed individually using randomized complete block in Statistix 10.

Results:

Environmental Conditions:

The environmental conditions of 2020 were similar to the long-term average for temperature, however precipitation was reduced by 43.5 mm (Table 3). The spring months of May and June were marked by cooler average temperatures as compared to the long-term, whereas July and August were warmer than the long-term. September was the only month in 2020 where temperatures were the same as the long-term average. All months demonstrated slightly reduced precipitation as compared to the long-term, except June, where total precipitation increased by 49.4 mm as compared to the long-term average. The 2021 season was marked by being warmer and dryer than the long-term average for several months of the growing season. The mean temperature was greater than the long-term average from June-September (**Table *2***). The deviation from the long-term mean temperature was most pronounced in September and July when the temperature was 3.2°C and 2.6°C greater than the mean respectively. May was the only month that was cooler than average with a monthly mean of 9.6°C relative to the long-term mean of 10.7°C (**Table *2***). Across the 2021 growing season, Melfort received 55% of the long-term average for precipitation. From May-September, all months except August received below average precipitation. This deficit was most pronounced in July and September which received 76.5 mm and 31.2 mm of precipitation less than the long-term average.

Table 2: Mean temperatures and precipitation collect from the Environment Canada Weather Station at Melfort SK., from May to September 2021.

	May	June	July	August	September	Average/Total
			--- Mean Temperature (°C) ---			
2020	10.1	14.3	18.8	17.6	10.8	14.3
2021	9.6	18.2	20.1	16.9	14	15.8
Long-Term[x]	10.7	15.9	17.5	16.8	10.8	14.3
			--- Total Precipitation (mm) ---			
2020	26.7	103.7	52.4	18.5	21.2	222.5
2021	31.4	37.6	0.2	69.3	7.5	146
Long-Term[x]	42.9	54.3	76.7	52.4	38.7	265.0

[x] Long-term climate normal from Environment Canada Weather Station located at Melfort SK., from 1981-2010

Year 1:

Crop Establishment:

Crop establishment was assessed for annual forage mixtures on June 22nd, 2020 using the line intercept method. The line intercept method measures establishment by counting the number of 10-cm increments, along 1-meter crop row, in which seedlings are present. Each 10-cm increment in which a seedling is not present is considered a 10% reduction in establishment. Establishment was determined for every species in every plot. Due to the vast differences in seeded proportion and the type of species present in each plot, establishment was not statistically analyzed and only treatment means were compared (Table 4). As expected, when cereals were combined in the mixture the establishment of cereals was the greatest in comparison to any of the other species used. Oats and barley were noted as the most highly prevalent species in all treatments aside from the N-fixing treatment. However, when more species were included in the mixture cereal establishment decreased compared to the control. Clover establishment in the treatments varied from 38.8%-63.8% (Table 4). Clover presence was higher when cereal establishment was reduced and when fewer species were included in the mixture. Radish establishment was greatly affected by the presence of clover and cereals, and was greatly reduced when multiple species were included in the mixture. Lastly, establishment reflects the species most prevalent in the biomass harvest, as barley and oats were mostly noted, along with peas and clover in the nitrogen fixing mixture.

Table 4. Average % establishment of each crop per treatment in Crop rotation benefits of Annual Forages preceding spring cereals in Melfort, SK 2020.

Establishment							
TRT	**% cereal**	**% clover**	**% radish**	**% H. vetch**	**% pea**	**% corn**	**% Millet**
Control	97.5	--	--	--	--	--	--
Balanced Mix	78.8	63.8	33.8	--	--	--	--
N-fixing Mix Simple balanced mix	--	46.3	--	26.2	70.0	--	--
Simple balanced mix	86.3	51.3	28.8	--	--	--	--
Weed control mix	90.0	43.8	22.5	--	--	--	--
Complex balanced mix	90.0	48.8	23.8	15.0	--	--	--
Complex soil amendment mix	81.3	38.8	12.5	13.8		6.3	10.0

Weed Control:

Visual weed control was rated in all plots in year 1 on July 21st, 2020. A scale of 1-5 was used, where 1 indicated minimal weed control and 5 indicated complete weed control. Weed control was found to be significant amongst all treatments (Table 5). The control treatment had the greatest overall weed control, however the simple balanced mix, weed control mix, and complex balanced mix were all comparable to the control. The balanced mix, nitrogen fixing mix, and complex soil amendment mix all had significantly reduced weed control as compared to the control. Generally, treatments with lower cereal establishment had greater weed prevalence. Most notably the treatment with no cereal present or the nitrogen-fixing mixture had the lowest average weed control of all the treatments. Cereal crops are known to be much more competitive against weeds as compared to legumes as this was likely the reason for reduced weed control in treatments with less cereal establishment. Furthermore, the treatment that was targeted for weed control did not have the greatest overall weed control. It was comparable to all other treatments except the n-fixing and balanced mix, but did have the second greatest overall weed control rating.

Biomass Yield:

All plots were harvested in year 1 for biomass on August 6th, 2020 and sub-samples were collected, weighed, and dried to a consistent moisture. Plot weights and dry sub-plot weights were used to convert yields into kg/ha equivalents. Biomass yields were not statistically significant between treatments (Table 5). All treatments had comparable biomass yields, aside from the balanced mix which had significantly lower biomass yields, however it was also similar to the N-fixing mix. Overall, the greatest yields were found with the Simple Balanced Mix which had 243 kg/ha more yield than the control. This treatment had good establishment of all species used and thus may be an ideal polyculture for enhancing yields. When 6 species were included in the mixture, such as the Complex Balanced Mix and the Complex Soil Amendment Mix the average yield decreased from the control by 175 kg/ha and 101 kg/ha, respectively. Additionally, the Balanced Mix had the only significantly reduced yields as compared to the control. This is likely due to it's decreased cereal establishment and more prevalent legume and brassica presence (Table 4). Finally, having 2 cereals and 1 legume in conjunction with 1-3 brassica species as in the Simple Balanced Mix and Weed Control mix resulted in some of the greatest biomass yields; however, increasing to 3 brassica species in the Weed Control Mix did reduce average yields by 53 kg/ha from the Simple balanced mix, which only included one brassica species.

Table 5. Statistical analyses and treatment means for weed control ratings and biomass yield in Crop rotation benefits of annual forages preceding spring cereals in Melfort, SK 2020.

	Weed Control[z]	**Biomass yield[z]**
p-value	0.0004**	0.0616
Grand Mean	3.1	5788.8
CV	20.38	9.46
Control	4.0a	5979.0a
Balanced Mix	2.5c	4976.7b
N-fixing Mix	1.5d	5492.2ab
Simple Balanced Mix	3.5ab	6221.9a
Weed Control Mix	3.8ab	6168.7a
Complex Balanced Mix	3.5ab	5804.8a
Complex Soil Amendment Mix	3.0bc	5878.0a

[z]Letters signify treatments that are significantly different at $p<0.05$

<u>*Feed Analysis:*</u>

Sub-samples from the harvested biomass were collected on August 6th and sent to Central Testing for feed analysis. Multiple components of feed analysis were reported and all were found to be significantly different between treatments (Table 6). All treatment mixtures had increased crude protein (CP) as compared to the control, with a significant increase for the Nitrogen Fixing Mix. This was not surprising as this treatment had the greatest prevalence of legume species, which have higher protein levels than cereal or brassica species. Acid detergent fiber (ADF) and Neutral detergent fiber (NDF) are indications of the fibre content of the feed. ADF measures the indigestible components of the feed, whereas NDF is a measure of the total fibre content. High ADF and NDF are undesirable in feed as they limit intake because they add bulk or contain indigestible components, such as lignin. All treatments demonstrated increased ADF as compared to the control, however the Nitrogen-fixing Mix was very comparable to the control for NDF content. This likely lead to a similar relative feed value for both treatments. Treatments with higher NDF and ADF have lower feed value because they contain a greater amount of indigestible material. Total digestible nutrients (TDN) are a direct reflection of the energy available to the animal from the digested feed, therefore greater TDN results in more energy for gains and maintenance. All treatments had less TDN than the control, with the Balanced mix having the greatest TDN and all other treatments falling within a very similar range. Lastly, the Relative Feed Value indicates feed intake and overall digestibility. Therefore, the mixtures with higher ADF and NDF will have lower feed value. Overall, the control and Nitrogen-fixing Mix had comparable feed values followed by the Balanced mix. All other treatments had lower values and were comparable to one another. Therefore, the mixtures with greater amounts of species tended to have reduced feed value, as compared to the mixtures with 3 or less species, as in the control, Balanced Mix, and N-Fixing Mix.

Table 6. Statistical analysis and treatment means for feed analysis components in Crop rotation benefits of annual forages preceding spring cereals in Melfort, SK 2020.

Feed analysis

	CP[z]	ADF[z]	NDF[z]	TDN[z]	Relative Feed Value[z]
P-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Grand Mean	9.46	36.15	54.79	60.02	104.72
CV	12.09	4.29	3.55	2.76	4.68
Control	7.54b	29.39b	47.89c	67.41a	128.75a
Balanced Mix	8.31b	36.17a	52.67b	60.00b	108.00b
N-fixing Mix	17.28a	37.08a	45.78c	59.03b	121.26a
Simple Balanced Mix	7.86b	38.38a	58.61a	57.64b	93.93c
Weed Control Mix	7.80b	36.22a	58.08a	59.94b	97.26c
Complex Balanced Mix	8.84b	38.62a	61.30a	57.38b	89.88c
Complex Soil Ammendment Mix	8.58b	37.36a	59.20a	58.72b	93.93c

[z]Letters signify treatments that are significantly different at $p<0.05$

Year 2:

Soil Residuals:

In 2021, each treatment was soil sampled from a 0-15 cm and 15-30 cm depth and sent to an accredited lab for analysis (Table 7). Soil samples were taken as composites of every treatment, and no statistical analysis was completed. On average, residual nitrogen was increased for all forage mixtures as compared to the control. Sulphur and potassium were usually reduced in polycultures as compared to the control, and differences on phosphorus were very minimal between treatments. Overall, treatment differences in soil analysis were very minimal the following spring after the annual forage mixtures had been harvested.

Table 7: Residual soil nutrient levels found in the treatments of Crop rotation benefits of Annual forages preceding spring cereals in Melfort, SK 2021.

	Control	Balanced Mix	N - Fixing Mix	Simple Balanced Mix	Weed Control Mix	Complex Balance Mix	Complex Soil Amendment Mix
N *(lb/ac)*	35	47	43	41	43	51	41
P (ppm)	10	9	7	8	9	9	6
K (ppm)	445	369	383	379	375	404	356
S (lbs/ac)	40	30	24	20	26	22	50
Ca (ppm)	5053	3708	4901	3772	3843	4095	4613
Mg (ppm)	908	812	924	822	879	869	910
Na (ppm)	18	16	16	13	15	15	17
Salts (mmho/cm)	1.04	0.68	1.35	0.65	0.53	0.82	1.27
Zn (ppm)	2.41	2.36	2.33	2.43	2.60	2.63	2.15
CEC (meq)	37.0	35.2	36.9	31.2	34.2	36.8	35.1
SOM (%)	9.9	9.9	9.5	10.6	9.6	10.9	9.3
pH	6.6	5.9	6.4	5.9	6.0	6.0	6.3

Parameters measured from 0-12'': Nitrogen, sulphur, salts, and pH
All remaining parameters based on measurements from 0-6''

Plant Density:

Plant density was measured on May 31st, 2021 by counting the number of emerged wheat plants along two 1m sections of crop row in each plot. An analysis of variance (ANOVA) followed by pairwise comparison noted that there was no difference (p=0.54) in the plant density between treatments (**Table**). Numerically speaking, the wheat following the simple balanced mixture (139.44 plants/m^2) had the highest plant density while the wheat following the nitrogen fixing mixture had the lowest plant density at 105.81 plants/m^2.

Table 8. Statistical analysis of the parameters measured on the wheat in 2021 after annual forages in 2020 for Crop Rotation Benefits of Annual Forages Preceding Spring Cereals in Melfort, SK.

	PPMS (plant/m^2)		**Weed control**		**Height** (cm)		**Yield** kg/ha		**Yield** bu/ac	
p-value	0.54		0.8157		0.088		0.90		0.90	
Grand mean	130.88		2.4286		61.41		3677.9		54.641	
CV	19.14		37.32		3.78		10.37		10.37	
Control	134.51	a	2.5	a	63.125	a	3681	a	54.687	a
Balanced Mix	139.03	a	3	a	62.5	a	3732.7	a	55.455	a
N-fixing Mix	105.81	a	2.5	a	57.875	b	3445.2	a	51.184	a
Simple Balanced Mix	139.44	a	2.25	a	62.5	a	3762.4	a	55.897	a
Weed Control Mix	135.74	a	2	a	61.25	ab	3757.9	a	55.829	a
Complex Balanced Mix	132.87	a	2.25	a	61.5	a	3739.3	a	55.553	a
Complex Soil Amendment Mix	128.77	a	2.5	a	61.125	ab	3626.6	a	53.879	a

Weed Control:

Weed control was rated visually on June 8th, 2021 using a 1-5 scale where 1 indicated there was no control over weeds and 5 indicated complete control over weeds. The ANOVA results and pairwise comparison indicated that there was no difference (p=0.82) in the weed control ratings across treatments (**Table**). All treatments were in a relatively narrow range of visual weed control with the balanced mixture having the numerically greatest weed control at 3 and the weed control mix having the lowest weed control at a rating of 2. The lack of difference in weed control between the annual forage treatments is reasonable given that by the date of the rating, all treatments had received a pre-emergent and post-emergent herbicide.

Plant Height:

Plant height was measured on July 23rd by measuring the height of the crop at the back and front of each plot to the nearest cm. ANOVA results indicated that there was no significant difference (p=0.088) in the plant height between the treatments. Pairwise comparison did show that the treatments with the tallest wheat in descending order were following the control (63.13 cm), balanced mixture (62.5 cm), and simple balanced mixture (62.5 cm). The wheat of these treatments was significantly taller than following the nitrogen fixing mixture (57.88 cm). Plant height of the wheat did not appear to be related to soil characteristics such as residual nitrogen or organic matter (**Error! Reference source not found.**; **Table**).

Grain Yield:

Grain yield expressed in kg/ha and bu/ac and was measured by cleaning and drying the harvested grain to 14.5% moisture. ANOVA results were the same from both unit perspectives with there being no significant difference (p=0.90) in the wheat grain yield of each treatment (**Table**). Numerically speaking, the wheat following the simple balanced mixture had the highest grain yield (3762.40 kg/ha & 55.90 bu/ac) with the wheat following the nitrogen fixing mixture having the lowest grain yield (3445.20 kg/ha & 51.18 bu/ac).

Conclusions and Recommendations:

All polyculture mixtures used in this demonstration resulted in different establishment rates, weed control, biomass yields and feed quality in year 1. Treatments with greater cereal presence tended to demonstrate increased weed control. Treatments such as the N-fixing Mix, Balanced Mix and Complex Soil Amendment Mix all demonstrated lower weed control as compared to the control. These three mixes also had reduced or no cereal presence as compared to the other treatments. Thus, having an adequate establishment of cereals within the mixture significantly improved weed control. Additionally, the treatments with the lowest weed control, including the N-fixing Mix and Balanced Mix had the lowest overall biomass yields. The treatment with the greatest average yield was the Simple Balanced Mix which included an additional cereal in the mixture as compared to the Balanced Mix. Including legumes and brassicas in the forage mixture did increase yields as compared to the control, however having a greater proportion of cereals compared to legumes and brassicas greatly increased yields. Unfortunately, feed value was reduced with more complex mixes and treatments, with 3 or less species demonstrated the best feed value. Lower feed value may be detrimental to the producer, and prevent the adoption of more diverse polycultures, even though biomass yields were increased in some instances.

With rising input prices and public pressure to improve environmental sustainability, farmers may need non-conventional strategies to improve efficiency on their operations by decreasing the use of external inputs like fertilizer and crop protection products. Forage polycultures may play a role in this through outcompeting weeds, fixing nitrogen, and providing residual nutrient benefits. The objective of this research project was to assess mixtures of annual forage legumes, cereals, and brassicas for weed control, biomass production, forage quality, and their effect on the subsequent cereal crop for grain production. The second year of the trial assessed the performance of wheat planted into the forage stubble. There were no significant differences observed in the plant density, weed control, plant height, or grain yield of any of the treatments. These results could indicate that there was no negative impact of growing a forage polyculture on the following wheat crop when conventional management strategies like multiple herbicide passes and adequate fertility are used. To assess the potential for annual forage polycultures to reduce inputs in a grain crop rotation, further research should be conducted that utilizes treatments such as alternative removal strategies of the forage polyculture (Ex: Grazing, hay, silage) and reduced fertilizer or herbicide in the following wheat crop.

Supporting Information

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Abstract

Abstract/Summary

Recent forage and grain research has investigated ways to provide more sustainable cropping options, such as minimizing crop inputs, while improving forage and grain yields and quality. Annual forage mixtures, known as polycultures are great options to diversify cropping rotations, increase soil health and potentially decrease crop inputs. Legumes and cereals are common annual forage crops, and brassicas can also be used in polycultures to improve soil health and enhance weed control. Brassicas must be used with caution in forage mixtures as high levels of nitrates and sulfates are toxic to animals when consumed in large quantities. Legumes provide nitrogen-fixation and thus they may minimize the need for nitrogen fertilization in subsequent cropping years, and they also increase the crude protein level in feed mixtures. Furthermore, cereals provide easily digestible carbohydrates and are more competitive than legumes and thus may provide additional weed control. Including the right ratio of cereals, legumes, and brassicas in forage mixtures has the potential to increase biomass, weed control and feed quality, as well as effect the growth and yields on subsequent crops. To demonstrate the effects of various annual forage mixtures of cereals, legumes and brassica species, a small plot demonstration was set-up to evaluate establishment, weed control, biomass yields and forage quality in year 1. In year 2 of the demonstration establishment, weed control, height, and grain yield were evaluated for a spring wheat crop to determine the effects of the forage mixtures preceding a cereal crop. When comparing forage mixtures in year 1 (2020), mixtures with greater cereal presence had greater weed control, and subsequently higher biomass yields. Mixtures that involved good cereal establishment in conjunction with a legume and some brassica presence, had the greatest overall yields. Conversely, mixtures with 3 or less species had significantly better feed values. In year 2 (2021), residual soil nitrogen levels were greater in all forage mixtures as compared to the control of barley in year 1. Wheat establishment, weed control, plant height and grain yields were all not significantly impacted by the preceding forage mixture in year 2. Grain yields were greater on average for 4 of the 6 mixtures, with the complex soil amendment mix and the nitrogen-fixing mix have lower average yields than the control. Overall, utilizing forage polycultures often increased biomass yields, increased soil residual nitrogen, had minimal effects on a preceding wheat crop, but had reduced feed value as compared to a monoculture

Finances

Budget Report

See attached excel spreadsheet