The Effect of Grazing and Non-grazing of Annual Green Manures on Following Crops (Year 2)

Project duration: May 2019 – October 2020
Objectives: To evaluate the use of an annual green manure crop for grazing by livestock and to provide fertility for the following crop (2019); and to evaluate the performance of three annual field crops after a green manure crop, with and without grazing (2020).
Collaborators: PCDF

Background

The use of green manure crops to provide nitrogen is well-understood in organic agriculture. One of the barriers to adoption of green manures is that there is no "harvestable" product and no income from that year. Research conducted by the Natural Systems Agriculture laboratory at the University of Manitoba has demonstrated that grazing the green manure by livestock can kill the crop, providing an alternative to terminating the crop with tillage. Further, grazing results in large amounts of available N in the soil. Follow-up research by the Natural Systems Agriculture laboratory demonstrated that there was no significant difference in the year-2 crop yield for grazed and ungrazed treatments. The results for that research suggest that there is no yield decrease associated with grazing a green manure.

Results

2019

The current study established a green manure crop on May 14, 2019. Half of the green manure crop was swathed (to terminate the crop) and intensively grazed by sheep on August 19, and the other half was mowed. Both areas were disked in October, after a killing frost. Table 1 shows seeding rates and costs for the green manure blend. The feed test for the green manure at the time of grazing is shown in Table 2, with cattle feed requirements shown in Table 3.

Table 1: Green manure blend by species, rate and description

Species	Rate (lb/ac)	$/ac	Description
Pea (4010 forage)	40	8.33	Cool season legume; forage type
Oat (Haymaker)	30	7.02	Cool season grass; forage/hay type
Japanese millet	3	5.37	Warm season grass
Italian ryegrass	2	4.38	Cool season grass; limited over-wintering ability
Persian clover	2	8.38	Cool season legume; slow establishment
Chicory	0.5	4.79	Short-lived perennial broadleaf; deep taproot
Turnip	0.3	1.44	Cool season broadleaf; good frost tolerance
Feed beet	0.7	4.19	Cool season broadleaf; quick leaf regrowth
Common vetch	2	5.58	Cool season legume; shade tolerant
Phacelia	0.5	2.50	Warm season broadleaf; attracts pollinators
	Total $/ac	**51.98**	

Table 2: Feed test results for 2019 green manure (August 19) compared to animal feed requirements*

% Crude Protein	% TDN	Ca	P	Mo	Cu	Fe	Mn	Zn
11.60	68.96	0.69	0.18	0.34	3.80	161.72	0.34	14.06


Figure 1: (a) green manure before grazing; (b) sheep on swathed green manure.

Table 3: Cattle feed requirements*

	% Crude Protein	% TDN
	8.21	58.86
Mature cows		
Mid gestation	7	50-53
Late gestation	9	58
Lactating	11-12	60-65
Replacement heifers	8-10	60-65
Breeding bulls	7-8	48-50
Yearling bulls	7-8	55-60

* Developed by Elisabeth Nernberg (ARD).

Figure 2: Green manure after grazing

The biomass yield was 9,745.9 lb/ac (hay-dry), or 6.5 1500-lb round bales per acre. The stocking rate for animals was 195 sheep per acre for 5 days. This equals 39 animal units (1 animal unit = 1000 lb animal).

2020

Barley, canola and spring wheat were seeded on May 15, 2020 on the 2019 site (Table 4). Fertilizer was added to all treatments to ensure even fertility levels (Tables 6-8). The relatively low nitrogen levels for the green manure treatments are based on the soil test, conducted in early May 2020, and does not take into account the nitrogen contained in the plant and animal manure residues. The trial design is shown in Figure 4.

Table 4: 2020 treatments

Green manure (2019)	Crop seeded (2020)		
Yes, grazed	Barley	Canola	Wheat
Yes, not grazed	Barley	Canola	Wheat
No green manure	Barley	Canola	Wheat

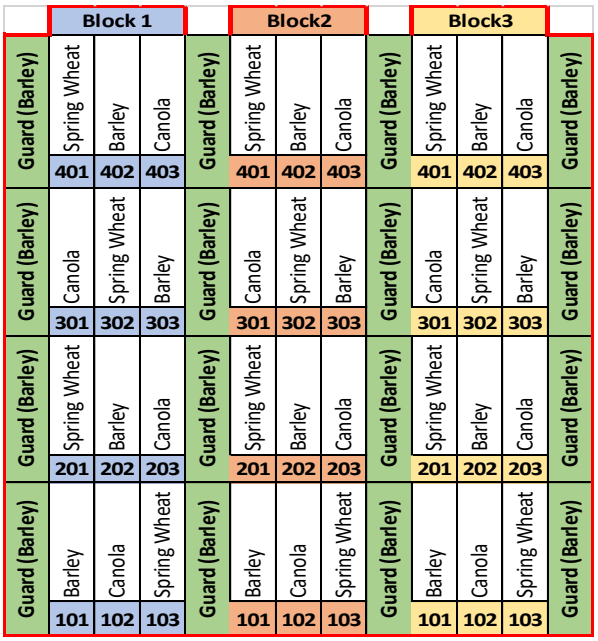

Figure 4: Plot design, showing (a) block 1, no green manure; (b) cover crop, grazed; (c) cover-crop, non-grazed

The trial design does not allow for results within each treatment to be compared across the treatments. That is, although the crops are replicated and randomized within each block, the treatments are not randomized across blocks. For this reason, the results provide suggestions about treatment effects, but do not provide statistically meaningful comparisons.

Table 5: Comparison of average yields (bu/ac), test weight and % CV by treatment

Crop	Treatment	Average Yield (bu/ac)	Average Test Weight	Yield % CV
Barley	No green manure	101.4	51.8	9.8
Barley	Green manure, grazed	100.3	51.7	10.0
Barley	Green manure, not grazed	106.4	55.4	9.4
Canola	No green manure	48.1	46.2	20.7
Canola	Green manure, grazed	46.0	46.7	21.7
Canola	Green manure, not Graze	47.8	46.0	20.9
Spring Wheat	No green manure	56.7	57.2	17.6
Spring Wheat	Green manure, grazed	73.5	58.2	13.6
Spring Wheat	Green manure, not grazed	67.5	58.3	14.8

The comparison of yields suggests that the differences between crop yields across treatments are small. This supports the research findings of the Natural Systems Agriculture laboratory. Note that the percent CV (that is, differences between replications of the same treatment) is high for canola. The higher percent CV for canola is due to challenges in establishment (including dry conditions at emergence and flea beetle pressure), resulting in uneven stand across replications.

Observations

The cost of the seed blend for forage is high relative to simpler cereal-only annual forages, such as barley planted for green feed (estimated at $16.88/ac in the MB Agriculture Cost of Production). However, some green manure species can provide extended in-season grazing, reducing pressure on perennial pastures. Strategic inclusion of these species in a green manure mix can improve its application to grazing. Other management options for green manures and livestock include swath or bale grazing, which can extend grazing into the winter months, reducing feeding and yardage costs. In future years, other benefits to soil characteristics, moisture infiltration and retention, and crop performance may be observed.

Materials & Methods

Experimental Design:	Random Complete Block Design (3 separate, non-comparable blocks)
Entries:	3 crops, 4 replications per block
Seeding:	May 15
Harvest:	Sep 11

Data collected	Date collected
Yield:	Sep 11
Moisture:	Sep 11
Previous year's crop:	Cover crop blend
Soil Type:	Erickson Loam Clay
Landscape:	Rolling with trees to the east
Seedbed preparation:	Heavy harrowed

Table 6: Fertility Information, No Cover Crop

	Available	Barley Added	Canola Added	Wheat Added	Type
N	42 lb/ac	82 lb/ac	112 lb/ac	147 lb/ac	46-0-0
P	23 ppm	15 lb/ac	10 lb/ac	15 lb/ac	11-52-0-0
K	249 ppm	-	-	-	N/A
S	38 lb/ac	-	-	-	N/A

Table 7: Fertility Information Cover Crop, Grazed

	Available	Barley Added	Canola Added	Wheat Added	Type
N	60 lb/ac	64 lb/ac	94 lb/ac	129 lb/ac	46-0-0
P	18 ppm	15 lb/ac	15 lb/ac	18 lb/ac	11-56-0-0
K	257 ppm	-	-	-	N/A
S	34 lb/ac	-	-	-	N/A

Table 8: Fertility Information Cover Crop, Non-Grazed

	Available	Barley Added	Canola Added	Wheat Added	Type
N	79 lb/ac	45 lb/ac	75 lb/ac	110 lb/ac	46-0-0
P	22 ppm	15 lb/ac	10 lb/ac	15 lb/ac	11-52-0-0
K	257 ppm	-	-	-	N/A
S	18 lb/ac	-	-	-	N/A