Temiskaming Crops Coalition/Cochrane District Soil & Crop Improvement Association

Rapid Development of Farmland from Boreal Forest and an Evaluation Relative to Traditional Clearing Methods

2016 Interim Report

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This project would not have been possible without the support and commitment from project partners:

GB Equipment, located in Sainte-Brigitte-des-Saults, Quebec, provided both rounds of land preparation (surface mulching & subsoiling) as an in-kind contribution. Further information on GB Equipment and their services can be found at www.gbequipment.ca

Carl Dodds & Will Runnalls: the producer cooperators have donated acres for the duration of the project and have donated their time and equipment for various activities, including timbering, planting, harvesting, etc.

OMAFRA: Dan Tassé, Tom Hamilton, Barry Potter

Project Steering Committee

Introduction

This three year project has two main objectives: (1) to assess and mitigate the soil impacts and crop growth potential resulting from a mulching/subsoiling process and (2) develop a business case that will evaluate mulching and other methods of traditional land clearing. Based on outcomes from this project, mulching and its role in agriculture will be better understood and producers will have sound information necessary to make informed decisions regarding their land management practices.

Project Background

Northern Ontario contains a vast amount of Class 2, 3 and 4 land which is not currently in production (4+ million acres). Some of this land was farmed in the past, but has lain idle for a number of years and has grown in up in scrub bush. Other blocks have had mature trees harvested and are now covered in successional scrub and trees, while other areas contain mature tree stands.

In order to convert these areas into productive farmland, the tree stems and large branches have to be physically removed, burned or mechanically processed in place. Stumps and roots may be excavated or raked out and removed from the site, piled and burned, left in the ground to rot or mechanically processed on site.

The use of large industrial shredder/grinders to process standing stems, slash, and root beds is increasing in the North. Information on the long term effectiveness, cost efficiency, and suitability for agricultural purposes of these machines is lacking. Some of this cleared land has seen successful crop growth afterwards and some has not – this could be attributed to a number of factors including method of mulching, tree composition, volume of woody material incorporated, etc. It is anticipated that this study will provide initial information related to these variables and how they could potentially impact future crop growth.

Project Progress

In 2015, the project sites were selected, baseline soil sampling and a forest inventory was completed and all land preparation, including mulching, subsoiling and installing tile drainage, was completed.

In 2016, both sites were planted with a combination of clover, oats and buckwheat, underwent spring and fall soil sampling, plant tissue analysis and a plant count.

In 2017, both sites are expected to be planted with a cash crop to further asses yield potential. It is anticipated that a section of each site will be left with 2015’s crop to assess the implications of incorporating additional crop residue into the soil.

Project Sites

Cochrane

The Cochrane site was planted on June 18, 2016 with a combination of oats & red clover (see Figure 1). Oats were seeded at 80 pounds/acre, red clover was seeded at 10 pounds/acre and 150 pounds of 8-32-16 was broadcast and lightly disked and 150 pounds of 11-52-0 were added to the site with a drill.

Approximately 5 mulched acres were seeded into red clover, 5.5 mulched acres were seeded into oats and red clover and 2 conventional acres were seeded into oats and clover. The oats were cut on October 10, 2016 and baled on October 11, 2016 with approximately 1,100 pounds/bale.

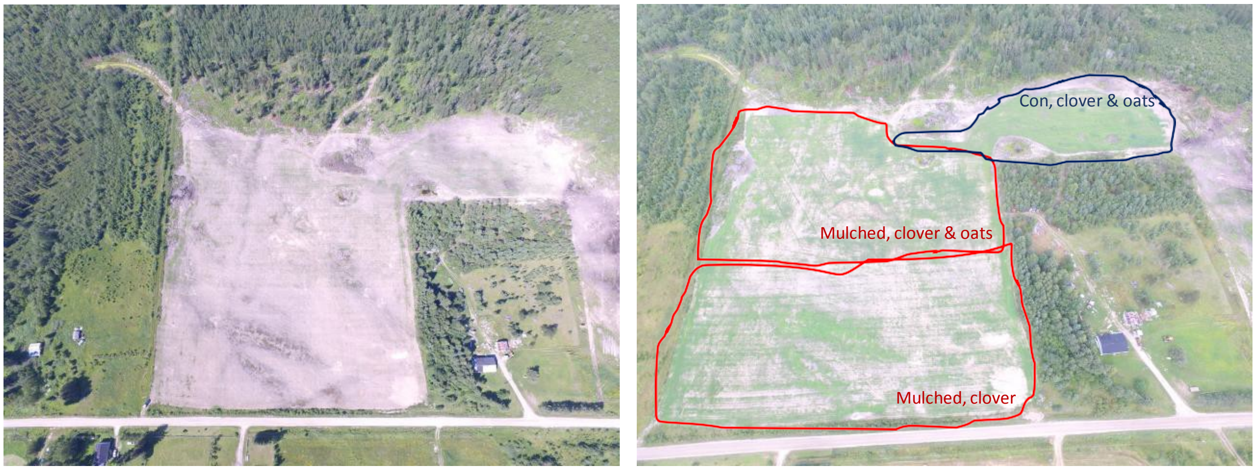


Figure 1: Aerial photos of the Cochrane site, picture on left taken on July 20, 2016 (approximately one month after planting) and picture on right taken August 17, 2016

Temiskaming

The Temiskaming site was planted on June 16, 2016 with a combination of oats, buckwheat and red clover (see Figure 2). Oats/buckwheat were seeded at 90 pounds/acre, red clover was seeded at 10 pounds/acre and 100 pounds of 0-0-60 and 180 pounds of 11-52-0 were broadcast and lightly disked into the soil. Growing conditions after seeding were quite dry.

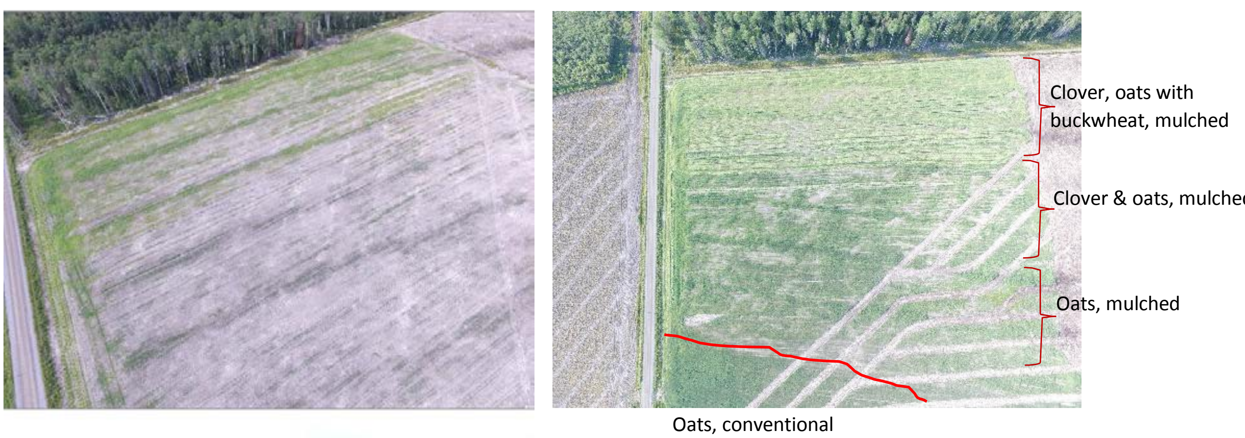
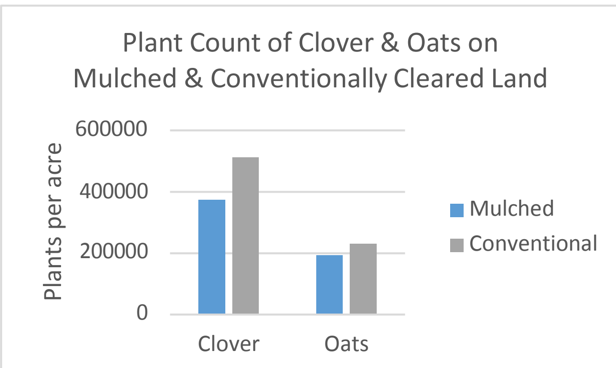


Figure 2: Aerial photos of the Temiskaming site, taken on (from clockwise) July 19, 2016, August 19, 2016 and October 27, 2016

Results

Based upon the 2016 soil sampling, tissue analysis and plant count, the soil impacts and crop potential of mulched land and traditionally cleared land was assessed. The preliminary results indicate that within the first year of the land being cleared, mulching has little impact on soil fertility within the parameters that were assessed (see Figure 5 & 6, Appendix 1). However, there was an impact on yield potential as the conventionally cleared land had higher plant counts and higher average and maximum plant heights, as seen in Figure 3 & Figure 4. Aerial photos in Figure 1 & Figure 2 also indicate a difference in crop growth between the conventional and mulched areas. Field data was subjected to a one-way ANOVA test, which found that there is a statistically significant relationship between plant growth and land preparation such that plant maximum height and plant average height are higher for conventionally cleared land compared to mulched land.



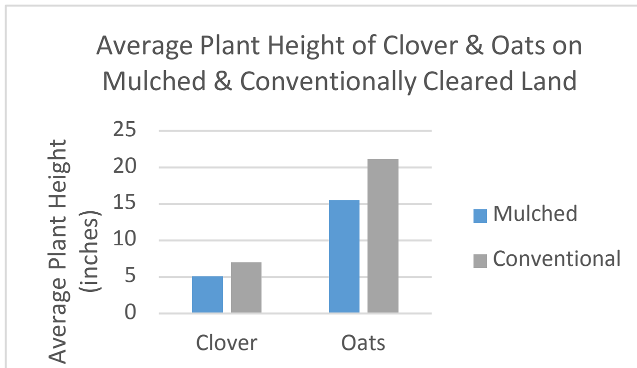
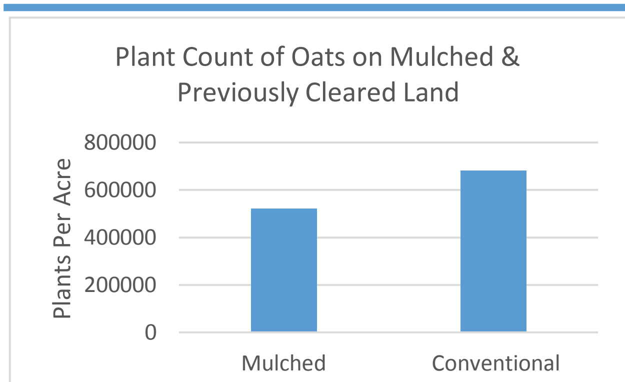


Figure 3: Plant count & plant height in Cochrane, conventional compared to mulched

Oat yield in Cochrane - 3,520 pounds/acre on conventionally cleared land vs. 2,750 pounds/acre on mulched land



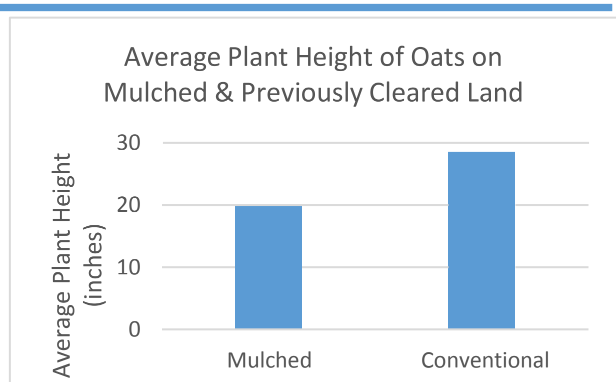


Figure 4: Plant count & plant height in Temiskaming, conventional compared to mulched

A secondary objective of the project was to assess the impacts of an oat cover crop and an oat/buckwheat cover crop. The Cochrane site had less bare ground with a cover crop (48%) than with no cover crop (52%) with 42% less weeds with a cover crop compared to no cover crop. The Temiskaming site had progressively less bare ground with the inclusion of additional crops – 61% bare ground with oats, 53% bare ground with oats/clover and 38% bare ground with oats, clover and buckwheat. The one-way ANOVA test found this relationship was statistically significant.

Figure 5 Temiskaming *Soil Sampling: June 26, 2015 (in brackets); May 20, 2016 (composite), October 28, 2016*

2016 Spring Sampling Event

T4S-16	T3S-16	T2S-16	T1S-16
OM: 8.4%	OM: 6.6%	OM: 6.5%	OM: 6.9%
Phos: 5 ppm	Phos: 5 ppm	Phos: 5 ppm	Phos: 5 ppm
K: 63 ppm	K: 60 ppm	K: 64 ppm	K: 65 ppm
pH:7.5	pH:7.5	pH:7.8	pH:7.7
C:N Ratio—11.2	C:N Ratio—10.2	C:N Ratio—10.9	C:N Ratio—9.8

N

T10 OM: 10.7 %(8.9) Phos: 7 ppm (??) K: 56 ppm (49) pH: 7.7 (7.1) C:N Ratio-11.0	**T9** OM: 8.8% (8.4) Phos: 8 ppm (5) K: 57 ppm (38) pH: 7.5 (7.0) C:N Ratio– 8.3	**T4** OM: 7.2% (8.6) Phos: 5 ppm (5) K: 52 ppm (44) pH: 7.8 (7.2) C:N Ratio—8.4	**T3** OM: 6.8% (7.4) Phos: 5 ppm (5) K: 60 ppm (44) pH: 7.6 (7.7) C:R Ratio—9.4
T11 OM: 7.9 %(6.6) Phos: 7 ppm (6) K: 43 ppm (43) pH: 7..5 (7.2) C:N Ratio—8.9	**T8** OM: 8.0% (5.0) Phos: 5 ppm (4) K: 56 ppm (29) pH: 7.5 (7.0) C:N Ratio—7.3	**T5** OM: 6.7%(5.8) Phos: 5 ppm (5) K: 49 ppm (28) pH: 7.5 (7.4) C:N Ratio—10.1	**T2** OM: 7.9% (7.1) Phos: 5 ppm (4) K: 43 ppm (42) pH: 7.5 (7.6) C:N Ratio—11.3
T12 OM: 6.8% (8.1) Phos: 7 ppm (6) K: 60 ppm (49) pH: 7.8 (7.4) C:N Ratio– 7.6	**T7** OM: 4.9% (6.1) Phos: 5 ppm (4) K: 55 ppm (38) pH: 7.5 (7.2) C:N Ratio– 8.3	**T6** OM: 5.8 % (6.8) Phos: 4 ppm (4) K: 51 ppm (31) pH: 7.9 (7.6) C:N Ratio—8.6	**T1** OM: 6.8% (6.2) Phos: 5 ppm (5) K: 58 ppm (54) pH: 7.8 (7.8) C:N Ratio—9.7

Spring sampling was based on composite grid sampling (ie. Grids outlined in orange correspond to the sample information in orange)

Fall sampling will be completed using the one acre grid pattern established in 2015

Highway 69

Tile drainage runs

Cane/Barber Twp Rd.

Figure 6 Cochrane *Soil Sampling: June 24, 2015 (brackets); May 23, 2016 (composite), October 31, 2016*

C6 OM: 7.6% (7.1) Phos 13 ppm (5) K: 125 ppm (83) pH: 6.6 (6.5) C:N Ratio—9.0	**C5** OM: 6.2% (5.9) Phos 21 ppm (3) K: 120 ppm (96) pH: 6.7 (6.8) C:N Ratio-8.2	**C4** OM: 6.0% (5.9) Phos 6 ppm (5) K: 104 ppm (85) pH: 6.8 (7.0) C:N Ratio– 9.9
C7 OM:8.0%(5.8) Phos 10 ppm (3) K: 113 ppm (90) pH: 6.7 (6.7) C:N Ratio—11.4	**C8** OM:4.6% (5.8) Phos 19 ppm (2) K: 102 ppm (97) pH: 7.5 (6.7) C:N Ratio-7.5	**C9** OM:6.1% (5.5) Phos 10 ppm (2) K: 107 ppm (90) pH: 7.1 (6.4) C:N Ratio– 9.0
C12 OM:7.1%(6.1) Phos 8 ppm (4) K: 87 ppm (86) pH: 7.2 (6.8) C:N Ratio-8.0	**C11** OM:5.9% (5.7) Phos 6 ppm (2) K: 109 ppm (87) pH: 7.0 (7.0) C:N Ratio-9.9	**C10** OM:6.7%(6.8) Phos 9 ppm (3) K: 127ppm (96) pH: 7.2 (6.9) C:N Ratio-9.3
C13 OM:5.9% (6.8) Phos 5 ppm (4) K: 100 ppm (79) pH: 7.1 (6.6) C:N Ratio-9.0	**C14** OM:10.4% (9.9) Phos 8 ppm (4) K: 73 ppm (55) pH: 6.8 (7.0) C:N Ratio—11.9	**C15** OM:4.9% (7.4) Phos 15 ppm (5) K: 90 ppm (89) pH: 7,.4 (6.9) C:N Ratio-8.6

Floods Landing Rd

N

C3S-16
OM: 6.8%
Phos: 4 ppm
K: 121 ppm
pH:7.1
C:N Ratio—10.3

C2S-16
OM: 6.1%
Phos: 4 ppm
K: 106 ppm
pH:7.3
C:N Ratio—8.9

C1S-16
OM: 7.7%
Phos: 7 ppm
K: 120 ppm
pH:7.3
C:N Ratio—10.1

Traditionally cleared section

CC (Fall 2016)
OM: 7.6%
Phos: 9 ppm
K: 69 ppm
pH:7.2
C:N Ratio—9.9

C4S-16 (Spring 2016)
OM: 10.0%
Phos: 5 ppm
K: 106 ppm
pH:7.2
C:N Ratio—9.9

C16 (2015)
OM: 8.5%
Phos: 6 ppm
K: 82 ppm
pH:7.0

C17 (2015)
OM: 8.0%
Phos: 4 ppm
K: 77 ppm
pH:6.9

C4-C6 higher density with larger trees (partially logged end of June/start of July); C7 & C14 quite swampy in sections; C13-C15 higher coniferous population; C15, C8 & C5 more open space

*C1-C3 plus section of C4-C6 (- - -) included in initial project layout but not mulched

Trees per hectare—853 Stand Volume—3.94 m^3/ha

Discussion

During the project planning stage, two factors were identified that might impact future crop potential on mulched sites: (1) the importance of seed bed preparation to ensure that woody residue did not impact seed placement (2) the potential for incorporated woody residue to impact the carbon-nitrogen ratio and cause potentially harmful impacts to soil fertility.

Seed bed preparation likely impacted the plant counts on both sites – the mulched project area had lower plant counts than the conventionally cleared project area, which might be due to larger chunks of wood residue displacing the seed drill. Approximately one month after planting, a site inspection at both project sites found uneven crop distribution and evidence that larger wood chunks negatively impacted the presence of seed in the immediate area.

The soil fertility, based upon the parameters assessed, remain relatively similar pre mulch and post mulch and between the mulched project area and the traditionally cleared project area. However, plant vigour and growth was higher in the conventionally cleared area than the mulched area – given that this difference in yield cannot be statistically attributed to a higher plant count and the impact of seedbed preparation, other variables could be impacting the yield potential of the mulched land.

Based on the second year activities, tentative recommendations for producers who are considering mulching include:

- Complete mulching in the fall, let the residue winter on the ground and subsoil in the spring
- Plant a high biomass crop for the first year or two to give wood residue time to break down and further incorporate within soil
- Consider broadcast or aerial seeding to reduce seed displacement caused by mulched seedbed.

Future Steps

The field work in Year 3 will build upon the findings from Year 2 and further assess the impacts on soil health and yield potential of mulching compared to traditional clearing. It may be determined that further study needs to be undertaken outside the scope of this project in a controlled environment to assess how mulch vs. conventional impacts other variables such as water retention, nutrient availability, etc. Further interpretation of the soil results will continue throughout early 2017 to assess what changes (if any) in the soil could be responsible for the difference in growth between the project areas.

Work is currently underway on developing a reference document for land clearing that will provide producers with the information required to make proper land management choices with respect to clearing land. This document is expected to be completed and released by July 2017.

2016 Cochrane Project Summary

	Description		Organic Matter	Phosphorus P-ppm Bicarb	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	%K	%Mg	%ca	%H	%Na	Sulphur S ppm	Zinc Zn ppm	Managnese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Saturation % P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	C:N Ratio
	Average pre-conventional	Soil	8.25	5.00	79.50	407.50	2615.00	15.50	6.95	6.90	18.50	1.10	18.35	70.65	9.55	0.35	8.00	2.20	14.50	102.00	0.75	0.25	1.00	1025.50	0.10	0.06	
	Average post-conventional	Soil	8.80	7.00	87.50	385.00	2585.00	13.50	7.20		17.20	1.30	18.70	75.15	4.50	0.35	7.50	2.95	15.00	101.00	0.90	0.30	1.50	964.50	0.10	0.07	9.85
	Average pre-mulch	Soil	6.56	3.50	86.08	345.75	2001.67	14.92	6.76	5.18	14.50	1.53	19.83	68.91	9.29	0.44	8.08	1.66	13.92	98.17	0.78	0.19	0.42	1056.83	0.20	0.08	
	Average post-mulch	Soil	6.71	10.07	107.00	335.36	2287.14	13.00	7.04	2.41	16.07	1.74	17.60	70.52	9.83	0.35	6.86	2.41	18.36	99.79	0.99	0.23	1.93	1052.36	0.12	0.10	9.44

Percent Base Saturation (%)

Sample Number	Description	Type	Organic Matter	Phosphorus P-ppm Bicarb	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	%K	%Mg	%ca	%H	%Na	Sulphur S ppm	Zinc Zn ppm	Managnese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Saturation % P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	C:N Ratio
C16	Conventional 2015 pre-clear	Soil	8.5	6	82	395	2530	14	7		18.6	1.1	17.7	68	12.8	0.3	8	2.2	15	100	0.7	0.2	1	1038	0.1	0.06	
C17	Conventional 2015 pre-clear	Soil	8	4	77	420	2700	17	6.9	6.9	18.4	1.1	19	73.3	6.3	0.4	8	2.2	14	104	0.8	0.3	1	1013	0.1	0.06	
C4S-16	Conventional Spring 2016	Soil	10	5	106	405	2790	13	7.2		18.5	1.5	18.3	75.4	4.5	0.3	8	3	15	99	0.9	0.4	2	869	0.1	0.08	9.9
CC	Conventional Fall 2016	Soil	7.6	9	69	365	2380	14	7.2		15.9	1.1	19.1	74.9	4.5	0.4	7	2.9	15	103	0.9	0.2	1	1060	0.1	0.06	9.8

			Nitrogen	Sulfur	Phosphorous	Potassium	Magnesium	Calcium	Sodium	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm	Chloride
CCO16	Conventional Oats 2016	Tissue	1.68	0.1	0.47	2.93	0.29	0.9	0.04	2	13	79	340	5	59	
CCC16	Conventional Clover 2016	Tissue	3.05	0.23	0.17	2.36	0.41	2.54	0.08	15	66	63	109	6	42	

Sample Number	Description		Organic Matter	Phosphorus P-ppm Bicarb	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	%K	%Mg	%ca	%H	%Na	Sulphur S ppm	Zinc Zn ppm	Managnese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Saturation % P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	C:N Ratio
C4 2015	Pre-mulch 2015	soil	5.9	5	85	300	1730	11	7		13.1	1.7	19.1	66.1	12.8	0.4	7	1.8	28	114	0.6	0.1	1	1093	0.2	0.09	
C4	Post Mulch Fall 2016	soil	6	6	104	310	1790	13	6.8	6.9	13	2	19.8	68.7	9	0.4	7	2.4	22	96	0.9	0.3	2	1123	0.2	0.1	9.9
C5 2015	Pre-mulch 2015	soil	5.9	3	96	315	1750	13	6.8	6.9	12.8	1.9	20.4	68.1	9.1	0.4	8	1.8	16	107	0.7	0.2		1118	0.2	0.09	
C5	Post mulch Fall 2016	soil	6.2	21	120	315	1790	12	6.7	6.7	15.5	2	16.9	57.7	23	0.3	7	3.6	19	102	0.9	0.2	3	1161	0.2	0.12	8.2
C6 2015	Pre-mulch 2015	soil	7.1	5	83	360	2010	11	6.5	6.9	14.5	1.5	20.7	69.4	8	0.3	9	1.6	11	91	0.9	0.2	1	1186	0.3	0.07	
C6	Post Mulch Fall 2016	soil	7.6	13	125	335	1990	12	6.6	6.7	16.7	1.9	16.7	59.7	21.4	0.3	7	3.1	23	113	1	0.2	3	1141	0.2	0.11	9
C7 2015	Pre-mulch 2015	soil	5.8	3	90	335	1790	11	6.5	6.9	13.2	1.8	21.2	67.9	8.8	0.4	7	1.6	11	93	0.7	0.2		1101	0.3	0.08	
C7	Post Mulch Fall 2016	soil	8	10	113	310	2000	11	6.7	6.8	15.3	1.9	16.9	65.4	15.5	0.3	6	2.6	21	112	1.1	0.3	3	1020	0.2	0.11	11.4
C8 2015	Pre-mulch 2015	soil	5.8	2	97	370	1980	11	6.7	6.9	14.4	1.7	21.4	68.6	8	0.3	8	1.7	12	89	0.8	0.2		1057	0.2	0.08	
C8	Post mulch fall 2016	soil	4.6	19	102	340	3060	13	7.5		18.4	1.4	15.4	83.1		0.3	6	2	23	93	0.9	0.2	2	990	0	0.09	7.5
C9 2015	Pre-mulch 2015	soil	5.5	2	90	315	1760	12	6.4	6.9	12.9	1.8	20.4	68.4	9.1	0.4	8	1.7	10	87	0.6	0.2		1086	0.4	0.09	
C9	Post mulch fall 2016	soil	6.1	10	107	330	2020	12	7.1		14.5	1.9	19	69.9	8.8	0.4	7	2.1	21	104	0.9	0.2	2	1110	0.1	0.1	9
C3S 2016	Post mulch Spring 2016 composite sample (C4-C9)	soil	6.8	4	121	320	2070	13	7.1		14.7	2.1	18.2	70.5	8.9	0.4	6	2.3	18	88	0.7	0.3	1	961	0.1	0.12	10.3

			Nitrogen	Sulfur	Phosphorous	Potassium	Magnesium	Calcium	Sodium	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm	Chloride
CC3S16	Composite clover sample (C4-C9)	Tissue	2.41	0.19	0.15	2.7	0.48	2.79	0.03	13	27	74	94	7	37	
CO3S16	Composite oat sample (C4-C9)	Tissue	1.62	0.17	0.21	3.41	0.24	0.98	0.05	3	12	44	95	5	44	

Sample Number	Description		Organic Matter	Phosphorus P-ppm Bicarb	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	%K	%Mg	%ca	%H	%Na	Sulphur S ppm	Zinc Zn ppm	Managnese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Saturation % P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	C:N Ratio
C10 2015	Pre-mulch 2015	soil	6.8	3	96	395	2390	13	6.9	6.9	16.7	1.5	19.7	71.6	6.9	0.3	9	1.9	11	95	0.9	0.3		1034	0.1	0.08	
C10	Post mulch fall 2016	soil	6.7	9	127	370	2370	12	7.2		16	2	19.2	73.9	4.5	0.3	7	2.5	18	103	1.1	0.3	2	1123	0.1	0.1	9.3
C11 2015	Pre-mulch 2015	soil	5.7	2	87	385	2040	11	7		15.5	1.4	19.6	65.8	12.8	0.3	7	1.4	14	102	0.8	0.2		1026	0.1	0.07	
C11	Post Mulch Fall 2016	soil	5.9	6	109	325	1820	12	7		13.9	2	19.5	65.4	12.8	0.4	5	1.8	18	101	0.9	0.2	2	1100	0.1	0.1	9.9
C12 2015	Pre-mulch 2015	soil	6.1	4	86	360	1960	13	6.8	6.9	14.2	1.5	21.1	68.8	8.2	0.4	8	1.5	12	93	0.8	0.2		1042	0.2	0.07	
C12	Post Mulch Fall 2016	soil	7.1	8	87	325	2180	15	7.2		14.6	1.5	18.6	74.9	4.5	0.4	6	2	14	103	1	0.2	2	1049	0.1	0.08	8
C2S 2016	Spring 2016 composite sample (C10-C12)	soil	6.1	4	106	315	2140	14	7.3		13.6	2	19.3	78.5		0.4	6	2.2	15	88	0.7	0.2		828	0.1	0.1	8.9

			Nitrogen	Sulfur	Phosphorous	Potassium	Magnesium	Calcium	Sodium	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm	Chloride
CC2S16	Composite clover sample (C9-C12)	tissue	2.62	0.21	0.17	2.46	0.51	3.24	0.06	14	23	85	119	7	60	

Sample Number	Description		Organic Matter	Phosphorus P-ppm Bicarb	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	%K	%Mg	%ca	%H	%Na	Sulphur S ppm	Zinc Zn ppm	Managnese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Saturation % P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	C:N Ratio
C13 2015	Pre-mulch 2015	soil	6.8	4	79	340	2210	13	6.6	6.9	15.3	1.3	18.5	72.2	7.6	0.4	9	1.7	10	92	0.9	0.2	1	1022	0.2	0.07	
C13	Post Mulch Fall 2016	soil	5.9	5	100	320	1970	14	7.1		14.1	1.8	18.9	70	8.8	0.4	7	2	14	99	1.5	0.2	1	1079	0.1	0.1	9
C14 2015	Pre-mulch 2015	soil	9.9	4	55	314	2170	13	7		15.7	0.9	16.7	69.2	12.8	0.4	8	1.4	16	115	0.8	0.1	1	918	0.1	0.05	
C14	Post Mulch Fall 2016	soil	10.4	8	73	340	2160	11	6.8	6.7	17.4	1.1	16.3	62	20.4	0.3	6	2.5	10	109	1	0.1	2	1040	0.2	0.07	11.9
C15 2015	Pre-mulch 2015	soil	7.4	5	89	360	2230	47	6.9	6.9	15.7	1.4	19.1	70.8	7.4	1.3	9	1.8	16	100	0.9	0.2	1	999	0.1	0.07	
C15	Post mulch Fall 2016	soil	4.9	15	90	345	3670	15	7.4		21.5	1.1	13.4	85.4		0.3	7	2	14	81	0.9	0.2	1	970	0	0.08	8.6
C1S 2016	Spring 2016 composite sample (C14-C15)	soil	7.7	7	120	410	3130	17	7.3		19.4	1.6	17.6	80.7		0.4	12	2.8	22	93	1	0.3	1	866	0.1	0.09	10.1

			Nitrogen	Sulfur	Phosphorous	Potassium	Magnesium	Calcium	Sodium	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm	Chloride
CC1S16	Composite clover sample (C14-C15)	Tissue	2.75	0.23	0.18	2.55	0.64	3.73	0.04	15	23	93	217	8	114	
CSO16	Overall site composite sample of visually deficient oats	Tissue	1.34	0.09	0.58	2.74	0.29	0.9	0.04	2	11	83	373	6	41	
CSC16	Overall site composite sample of visually deficient clover	Tissue	2.19	0.07	0.13	2.17	0.43	2.73	0.02	17	21	73	86	4	47	

2016 Temiskaming Project Summary

Description		Organic Matter	Phosphorus P- ppm Bicarb	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meg/100g	%K	%Mg	%ca	%H	%Na	Sulphur S ppm	Zinc Zn ppm	Managnese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Saturation % P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	C:N Ratio
											Percentage Base Saturation															
Average pre-mulch	Soil	7.083333	5.5	40.75	352.5	2371.666667	12.75	7.35	0	15.55	0.666666667	19.09167	76	4	0.366667	8.5	1.666667	25.5833333	92.41667	1.033333	0.191667	0.9166667	808.83333	0.06666667	0.035833	0
Average post-mulch	Soil	7.29375	5.5	55.75	345	2398.125	14.4375	7.63125	0	15.0375	0.96875	19.2375	79.625	0	0.425	6.5625	2.01875	22.375	86.3125	1.01875	0.23125	0.625	798.625	0.03125	0.051875	9.4375

(no conventional clearing was completed within the duration of the mulched clearing, however bare ground adjacent to the mulched site was planted in oats in 2016 and used within plant counts

Sample Number	Description	Type	Organic Matter	Phosphorus P- ppm Bicarb	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meg/100g	%K	%Mg	%ca	%H	%Na	Sulphur S ppm	Zinc Zn ppm	Managnese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Saturation % P	Aluminum Al ppm	Saturation %Al	K/Mg Ratio	C:N Ratio
												Percentage Base Saturation															
T1	Pre mulch 2015	soil	6.2	5	54	320	2930	12	7.8		17.5	0.8	15.3	83.8		0.3	9	1.8	26	77	1.1	0.1	1	719	0	0.05	
T1	Post mulch fall 2016	soil	6.8	5	58	370	2660	19	7.8		16.6	0.9	18.6	80.2		0.5	7	2.2	21	89	1.1	0.2		836	0	0.05	9.7
T2	Pre mulch 2015	soil	7.1	4	42	375	3010	13	7.6		18.3	0.6	17.1	82.2		0.3	8	1.7	26	90	1.1	0.2		718	0	0.04	
T2	Post mulch fall 2016	soil	7.9	5	43	310	1940	12	7.5		12.4	0.9	20.8	78.2		0.4	6	2	14	88	0.9	0.2	1	756	0.1	0.04	11.3
T3	Pre mulch 2015	soil	7.4	5	44	375	2490	14	7.7		15.7	0.7	19.9	79.3		0.4	11	1.8	15	88	1.1	0.3	1	757	0	0.04	
T3	Post mulch fall 2016	soil	6.8	5	60	380	2750	16	7.6		17.1	0.9	18.5	80.4		0.4	7	2.1	22	90	1.1	0.2		766	0	0.05	9.4
T1S16	Post mulch spring 2016 composite (T1-T3)	soil	6.9	5	65	355	2330	14	7.7		14.8	1.1	20	78.7		0.4	6	2.1	21	83	0.9	0.3		756	0	0.06	9.8
T4	Pre mulch 2015	soil	8.6	5	44	375	2640	13	7.2		17.3	0.7	18.1	76.4	4.5	0.3	10	1.6	28	102	1.3	0.2	1	832	0.1	0.04	
T4	Post mulch fall 2016	soil	7.2	5	52	340	2530	13	7.8		15.6	0.9	18.1	80.9		0.4	7	1.7	25	82	1.1	0.2		802	0	0.05	8.4
T5	Pre mulch 2015	soil	5.8	4	28	335	2090	14	7.4		13.3	0.5	20.9	78.3		0.5	6	1.3	30	88	0.9	0.1		793	0.1	0.02	
T5	Post mulch fall 2016	soil	6.7	5	49	360	2290	13	7.5		14.6	0.9	20.6	78.5		0.4	6	1.9	23	90	1	0.1	1	856	0.1	0.04	10.1
T6	Pre mulch 2015	soil	6.8	4	31	335	2380	11	7.6		14.8	0.5	18.9	80.5		0.3	7	1.4	24	87	0.9	0.2		738	0	0.03	
T6	Post mulch fall 2016	soil	5.8	4	51	295	2880	15	7.9		17	0.8	14.4	84.6		0.4	6	2	25	82	0.9	0.2		651	0	0.06	8.6
T2S16	Post mulch spring 2016 composite (T4-T6)	soil	6.5	5	64	350	2680	14	7.8		16.5	1	17.7	81.2		0.4	6	2	27	86	1	0.4		662	0	0.06	10.9
T7	Pre mulch 2015	soil	6.1	4	38	375	2390	13	7.2		15.9	0.6	19.6	74.9	4.5	0.4	7	1.6	32	90	1	0.2	1	788	0.1	0.03	
T7	Post mulch fall 2016	soil	4.9	5	55	330	1960	13	7.5		12.7	1.1	21.6	77.1		0.4	7	1.7	22	93	1	0.2	1	973	0.1	0.05	8.3
T8	Pre mulch 2015	soil	5	4	29	290	1560	14	7		11.9	0.6	20.4	65.7	12.8	0.5	8	1.7	23	100	0.8	0.1	1	898	0.1	0.03	
T8	Post mulch fall 2016	soil	8	5	56	365	2350	14	7.5		15	1	20.3	78.6		0.4	7	2.2	24	88	1.1	0.2	1	803	0	0.05	7.3
T9	Pre mulch 2015	soil	8.4	5	38	355	2220	11	7		16.3	0.6	18.2	68.1	12.8	0.3	9	1.6	24	98	1	0.2	1	761	0.1	0.03	
T9	Post mulch fall 2016	soil	8.8	8	57	360	2640	14	7.5		16.4	0.9	18.3	80.6		0.4	7	1.8	25	85	1.2	0.3	1	891	0	0.05	8.3
T3S16	Post mulch spring 2016 composite (T7-T9)	soil	6.6	5	60	315	2020	13	7.5		12.9	1.2	20.3	78.3		0.4	6	2.1	23	89	0.9	0.3	1	794	0.1	0.06	10.2
T10	Pre mulch 2015	soil	8.9	14	49	385	2590	12	7.1		17.9	0.7	17.9	72.3	8.9	0.3	10	2.1	25	100	1.1	0.3	3	915	0.1	0.04	
T10	Post mulch fall 2016	soil	10.7	7	56	375	2660	16	7.7		16.6	0.9	18.8	80.1		0.4	8	2.3	21	82	1.2	0.2	1	822	0	0.05	11
T11	Pre mulch 2015	soil	6.6	6	43	335	1960	13	7.2		13.4	0.8	20.9	73.4	4.5	0.4	9	1.8	30	96	1	0.2	1	883	0.1	0.04	
T11	Post mulch fall 2016	soil	7.9	7	43	290	1950	13	7.5		12.3	0.9	19.6	79.3		0.5	6	2.1	21	84	0.9	0.2	1	791	0.1	0.05	8.9
T12	Pre mulch 2015	soil	8.1	6	49	375	2200	13	7.4		14.3	0.9	21.9	77.1		0.4	8	1.6	24	93	1.1	0.2	1	904	0.1	0.04	
T12	Post mulch fall 2016	soil	6.8	7	60	375	2300	16	7.8		14.8	1	21.1	77.7		0.5	7	1.9	23	85	1.1	0.2	1	881	0	0.05	7.6
T4S16	Post mulch spring 2016 composite (T10-T12)	soil	8.4	5	63	350	2430	16	7.5		15.3	1.1	19.1	79.6		0.5	6	2.2	21	85	0.9	0.3	1	738	0	0.06	11.2

		Nitrogen	Sulfur	Phosphorous	Potassium	Magnesium	Calcium	Sodium	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm	Chloride
TOS16	composite oat sample	2.08	0.21	0.17	2.95	0.3	1.01	0.1	7	19	41	126	7	83	
TBS16	composite buckwheat sample	2.04	0.18	0.26	1.69	0.57	2.08	0.04	11	22	195	187	5	547	
TCS16	composite clover sample	3.66	0.18	0.2	2.71	0.61	3.26	0.02	12	25	68	102	8	27	