Cover Crops for Emergency Forages

(Interim Report)

Purpose:

Hay supplies during 2012 were almost non-existent after less than ideal weather from October to May. An abnormally early wheat harvest provided an excellent opportunity to plant a fall cover crop, which could be harvested as forage if growth was sufficient.

Wet feet in October 2011 took its toll on alfalfa fields, followed by extremely warm weather in March2012 that kick started early growth. Dry weather throughout March, April and May (40% of normal rainfall) doubled up with hard frosts repeatedly killing the unusually early growth. This forced plants to have to regrow from the crown, and left many hay producers with only 50% of a normal first cut harvest. This hay shortage had livestock producers scrambling. Early harvested wheat fields gave an excellent opportunity to replace some forage shortfall, with cover crops for hay.

As producers considered this opportunity, it became obvious that virtually no data existed on the best crop to fill this void. Even once the cover crop species was chosen, management for optimum forage yield was unknown. Optimum seeding and nitrogen rates were major areas were data was minimal or even non-existent.

This trial was initiated to determine agronomic recommendations for cereal crops grown as forage following a winter wheat crop.

Methods:

Small plot, 4 replicate trials were set up at four locations following wheat harvest in 2012. Three different crops (Oat, Barley, Oat/Pea mix) were planted at 4 different seeding rates (targeting 2, 3, 4, and 5 bushels per acre). Wheat and forage oats were also included at 2 of the 4 sites. The 4 sites were planted between July 31 and August 4. The seed was no-tilled into wheat stubble using a 1560 John Deere Drill. Four different nitrogen rates (0, 30, 60, and 90 lbs of actual N) were applied across these strips. Urea fertilizer was broadcast between September 7 and 11. Yields were measured using a Carter forage plot harvester that cut and weighed a 5 by 10 foot strip through each plot. The plants were cut at or near ground level. A sub sample was collected and chopped to determine moisture, phosphorus and potash tissue levels, along with several factors to calculate relative feed value across the treatments (ADF, NDF, protein, Mg, Ca, etc.). To reduce analysis costs only one seeding rate from each site was analyzed for feed quality, with the same relative seeding rate used for each species at any location, and every nitrogen rate tested at that seeding rate. It was assumed that seeding rate would not have a significant impact on forage quality. To further reduce the risk from making this assumption, the 2 bushels seeding rate was analyzed at 2 locations and the 3 bushel rate analyzed at the other 2 locations.

Results:

Seeding rate had little impact on cover crop yields (Table 1 and Figure 1). Oats and Peas (O+P) were the only crop that showed any response to higher seeding rates. O+P yields were the highest at a seeding rate of 140lbs/acre across all N rates. Oats alone and barley showed no response to increasing seeding rates above 2 bushels/acre. A lower seeding rate should have been included in the experimental design, to determine yield breakpoint of oat and barley.

Nitrogen (N) had a major impact on cover crop yields. Yield response to N was very significant. Oats and O+P had relatively strong yields with no nitrogen but yields still increased dramatically with the addition of 30lbs N and continued to increase up to 60 N. There was no additional yield response to 90N with the oats or O+P combination.

Barley showed the strongest response to N. Barley yields almost doubled from the addition of 90 N over the 0N check.

Table 1: Average Yield Results from 4 Sites (tonnes/acre)

Treatment	0 N	30 N	60 N	90 N
70 lbs Oats	1.35	1.96	2.17	2.13
105 lbs Oats	1.27	1.92	2.04	1.97
140 lbs Oats	1.39	1.86	2.04	2.02
160 lbs Oats	1.53	2.07	2.13	2.14
70 lbs O+P	1.27	1.69	1.91	1.88
105 lbs O+P	1.42	1.87	2.05	2.02
140 lbs O+P	1.73	2.07	2.19	2.13
170 lbs O+P	1.56	2.00	2.05	2.17
90 lbs Barley	1.14	1.67	1.88	2.04
130 lbs Barley	1.08	1.54	1.82	1.99
170 lbs Barley	1.21	1.67	1.86	2.13
205 lbs Barley	1.11	1.64	1.89	2.05

Figure 1: Seeding Rate Impacts

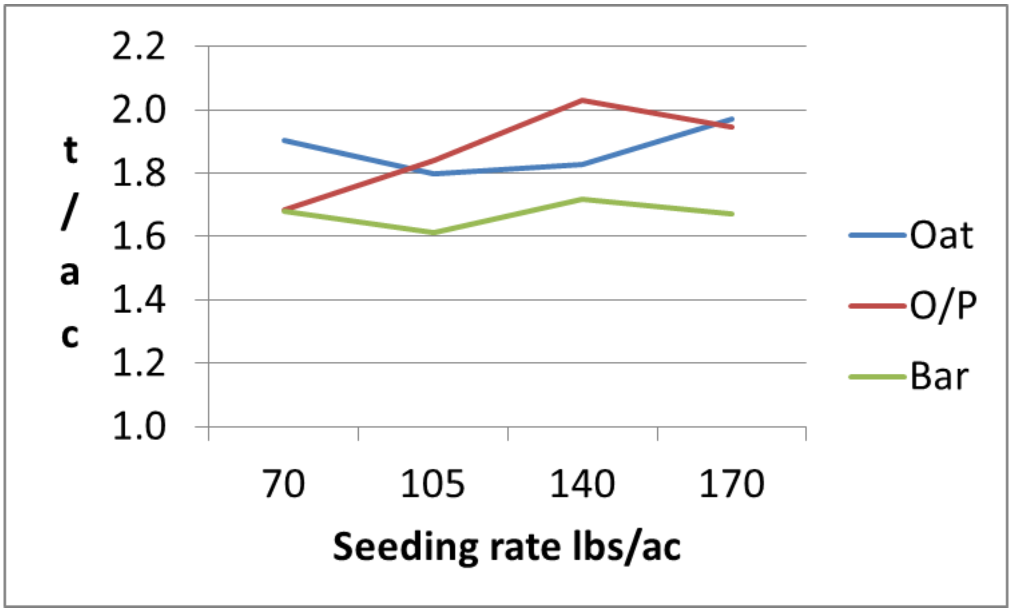


Figure 2 shows the yield results from the 2 sites including spring wheat. Table 1 shows that seeding rate has minimal impact on cover crop yields, thus all 4 seeding rates were averaged together at each N rate in Figure 2. The overall yield average is slightly lower than the 4 site average but shows the same trend. O+P yields are slightly higher than oats alone without N but nitrogen increases oats yields proportionately more and by 60 N oats have a slight yield advantage over O+P. Wheat and barley yields are very low with no nitrogen but show a higher response to nitrogen which continues right through the 90N rate. Table 1 suggests that with 90N barley yields can equal oat or O+P yields. Figure 1 suggests little difference between spring wheat and barley yields.

Figure 2: Yield Response Curve from 2 Sites with Wheat

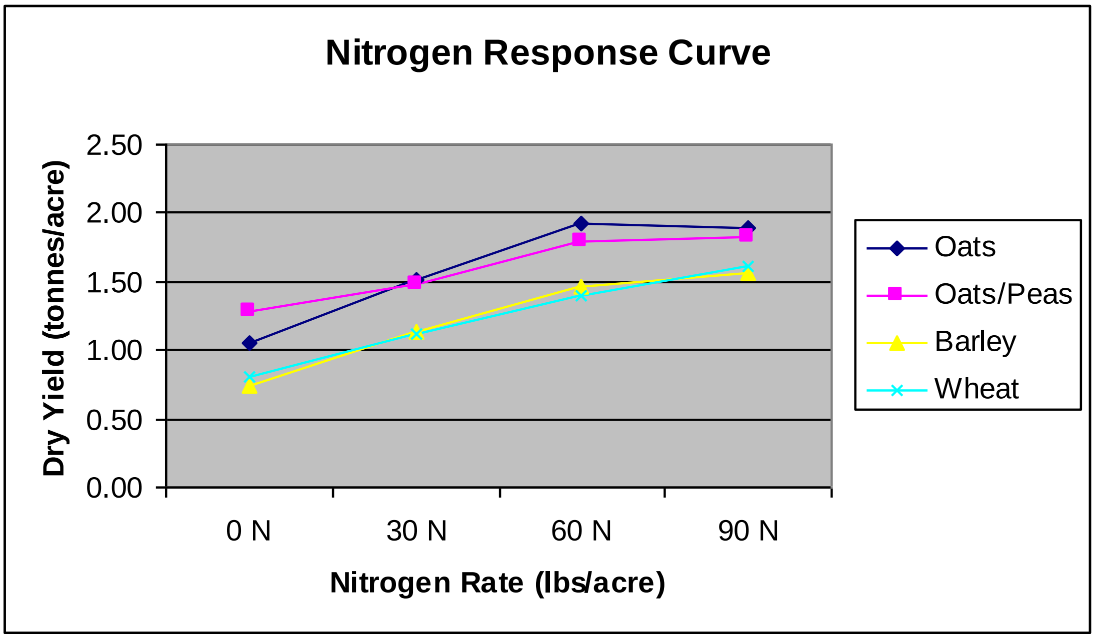


Table 2 describes a yield comparison from the 2 sites that included forage oats (FO) as a treatment. FO was supplied from Western Canada as a higher yield alternative to regular oat varieties. With 0 N FO and oat yields were similar but as N was increased forage oats began to lag behind. Both FO and oat yield increased with the addition of N but the oats response was higher. Both crops reached a maximum yield with 60 N. At harvest (mid-November) the forage oats were only at early flag leaf, while the oats were at early head stage, indicating that FO were a much later maturing oat then the normal oats grown.

Table 2: Forage Oat Yields (tones/acre)

Treatment	0 N	30 N	60 N	90 N
105 Oats	1.31	1.95	2.08	1.91
140 Oats	1.49	1.90	2.16	2.12
105 Forage Oats	1.34	1.49	1.70	1.67
140 Forage Oats	1.32	1.61	1.66	1.71

Yield is not the only factor that influences the suitability of cover crops as a forage. The relative feed value (RFV) determined from the quality analysis across locations is summarized in Table 3. RFV incorporates potential intake along with digestibility to produce one value to represent forage quality. RFV values for barley and oat decreased as nitrogen rates increased. The exact reason for this decrease has not been determined. Whether higher nitrogen rates caused slightly quicker growth and maturation, or increased lignin content in the stem, or some other factor, this outcome remains to be investigated. However, this trend was consistent over locations. Increasing nitrogen rates had little impact on the quality of the O+P mix, where peas helped maintain forage quality across N rates.

Table 3: Relative Feed Value from 4 Locations

Treatment	0 N	30 N	60 N	90 N
Oats	121.0	119.4	110.9	107.5
O+P	115.4	118.0	113.5	112.9
Barley	121.4	114.2	109.9	106.1

RFV is one indicator of forage quality but does not consider all factors affecting forage value**.** Net Energy Gain (NEG) is used to express the amount of energy available for weight gain. NEG is based on ADF (Acid Detergent Fibre) values and is expressed in mega calories per pound. Similar to RFV, NEG for oats and barley decreased with the addition of nitrogen, while NEG from oats and peas remained relatively constant.

Milk/tonne is a more comprehensive analysis to predict milk production from each treatment. It is based on NDF (Neutral Detergent Fibre), crude protein, ash, and ether extract. In general milk/tonne values from oats and O+P increased with additional nitrogen. Milk/tonne values for barley stayed relatively constant with increasing nitrogen rates.

Table 4: NEG and Milk/tonne

Treatment		0 N	30 N	60 N	90 N
Oats	NEG	1.09	1.07	1.04	1.02
	Milk/tonne	3571.8	3587.8	3564.1	3618.7
O+P	NEG	1.04	1.05	1.03	1.03
	Milk/tonne	3574.1	3677.3	3650.0	3691.8
Barley	NEG	1.12	1.07	1.05	1.04
	Milk/tonne	3602.6	3582.0	3595.5	3607.1

Protein is a very import aspect of an animal's diet. Since crude protein has little impact on RFV or NEG values, the crude protein values are summarized in Table 5. There was variation in protein response between sites but as expected protein increased with the addition of nitrogen. Across all locations and nitrogen rates oats and peas clearly had higher protein values then barley or oats alone. All protein values are relatively low, as crops were at the heading stage when harvested.

Table 6 contains the forage quality of forage oats compared to regular field oats. The FO are clearly the better feed source. This was expected based on the crop maturity at harvest. The oats were in early head while the forage oats were at the flag leaf to boot stage which is the optimum time to harvest forage if quality is more important than quantity. However, when yield results from Table 2 are factored in, the oats would produce more gain or milk per acre than the forage oats.

Table 5: Crude protein values

Crop	0 N	30 N	60 N	90 N
Oats	7.8	8.7	9.1	10.7
O+P	10.4	12.6	12.8	14.0
Barley	8.9	9.7	10.5	10.9

Table 6: Feed Value Forage Oats (2 locations)

Treatment	Quality Parameter	0 N	30 N	60 N	90 N
Oats	RFV	139.2	138.5	128.0	119.4
	NEG	1.16	1.15	1.13	1.09
	Milk/tonne	3672.9	3684.5	3646.0	3655.2
	Protein	8.2	8.6	9.0	10.6
Forage Oats	RFV	162.2	149.3	142.2	150.3
	NEG	1.22	1.21	1.17	1.21
	Milk/tonne	3889.1	3867.1	3880.2	3990.0
	Protein	9.3	10.5	11.6	14.0

The feed value of wheat was very poor. Table 7 contains a summary comparing the feed value of wheat compared to barley at the 2 locations that had wheat included as a treatment. Except for crude protein wheat had the lowest feed value of all the crops. This is not surprising, as the spring wheat was well into grain fill at time of harvest. While this explains the lower feed quality, it does not explain this shift in maturity. Planted in the spring, spring wheat would be the last to head and reach maturity of the cover crops investigated. Planted August 1, spring wheat was 3 weeks earlier to head out than either barley or oat. This difference in maturity is most intriguing, and has something to do with the daylength response of the 3 crops.

Table 7: Feed value of Wheat (2 locations)

Treatment		0 N	30 N	60 N	90 N
Barley	RFV	126.5	119.8	113.8	108.7
	NEG	1.12	1.10	1.07	1.05
	milk/tonne	3603.0	3579.5	3585.5	3617.0
	protein	7.8	8.1	9.2	10.1
Wheat	RFV	91.5	92.2	93.1	94.0
	NEG	0.93	0.94	0.96	0.96
	milk/tonne	3453.1	3474.0	3511.0	3545.2
	protein	8.4	8.9	10.4	11.3

Another thing consideration when growing any forage is nutrient removal. Phosphorus and potash removal from the 4 locations is summarized in table 8. The removal values are summarized as the amount of fertilizer needed to replace crop removal. This phosphorus removal is P2O5 and potash is K2O, the equivalent form that commercial fertilizer is based on. Removal per acre is based on the nutrient concentration in the plant and the average yield across all seeding rates at each location: eg: oats with 60 lbs N applied removed 30.6 lbs of P2O5 and 136.3 lbs of K2O per acre (on average).

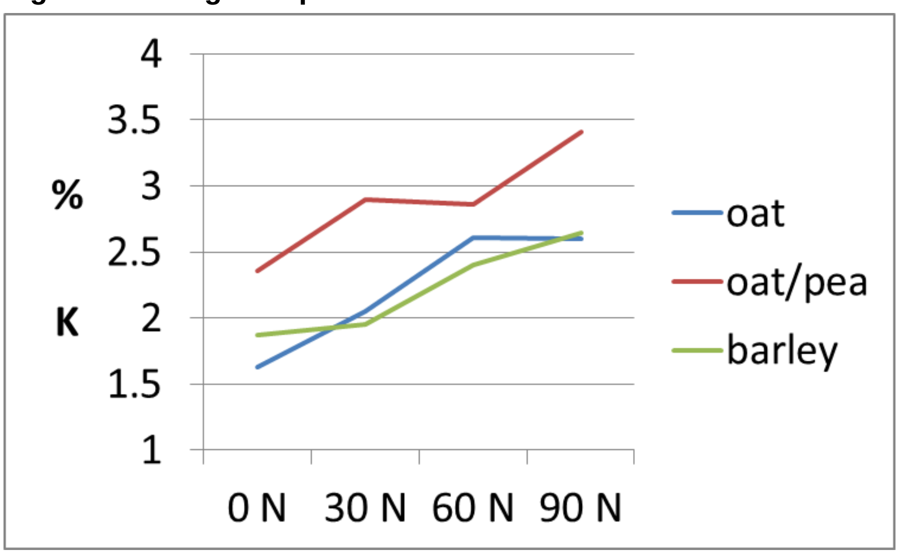
Table 8: P2O5 + K2O removal from 4 locations (pounds/acre)

Crop	Nutrient	0 N	30 N	60 N	90 N
Oats	Phosphorus	19.2	28.6	30.6	31.8
	Potash	70.2	120.8	136.3	150.2
O+P	Phosphorus	22.8	31.3	32.5	35.0
	Potash	91.6	136.1	151.7	167.9
Barley	Phosphorus	17.6	26.8	32.5	36.5
	Potash	59.0	93.0	119.4	138.1

Wheat removed relatively the same amount of P2O5 as barley but slightly less K2O. P2O5 removal by forage oats was consistent with field oats but consistently removed an additional 20lbs of K2O per acre more then oats. **These are extremely high removal rates.** In high yield situations, over $100/acre can easily be removed in P and K fertilizer values alone.

Potash concentrations in all crops increased dramatically as nitrogen rates increased (Figure 3). This finding was another surprise, and has not been fully explained. It may have to do with ion balance in the plant, and higher N rates (negative charge) requiring higher potash uptake (positive charge) to maintain proper ion balance, but this has yet to be verified.

Figure 3: Nitrogen impacts on Potash Concentration



Summary:

This trial unveiled some critical findings. However, as this is only one year of data from only 4 locations, findings must be taken with caution.

Seeding rates had little impact on yield while nitrogen dramatically increased forage yields. With added nitrogen oats show the greatest yield potential, reaching a maximum yield with 60lbs N. Where seed costs are high and nitrogen costs low, oats would be the preferred cover crop.

A blend of oats and peas clearly showed the most potential if no nitrogen will be applied. At higher seeding rates the oat and pea blend showed reasonable yield potential with no added nitrogen. If nitrogen costs are high and seed cost low, oats and peas might have the greatest potential.

Taking the next step and including yield plus forage quality, oats with 60 lbs N continue to show excellent potential production per acre. If highest crude protein is required then an oat-pea blend would be the best choice. Where overall forage quality is key, harvesting oats or oat-pea combinations earlier would appear to have the highest potential, based on the forage oat data in the trial. Forage oat yields were poor but they had the highest feed value of all the crops. The forage oats were at the boot stage at harvest while the other crops had started into grain fill, indicating the importance of stage of growth on quality and yield parameters.

Wheat showed little potential based on yield or feed value. Surprisingly the wheat was the most advanced crop at harvest. If these crops were planted in the spring the barley would mature first, then oats, and wheat would be last. Wheat appears most sensitive to photoperiod so as the days get shorter the wheat quickly advances through its growth stages to maturity. This resulted in less crop growth and poor feed quality.

Next Steps:

This trial will continue again in 2013 to further examine which management strategies result in the best cover crop for many different uses. Wheat will no longer be explored in this trial as a viable cover crop option. With poor yields, low forage quality, high nitrogen demand and high seed cost it just does not look like a good cover crop option. Anyone interested in cooperating in this trial in 2013 should contact Peter Johnson at peter.johnson@ontario.ca or Shane McClure at shane.mcclure@ontario.ca

Acknowledgements:

A huge vote of thanks to our co-operators, as always. A special thanks to Cribit Seeds for providing seed for this trial. We would also like to thank Dr. Chris Gilliard and the Huron Research Station for allowing us to use their Carter forage plot harvester. Thanks to Anna-Marie Megens, Shane McClure, Jessica Brock and Kaye McLagan for all their efforts in making these trials happen, and to Marian Desjardine for keeping the wheels turning. Thanks to Elgin, Oxford and Middlesex Soil and Crop Improvement Associations for their financial support.

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Location of Project Final Report:

Peter Johnson