Cover Crops for Emergency Forage

(Paired Partner Grant – Thames Valley/Eastern Valley)

Purpose:

There is a great opportunity following winter wheat to grow cover crops, which can also be used as additional forage. As producers consider the forage opportunity, it becomes obvious that virtually no data exists on the best crop to fill this void. Even if the cover crop species is chosen, management for optimum forage yield is unknown. Optimum seeding and nitrogen rates are major areas where data is minimal or even non-existent.

This trial will attempt 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 4 locations in 2012 and 6 locations in 2013. 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 in 2012. In 2012 the 4 sites were planted between July 31 and August 4, while in 2013 planting was delayed until August 15th through 22nd. 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. In 2013 a 120 N rate was also included. Urea fertilizer was broadcast between September 5 and 11 in both 2012 and 2013. 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 seeding rate used for sampling was alternated across locations.

Results:

The 2 year yield data is summarized in table 1. Seeding rates had minimal impact on yields based on the average data but results were variable between years. All yields are reported on a 100% dry matter basis (0% moisture).

Table 2 contains the seeding rate data broken down by year. In 2012 Oats and Peas (O+P) were the only crop that showed any response to higher seeding rates. Oats alone and barley showed no response to increasing seeding rates above 2 bushels/acre. In 2013 all 3 crops had a yield response to higher seeding rates. However, yield response was variable across locations. The low yields in 2013 are due to late planting dates (early Aug in 2012 and mid to late Aug in 2013) and extremely dry August/early September conditions in 2013 vs high rainfall in 2012. While there is response to seeding rate in 2013, it is generally not an economic response.

Table 1: Average Yield Results 2012/2013 8 Sites (t/ac)

Seeding Rate (lbs/ac)	0 N	30 N	60 N	90 N
70 lbs Oats	1.13	1.58	1.75	1.97
105 lbs Oats	1.00	1.56	1.71	1.94
140 lbs Oats	1.22	1.65	1.86	1.95
160 lbs Oats	1.28	1.84	1.98	2.20
70 lbs O+P	1.09	1.40	1.53	1.66
105 lbs O+P	1.34	1.60	1.79	1.91
140 lbs O+P	1.45	1.78	1.91	2.00
170 lbs O+P	1.41	1.75	1.88	2.02
90 lbs Barley	0.86	1.15	1.33	1.43
130 lbs Barley	0.90	1.23	1.44	1.60
170 lbs Barley	0.95	1.26	1.44	1.65
205 lbs Barley	0.92	1.35	1.49	1.70

Table 2: Seeding Rate Impacts by Year

Seeding Rate (bu/ac)	Oats		O+P		Barley	
	2012	2013	2012	2013	2012	2013
2	1.90	1.43	1.69	1.23	1.68	0.74
3	1.80	1.46	1.84	1.56	1.61	1.04
4	1.83	1.63	2.03	1.60	1.72	1.00
5	1.97	1.80	1.94	1.67	1.67	1.13

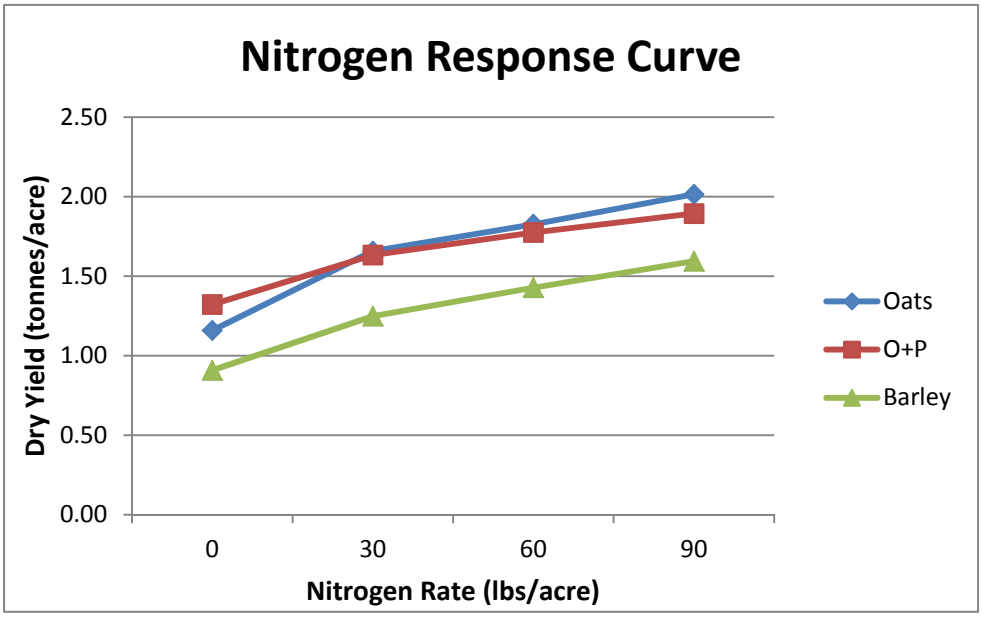
Nitrogen (N) rates had a major impact on yields. Yield response to N is summarized in Table 3. In 2012 oats and O+P had relatively strong yields with no nitrogen but yields still increased dramatically with the addition of 30lbs N and continued to increase up to 60 N. There was no additional yield response 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.

In 2013 a 120 N treatment was added to the trial. Similar to 2012 oats and O+P had relatively strong yields with no nitrogen. Yield response to 30 N was not as significant in 2013 but yields continued to respond to added N up to the 120 N treatment. Based on 2013 data a 150 N treatment should have been included to discover if yields could continue to increase. In both years 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.

Table 3: Yield Response to Applied N by Year

N Rate (lbs/ac)	Oats		O+P		Barley	
	2012	2013	2012	2013	2012	2013
0	1.39	0.93	1.49	1.15	1.14	0.68
30	1.95	1.36	1.91	1.36	1.63	0.87
60	2.10	1.56	2.05	1.50	1.86	0.99
90	2.07	1.96	2.05	1.74	2.05	1.14
120	-	2.08	-	1.83	-	1.21

Figure 1: Yield Response of Cover Crops to Added Fertilizer N 2012/2013 Average



Yield is not the only factor that affects cover crops grown as forage. The relative feed value (RFV) determined from the quality analysis across locations is summarized in Table 4. RFV incorporates potential intake along with digestibility to produce one value to represent forage quality. In 2012 RFV for barley and oat decreased slightly but consistently as nitrogen rates increased. The exact reason for this decrease has not been determined. Whether higher nitrogen rates caused increased stem elongation and increased lignin content, or some other factor, this result remains to be explained or verified. 2013 results showed almost no difference in RFV across treatments. Increasing nitrogen rates had little impact on the quality of the O+P mix in both years, where the addition of peas helped maintain forage quality across N rates.

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, and is used as an indicator of feed value in the beef and sheep industry. NEg is based on ADF (Acid Detergent Fibre) values and is expressed in mega calories per pound. Results varied across locations but barley consistently had a slightly higher

NEg at all sites in 2013. Except for some variation in NEg in oats, nitrogen rate had little impact on NEg.

Table 4: Relative Feed Value (4 Locations)

N Rate (lbs/ac)	Oats		O+P		Barley	
	2012	2013	2012	2013	2012	2013
0	121	118	115	116	121	136
30	119	113	118	112	114	131
60	111	109	114	114	110	129
90	108	108	113	119	106	135
120	-	115	-	118	-	134

Milk/tonne is a more comprehensive analysis to predict milk production from each treatment, and is a better tool to assess value in the dairy industry. It is based on NDF (Neutral Detergent Fibre), crude protein, ash, and ether extract. Similar to NEg, barley had slightly higher milk/tonne across all locations in 2013. Surprisingly, the oat/pea combination did not result in higher milk/tonne, as might have been expected with the higher protein level achieved with the peas in the mixture.

Table 5: NEg (Mcal/lb) and Milk/tonne (lb milk/tonne)

Crop	Assessment	0 N	30 N	60 N	90 N	120 N
Oats	Milk/tonne	3141[1]	3103	3064	3052	3068
	NEg	0.90 [2]	0.82	0.83	0.79	0.87
O+P	Milk/tonne	3104	3056	2989	3057	3049
	NEg	0.87	0.85	0.85	0.86	0.84
Barley	Milk/tonne	3164	3176	3135	3144	3111
	NEg	0.95	0.91	0.91	0.94	0.93

[1] lbs milk per tonne of feed; [2] Mcal/pound

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 O+P clearly had higher protein values than barley or oats alone. The protein values are relatively low in 2012 because the crops were at the heading stage when harvested compared to the flag leaf stage in 2013.

Another consideration when growing any forage is nutrient removal. Phosphorus and potash removal is summarized in Tables 7 and 8. The removal values are summarized as the amount of fertilizer needed to replace crop removal. 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: i.e. oats with 60 lbs N applied removed 30.6 lbs of P2O5 and 136.3 lbs of K2O per acre (on average) in 2012.

Table 6: Crude protein values (%)

N Rate (lbs/ac)	Oats		O+P		Barley	
	2012	2013	2012	2013	2012	2013
0	7.8	11.6	10.4	15.4	8.9	13.1
30	8.7	12.2	12.6	15.1	9.7	14.3
60	9.1	13.2	12.8	16.6	10.5	15.3
90	10.7	14.0	14.0	16.1	10.9	15.8
120	-	16.2	-	17.9	-	16.4

Table 7: P2O5 Removal (lbs/ac)

N Rate (lbs/ac)	Oats		O+P		Barley	
	2012	2013	2012	2013	2012	2013
0	19.2	10.4	22.8	12.8	17.6	9.3
30	28.6	18.3	31.3	17.3	26.8	12.5
60	30.6	19.6	32.5	20.4	32.5	15.8
90	31.8	23.4	35	20.6	36.5	17.6
120	-	25.9	-	22.9	-	20.0

These removal rates are extremely high**.** In high yield situations, over $100/acre can easily be removed in P and K fertilizer values alone. The difference in phosphorus and potash removal between 2012 and 2013 is explained by the higher yields in 2012.

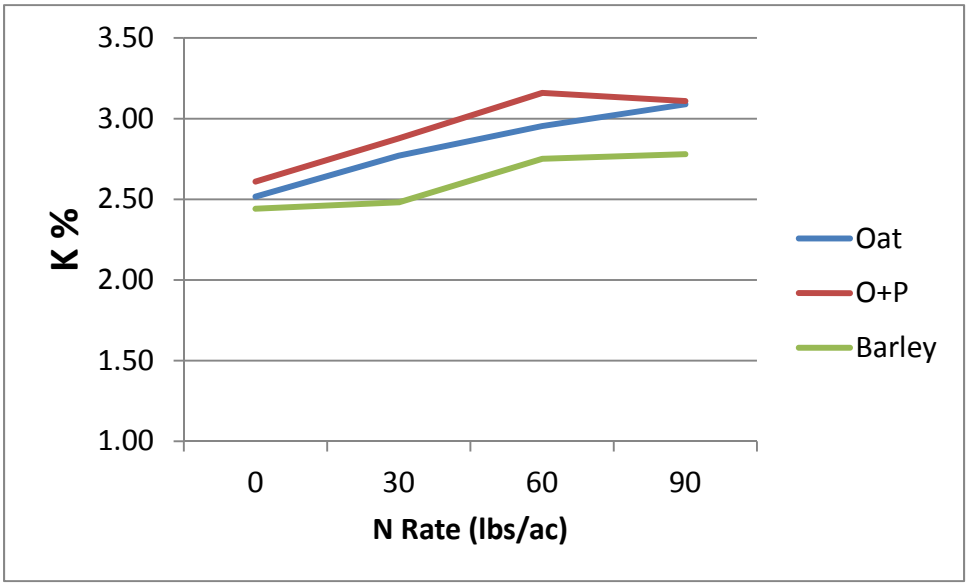
Table 8: K2O Removal (lbs/ac)

N Rate (lbs/ac)	Oats		O+P		Barley	
	2012	2013	2012	2013	2012	2013
0	70.2	54.6	91.6	65.2	59.0	42.8
30	120.8	98.0	136.1	91.8	93.0	57.7
60	136.3	112.8	151.7	112.6	119.4	74.3
90	150.2	121.4	167.9	106.9	138.1	84.0
120	-	140.9	-	122.0	-	100.7

Potash concentrations in all crops increased dramatically as nitrogen rates increased (Figure 2). 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. However, the consistency of this outcome, and the huge impact on nutrient removal, means it must be considered when harvesting the crop.

Figure 2: Nitrogen impacts on Potash Concentration (2012/2013 avg)



Summary:

Bottom line: recommendations based on the 2 years of this study (to date) support oats as the cover crop of choice, with seeding rates kept reasonably low and additional dollars spent on nitrogen. Weed control is critical to successful cover crop growth. High potash removal rates must be accounted for when removing a cover crop grown after winter wheat as forage.

Seeding rates had little impact on yield while nitrogen dramatically increased forage yields. With no added nitrogen oat-pea blends had the highest yields in both 2012 and 2013. With only 30 N applied oat yields began to surpass O+P yields. Additional seed costs associated with the inclusion of peas indicate that oats alone would be more economical, when 30 units of applied N was applied, unless high protein feed is required.

Oat forage yields increased sufficiently to warrant 60 lbs/ac N applied in 2012, and 90 lbs N/ac in 2013. The oat-pea blend responded to 30 N and 90 N, and the barley to 90 N and 90 N, respectively.

When considering both yield and forage quality, oats plus nitrogen still come out on top. Barley had the highest relative feed value but low barley yields mean less total feed value harvested/acre. Barley required 90 N/ac to match oats or O+P with 30N in NEg or milk/acre. If highest crude protein is required then an oat-pea blend would be the best choice but based on milk or NEg production per acre oats with applied N is the clear winner. Not only do oats with N have the highest production per acre but also the lowest cost.

In 2012 two sites also included spring wheat and forage oats. Spring wheat showed little potential based on yield or feed value. Spring wheat advanced much quicker through its growth stages than expected. Wheat appears most sensitive to photoperiod: 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. Forage oat yields were poor but they had the highest feed value of all the crops. This was likely do to the fact that the forage oats were at the boot stage while the other crops had advanced well into heading.

The yields and quality from one location in 2013 were not including in this report due to large variability in the data. This is likely due to the high weed pressure at this location which illustrates the importance of proper weed control to grow a successful cover crop.

Potash removal rates border on extreme. Phosphorus removal rates are significant. Removal of fertilizer nutrients can easily top $100/acre. These costs must be included when determining the practicality of these crops as forage, and replacement of these nutrients is critical.

Next Steps:

This trial will continue again in 2014 to further examine which management strategies result in the best cover crop for many different uses. Anyone interested in cooperating in this trial in 2014 should contact Peter Johnson at peter.johnson@ontario.ca or Shane McClure at shane.mcclure@ontario.ca

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Location of Project Final Report:

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