Saskatchewan
Soil Conservation
Association

Soil Facts

Forage Stand Rejuvenation using Liquid Fertilizer

Establishing perennial forage stands for grazing and hay production is an important way to diversify farm income and improve the economic value of marginal land. Forage stands lose productivity over time for a variety of reasons including reduced stand vigor, export of nutrients, loss of desirable species, over grazing and poor soil fertility. In the past, old stands were broken with extensive tillage and then reseeded (Kruger, 1997). This approach has major economic problems: lost productivity while the old stand is removed and the new stand established; and the high cost involved to remove and then reseed a forage stand. Extensive tillage increases the soil erosion potential, and difficulties with germination and stand establishment can occur.

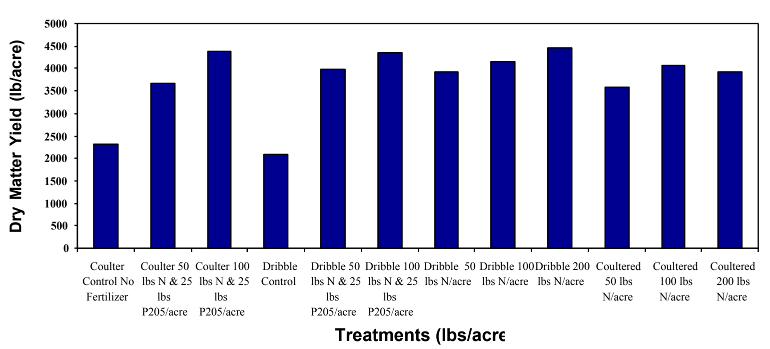
50 lb/acre dribble band treatment. The largest response to fertilizer N was for the first 50 lb/acre. The yield response in 2005 was around 1 ton/acre.

Nitrogen (N) is the most commonly deficient essential nutrient in prairie soils and generally has the greatest impact on forage production (Lardner et al., 2004). Phosphorus (P) may also be limiting in some soils (Berg and Sims, 1995). Rejuvenation is usually the most economical and practical method for improving the productivity and quality of forage stands (Lardner et al., 2004). Significant research across the Canadian Prairies and northern Great Plains shows the benefits of forage fertilization in rejuvenating forage stands (Malhi et al., 2004). The effectiveness of fertilizers in increasing forage dry matter yields (DMY) and economic return depends on the nutrient levels in the soil, climatic conditions, fertilizer source, rate and application method, soil type, and forage species (Lardner, 1998). The decision to fertilize in a rejuvenation program must therefore be based on the yield potential of the soil and the degree of pasture deterioration.

Zero fertilizer check plot. Old "sod-bound" grass stands are very responsive to N fertilization.

Since the spring of 2005, the Saskatchewan Soil Conservation Association and the University of Saskatchewan soil science department, with funding from the Greencover Canada program, studied the effects of managing forage production on marginal land for longevity using liquid fertilizer. This project examined the forage response to varying rates of liquid UAN fertilizer with and without P and addressed the nutrient use efficiencies of both coulter injecting and dribble banding placement methods. The final part of the study determined the economic viability of fertilizing for forage yield versus breaking an old stand and reseeding.

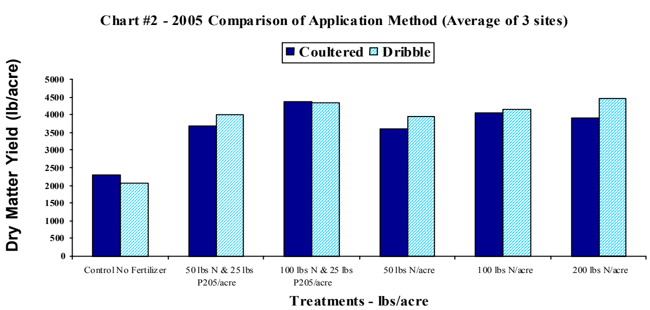
Chart #1 - 2005 Dry Matter Yields (Average of 3 sites)



The experiment was conducted on old, unproductive meadow bromegrass-dominated pastures near Rosthern, Vanscoy and Colonsay, Saskatchewan. Each forage site had been established on marginal land with sandy textured, infertile soils. In April 2005, UAN solution (28-0-0) was applied at rates of 50, 100 and 200 lbs of actual N/acre with and without 25 lbs/acre of actual P (10-34-0 solution) using two different application methods – dribble banded (surface applied as a dribble band on 12 inch centers) and coulter injected (a coulter disc placed the fertilizer directly into the soil as a band at a depth of 3-4 cm and 12 inches apart). Each site had a total of 12 treatments and each treatment was replicated 3 times.

Yield Responses in Year of Application (2005)

The N and P fertilizer treatments produced significantly higher forage dry matter yields than the control (no fertilizer) plots (chart #1). The 50 lb N/acre rate had the largest incremental yield increase, yielding close to 1 ton/acre of additional dry matter production over the unfertilized controls. Increasing the N rate above 50 lbs N/acre had a greater impact on the protein content than yield. Much of the forage dry matter yield response in this study is attributed to the added N, as there were insignificant yield responses from the added P. Previous studies suggest that nitrogen is the major limiting nutrient in grass pastures (Malhi et al, 1993. & Campbell et al., 1986) and the results of this study support this. Harapiak et al. (1984) also reported that grass dominated haylands are much less responsive to P fertilizer than N. This may be due to mineralization of organic P in the rhizosphere of grasses and/or a significant role of arbuscular mycorrhizal fungi in enhancing P turnover and availability.



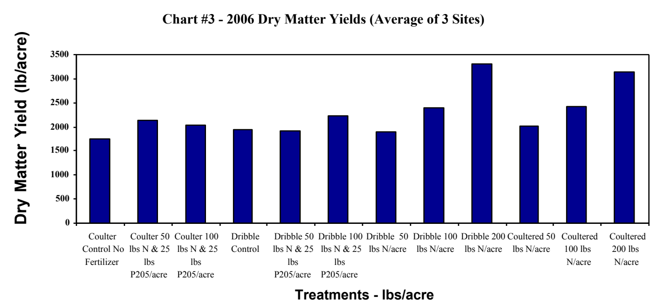
The degree of response grass stands will show from added N will depend on the amount of rainfall during the growing season. Under dry soil conditions, nitrate mobility in the soil will be reduced, causing limited flow of N to the roots (Cohen et al., 2003). In this study, the increase in forage dry matter yields in the fertilizer treatments was also attributed to above average precipitation.

Coulter Band Versus Dribble Band

There were no significant differences in forage dry matter yield comparisons between the 2 application methods for any fertilizer treatments in this study (chart #2). Significant rainfall after application of the fertilizer likely contributed to the similarities between the two application methods, as the precipitation moved the surface banded nitrogen into the mineral soil. This implies that cattle producers will not need to make a large capital expenditure such as the purchase of a coulter drill to inject liquid fertilizer into the mineral soil. Instead, producers can simply retrofit their sprayers (at a relatively low cost) with dribble band nozzles and surface dribble apply the liquid fertilizer. The fertilizer can be applied either in the late fall or before a significant rainfall event in the spring. The fertilizer will move down into the root zone with the added moisture, thereby reducing atmospheric losses of N while improving nutrient use efficiencies.

Yield Responses in the Year Following Application (2006)

In the second year following the fertilizer application, all 3 sites exhibited limited responses in dry matter yields at all treatment levels except for the highest N application rates (Chart #3). As predicted by the soil N residual supply measurements taken in the fall of 2005, only the high N application treatments made the previous year showed a significant yield benefit in 2006, with the 200 lb N/acre rate treatments yielding about 1 ton/acre higher than the other treatments. The dry matter yields obtained in the 200 lb/acre treatments of 2006 were very similar to those collected in the year previous. High rates of N fertilizer applied in excess of crop requirements in the year of application can carry over and supply N to the forage the following year, although leaching and denitrification losses are a possibility. Previous studies by Lardner (1998) and Malhi et al. (2004) showed lower yields in the second year after application as all the applied N was utilized by the crop in the first year.



The yield data obtained in this study shows that in order to get consistent forage productivity, producers should expect to annually apply 40 – 50 lbs of N per acre to help keep forage stands productive (given adequate precipitation in the year of application). Producers need to conduct soil tests to determine the nutrient status of the soil to refine fertilization requirements.

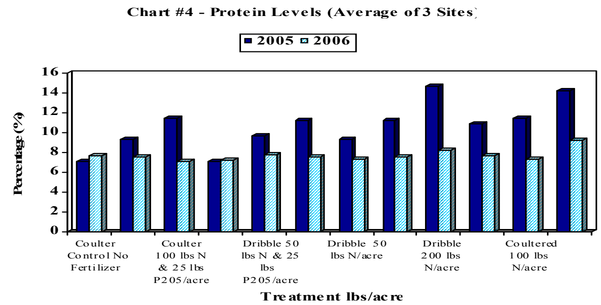
This study also shows that N applications made in a drier year should carry over and be available for the forage crop the following year. The results of this study are supported by Cohen et al (2003), whose forage research in the semi arid prairies also shows that much of the applied N that is not used by a forage crop in the year of application stays in the soil without significant leaching or denitrification, and that the added N has contributed to positive yields particularly in the first year after application.

With any forage fertilization program, producers should utilize tissue tests as a precaution to determine nitrate accumulations in the forage. Nitrates will tend to accumulate in plant tissue in periods of environmental stresses such as droughts and cool weather conditions.

N Concentration & Crude Protein

The N concentration in the forage was increased at all 3 sites in 2005 by applying N fertilizer. The concentrations increased with increasing N application rates. In 2006 the N concentrations in the dry matter decreased, with only the highest N application rates showing any significance. The N concentration is used to estimate crude protein in plants, calculated by multiplying % N by 6.25. (Malhi and Ukrainetz, 1990)

Protein is the main element determining gain in animals. In 2005, the protein concentration of the meadow bromegrass increased with higher rates of N in all treatments versus the control treatments (Chart # 4). Generally protein responses varied from 3.6% increase at the lowest N application rate up to 9.0% increase with the highest N application rates throughout the 3 sites. In a study conducted by Malhi et al (2002) near Lacombe, Alberta, nitrogen applications of 54 and 160 lbs/acre also showed similar protein responses.



In 2006, there was a general trend for higher protein levels to be found only in the highest N application treatments. It can be concluded that a protein response could be obtained for only 1 or 2 years after application based on initial N application levels.

Economics of Forage Rejuvenation

An economic analysis was conducted to determine costs per acre for rejuvenating a forage stand through fertilization versus the traditional method of breaking and reseeding. The machinery costs given in the tables are based on Saskatchewan Ministry of Agriculture's *Farm Machinery Custom Rate and Rental Guide 2007.* Fertilizer prices are based on fall 2007 pricing.

Table 1 shows the limited operations required to fertilize an old forage stand. The costs are very simple, purchase the fertilizer and rent a coulter drill. The liquid fertilizer could be surface applied with a sprayer, which has reduced draft requirements therefore reduced cost per acre. The fertilizer costs are based on fall of 2007 pricing. In the first scenario (Table 1) the total cost per acre was estimated to be approximately $39.00/acre for a yearly fertilizer application. However individual grower costs will change based on soil test results, as 50 lb/acre may be a high end fertilizer rate for forage stands. In the current study, the 50 lb/acre rate of applied N produced approximately 1 ton of extra forage dry matter yield in the first year. The value of meadow brome will change yearly, based on supply and demand, however in this study we valued it at $50.00/tonne. The end result is the fertilizer application produced a net return of $11.00 per acre. Returns may be better if we assume the rejuvenation is being completed on pasture and the additional production is being sold as beef.

In Table 2, the variable costs given in the break and reseed scenario will vary from farm to farm as individual growers will have different machinery complement to effectively produce the same results. However in this scenario a net cost per acre of approximately $93.00 was required to break and reseed the stand. This figure is relatively low and does not reflect the true costs as loss of production for 1 or 2 years should also be factored in. Secondly fertilizer N was not added because mechanical disturbance results in an accelerated release of nitrogen that was tied up in the soil and the roots. Eventually fertilizer N will have to be added 2 or 3

Table 1 – Total Cost To Fertilize an Established Forage Stand

Variable costs	Costs per acre
Fertilizer cost (50 lbs N + 15 lbs P) (N @ $0.45/lb – P @ $0.50/lb)	$30.00
Tractor + fertilizer applicator (custom hired)	$9.00
Total cost per acre to fertilize	**$39.00**

Table 2 – Total Cost To Establish and Break Up Tame Forage

Variable costs	Cost per acre
Breaking cost – 20 foot tandem disc – twice -custom hired	$25.60
Custom spraying	$4.25
Chemical (1 litre glyphosate + 0.45 litre 2,4-D)	$9.90
Air disc drill and tractor (custom hired)	$20.57
Meadow bromegrass seed (10 lbs/acre) (seed = $2.50/lb)	$25.00
Fertilizer (15 lbs actual P) (P @$0.50/lb)	$7.50
Total cost per acre to establish and break up hay	**$92.82**

years in to the breaking and reseeding and then applied thereafter on a yearly basis. To reflect the true costs of breaking and reseeding, the costs per acre should be factored over a period of 5 to 7 years, as resulting production will help lower costs per acre over time.

Table 3 lists all of the existing rejuvenation methods for forage growers to use. For more information on each individual rejuvenation techniques and when it should be used, please refer to the following Saskatchewan Ministry of Agriculture's website titled The Rejuvenation of Tame Forages – Parklands.

In the scenario presented in Table 3, net returns of individual rejuvenation options are calculated over a 3-year period except for the break and reseed method, which is calculated over a 5-year period. The value of hay is also assumed to be $50.00/tonne. Fertilizing tame hay had the highest and most consistent net returns followed by sod seeding. However it was estimated that the breaking and reseeding method had a negative net return of 7-8 dollars per acre. The high costs involved in breaking and reseeding and the loss of production for 1 or 2 years have largely contributed to the negative net return.

Conclusions

An established grass stand that is losing productivity but has an adequate population of desirable plant species may be rejuvenated by an application of fertilizer N. With adequate levels of soil moisture, fertilizer N has been shown to have positive responses with dry matter yields, N uptake, fertilizer recovery, crude protein levels, and increases in total organic carbon levels of the soil. To maintain a consistent yearly level of forage production, forage growers should consider fertilizer applications. Determining the correct fertilizer application rate should be based on soil tests. While fertilizing can be done either in the late fall or early spring, results and profitability will depend on available moisture, the price of fertilizer, and the value of hay.

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References

Berg W.A. and Sims P.L. 1995. Nitrogen fertilizer use efficiency in steer gain on old world bluestem. J. Range Manage. 48: 64-67.

Campbell, C.A., A. J. Leyshon, H. Ukrainetz, and R. Zentner. 1986. Time of application and source of nitrogen fertilizer on yield, quality, nitrogen recovery, and net returns for forage dryland grasses. Can. J. Plant Sci. 66. 915-931.

Cohen, R.D.H., Howard, M.D., Wright. S.B.M., Tomas, L.R., and McCaughey, W.P., 2003. Current and residual effect of nitrogen fertilizer applied to grass pasture on production of beef cattle in central saskatchewan. Can. J. Anim. Sci. 84:91-104.

Kruger G. 1997. Seed production of meadow bromegrass (*Bromus riparius* Rehm.). Agric. and Agri-Food Can., Saskatoon, SK.

Lardner, H.A. 1998. Rejuvenation of tame forages. Ph. D. Thesis. Department of Animal and Poultry Science. University of Saskatchewan. Saskatoon, SK.

Lardner H.A., Wright S.B.M., Colen R.D.H., Curry P. and MacFarlane. 2002. Rejuvenation affects nutritive value of long-established tame forages. Can. J. Anim Sci..

Malhi S.S., Gill K.S., McCartney D.H. and Malmgren R. 2004. Fertilizer management of forage crops in the Canadian Great Plains.

Malhi, S.S. and Ukrainetz D. 1990 Effect of band spacing of urea on dry matter and crude protein yield of bromegrass. Fert. Res. 21: 185-187.

Saskatchewan Agriculture and Food. 2002. Rejuvenation of tame forages - Parklands.

Sedivec K.K. and Manske L.L. 1990. Renovation of rangeland and grassland pastures. N.D.S.U. Ext. Serv. Publ. Fargo N.D. Vol. 14: 6.

Table 3 - Net Return Per Acre Totaled Over 3 Years For Rejuvenation Options

Treatment	Production Change %	Yield Change 1b/acre	Value $/acre	Cost of Operation $/acre	Net Return $/acre
Spike	5.4	146	3.65	4.40	-0.75
Knives	20	540	13.40	4.40	9.00
Mow	7	189	4.72	10.00	-5.28
Burn	12.5	324	8.10	2.50	5.60
Broadcast Fertilizer	-	1600	40.00	31.50	8.50
Deep-band Fertilizer	-	1750	43.75	34.30	9.45
Sod Seed	-	-	51.40*	42.96	8.44*
Over-seed	-	-	-	9.85	N/A
Break & Reseed	-	-	111.36*	118.94*	-7.58

Value of hay production at $50.00/ton
*Based on five years of yields for treatment to achieve full establishment and yield.
Source – Rejuvenation of Tame Forages – Parklands, SK. Ag & Food. 2002

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