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Profitability of Nitrogen Applications for Stockpiling Tall Fescue Pastures, 2011

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The profitability of cow-calf operations is finally looking good in 2011 due to the historically high calf prices. However, one of the challenges producers still face is high hay feeding costs. Kentucky cattle farmers have an opportunity to reduce their hay requirements by applying nitrogen on select pastures to stockpile for fall and winter grazing. By increasing the total pasture production during this time period, the grazing season can be extended and the amount of hay required can be reduced.

The concept of stockpiling is pretty straightforward, but the challenge each year is to determine the likelihood that this practice will be profitable given the economic and agronomic conditions present at mid-summer. This practice can yield significant benefits, but it also carries significant costs. These benefits and costs must be quantified and compared to assess the overall profitability of the practice.

Nitrogen prices have increased significantly since last year. Ammonium nitrate is currently selling for around \$500 per ton (\$.75/unit), and urea prices range from \$550 to 625 per ton (\$.60-.68/unit). These costs will decrease the profitability of this practice compared to last year.

Soil moisture conditions in late July 2011 are highly variable throughout the state with some areas near ideal conditions and others in mild drought. As a consequence, multiple response rates are used in this analysis to simulate different soil moisture conditions for your location. Those areas that have received more rainfall will offer the best opportunities for applying nitrogen and stockpiling. *The primary objective of this publication is to help farmers identify those situations where applying nitrogen to late summer pastures will be profitable in 2011.*

This publication has two main sections:

- **Agronomic Basics for Stockpiling Fescue** provides the basics for applying nitrogen to late summer pastures and how to stockpile this forage for fall and winter grazing.
- **Potential Savings from Applying Nitrogen to Tall Fescue Pastures** describes the methods used in the profitability analysis, discusses important assumptions, and provides a summary of the profitability for stockpiling tall fescue pastures given various scenarios. Three prices for nitrogen and four prices for hay are evaluated as well as multiple nitrogen response rates for both tall fescue and fescue-clover pastures.

Agronomic Basics for Stockpiling Fescue

Stockpiling can be defined as growing pasture for later use. In Kentucky this typically means applying nitrogen (N) to tall fescue pastures in August, letting them grow through the fall, then grazing during the late fall and early winter. Kentucky bluegrass and other cool-season grasses will also respond to nitrogen applications in the fall, but this publication focuses on tall fescue since it shows a higher N response and stockpiles better for winter grazing.

The best pastures to target are those with the thickest stands of fescue. Fescue responds extremely well to N applications in late summer and has an amazing ability to retain its nutrient value through the winter. Targeted pastures should have low concentrations of weeds and low amounts of clover since legumes do not stockpile well after frost and the yield benefit of added N is less than in pure fescue stands. Moreover, N has the

potential to reduce the clover component of the sward as the additional fescue growth will compete with the legumes. A good rule of thumb is that where clover makes up more than 20 percent of the stand, the short-term yield increase from nitrogen will not typically outweigh the long-term forage quality and nitrogen fixation benefit of the lost clover.

Pastures should be grazed or mowed to reduce fescue height to 2 to 3 inches during early to mid-August. Remove animals before overgrazing occurs or initial regrowth will be slow. Grazing or mowing removes low-quality summer growth and allows the plant to produce high-quality leaves. Assuming that there is adequate soil moisture, a considerable amount of growth will occur within 4 to 6 weeks, but waiting 8 to 12 weeks before grazing is preferable.

The optimal time to apply N is early to mid-August. Prior applications may encourage the growth of weedy grasses such as crabgrass. Waiting until September will reduce the efficiency of N conversion into plant growth. For example, one Kentucky study showed that N conversion efficiency (lbs dry matter fescue growth per unit N) was 27:1 on Aug 1, 26:1 on Aug 15, 19:1 on Sept 1, and 11:1 on Oct 1. *Therefore, when N application is delayed until September or beyond, optimal N application rate will decrease, and you should carefully consider the benefit of increased fescue growth compared to the cost of purchased hay.* N response efficiency also depends on soil moisture. Without rain and/or adequate soil moisture, N response will be low, but even with small amounts of rain tall fescue has an amazing potential for fall growth. *In areas that are exceptionally dry, applying N can be a gamble in terms of the response.*

Contributors

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Traditional stockpiling involves keeping cattle off the pasture until late fall, but this practice may be difficult when pasture production is low. If forage is needed, N fertilized pastures can be grazed in the early fall, but it is recommended that cattle be kept off these pastures for at least a month. An alternative strategy is to feed hay during the stockpiling period to supplement the pastures that cattle are on.

Tall fescue growth will occur without added N, but University of Kentucky Cooperative Extension emphasizes the importance of adding N for maximum growth and forage quality. In Kentucky, nitrogen (90 units or actual lbs N) increased forage production by over a ton and protein by 5 percentage points. In Ohio, nitrogen (90 units or actual lbs N) increased protein by 9 percentage points and improved overall digestibility. Another reason to stockpile fescue is that it retains its quality extremely well through the winter months. In an Arkansas research study, stockpiled fescue was higher quality (12% CP and 55% TDN) even in early March than average quality hay. This attribute can be particularly beneficial for a late winter or spring calving cow herd.

Several forms of N are available for pasture use, but the two main types are ammonium nitrate and urea. Ammonium nitrate is an excellent form to use in late summer because it is not subject to surface volatilization. Urea is generally a cheaper source of N, but a significant amount of N can be completely lost under hot, humid, and dry soil conditions favoring volatilization. Typical urea losses in late summer range from 15 to 30 percent, but can approach 40 to 50 percent when there is no rainfall for several weeks after application. Fortunately, urease inhibitors (e.g. Agrotain) have been recently developed to reduce volatilization losses with urea (see AGR-185 at <http://www.ca.uky.edu/agc/pubs/agr/agr185/agr185.pdf>). Even though they add to the overall cost, urease inhibitors are recommended in the summer for urea due to the unpredictable rainfall in August. The most effective urease inhibitors will typically prevent volatilization for two weeks without rain, compared to pure urea where volatilization begins immediately after application. Be aware that all urease inhibitors are not equally effective.

Besides the application of N, it is important that stockpiled fields be limed and fertilized with phosphorous (P) and potassium (K) to acceptable levels (see AGR-1 at <http://www.ca.uky.edu/agc/pubs/agr/agr1/agr1.pdf>). Where possible, stockpiled tall fescue fields should be strip grazed and stocked heavily enough to graze down each paddock in 7 to 10 days or fewer. This practice allows the forage to be efficiently utilized without excessive trampling and waste. Since tall fescue does not re-grow in the winter, a back fence is not needed when strip grazing stockpiled growth (see AGR-162 at <http://www.ca.uky.edu/agc/pubs/agr/agr162/agr162.pdf>).

Potential Savings from Applying Nitrogen to Tall Fescue Pastures

The analysis presented here accounts for the major factors that impact the profitability of nitrogen applications to late summer tall fescue pastures and includes the price of nitrogen, price of hay, response rate of nitrogen, labor costs of feeding hay and stockpiled fescue, waste rates, nutrient recycling of hay, and forage quality. As the price of N increases, profitability of the practice will decrease. As the price of hay increases, profitability will increase. As soil moisture conditions improve, profitability will increase. This analysis determines the changes in net revenue from late summer nitrogen applications of 40 and 80 units (120 lbs and 240 lbs of ammonium nitrate respectively) compared to no application. Changes in profitability are based on a 30-cow, spring-calving herd.

Two of the most important factors in this analysis are the price of nitrogen and the price of hay. The price of nitrogen was evaluated on an elemental (lbs actual N) or unit basis between \$.65 to \$.85 per unit, representative of prices in mid-July 2010 (\$.65/unit N = \$435/ton AmmNit and \$600/ton urea; \$.75/unit N = \$500/ton AmmNit and \$690/ton urea; \$.85/unit N = \$570/ton AmmNit and \$780/ton urea). For urea, multiply the actual price by 1.2 to 1.4 to get an effective price (or use a lower response rate). To convert

Table 1. Recommended N response rating based on soil type/moisture condition.

Soil Type	Soil Moisture Conditions		
	Ideal	Average	Low
Excellent	High	Med/High	Low/Med
Good	High	Medium	Low
Fair	Med/High	Low/Med	Low

Note: N should be applied by mid-August for maximum effectiveness. Use appropriately lower N response rating for later applications.

Source: Faculty of University of Kentucky Department of Plant and Soil Sciences

elemental N to urea multiply elemental value by 2.17 (e.g. 100 units N = 100 x 2.17 = 217 lbs urea). To convert elemental N to ammonium nitrate multiply elemental value by 2.99. (e.g. 100 units N = 100 x 2.99 = 299 lbs ammonium nitrate).

Hay values were evaluated on a per ton basis between \$40 and \$70. These values should capture most of the variability in market conditions that is likely to occur this year. Users of this publication need to use their best judgment for anticipated price(s) including those outside the range presented here.

The application cost for spreading the nitrogen was set at \$5 per acre. Waste rates for both grazing and hay feeding (the latter includes both losses from weathering and feeding) were set at 35 percent. Machinery and labor costs were set to be representative of the average Kentucky cow-calf operation in both size (30-cow herd) and management intensity. This resulted in a labor cost of \$.06 per cow day for grazing (assuming open-access to stockpiled pasture—not strip grazed), and machinery and labor cost of \$.25 per cow day for hay feeding. Feeding hay results in imported nutrients being deposited in pastures. It is assumed that 50 percent of the P and K from feeding hay are effectively recycled into the soil at \$.57/lb for P₂O₅ and \$.52/lb for K₂O.

Finally, three nitrogen response rates were used in the analysis: low, medium, and high. Consult Table 1 to determine which nitrogen response curve is most appropriate for your specific condition. *The response rate is probably the single most important determinant in the analysis.* These response rates are based on a four-year Missouri study. The high response rate used in the model was actually the average of the four years from this study

Figure 1. Nitrogen response curve (low).

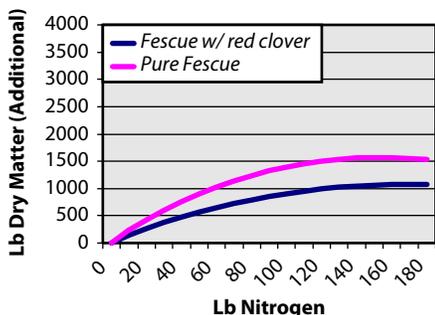


Figure 2. Nitrogen response curve (medium).

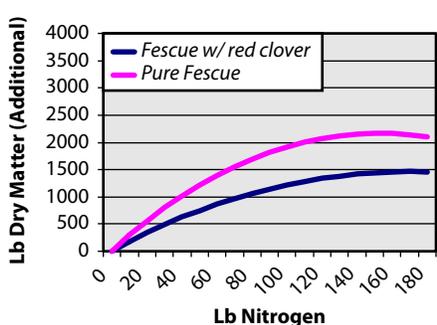
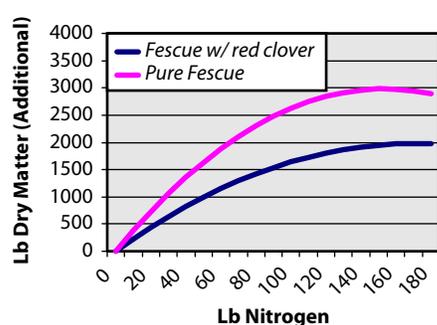


Figure 3. Nitrogen response curve (high).



that included both wet and dry years. However, the study site was on deep, fertile soil and would be representative of the best soil types in Kentucky. Thus adjustments needed to be made from this base response rate depending on the soil quality and the specific soil moisture conditions present. University of Kentucky agronomists (Drs. Lloyd Murdock and Ray Smith) adjusted the response functions for various combinations of soil quality and moisture conditions.

In addition to the response rates, the model also separately evaluates pastures that are predominantly fescue and stands that are a fescue-clover mix (Figures 1, 2, and 3). “Fescue-clover” stands in the Missouri study had an average of 20 to 30 percent clover (mostly red). “Fescue” stands were on average about 95 percent tall fescue. Thus if you have a fescue-clover stand that contains 10 to 15 percent clover you would probably want to average the results for the two stand types. As men-

tioned earlier, nitrogen has the potential to reduce the clover component of the sward, so nitrogen applications are not normally recommended where clover makes up more than 20 percent of the stand.

Results

Table 2 summarizes the cost savings from applying 40 or 80 units of nitrogen on a per acre basis. Using the most likely price estimates for nitrogen (\$.75/unit or actual lbs N for ammonium nitrate)

Table 2. Cost savings (\$/acre) of applying nitrogen to late summer pastures in Kentucky (2011).

Price		Low Response to Nitrogen				Medium Response to Nitrogen				High Response to Nitrogen			
		Fescue ¹		Fescue-Clover ²		Fescue ³		Fescue-Clover ⁴		Fescue ⁵		Fescue-Clover ⁶	
Nitrogen (\$/unit)	Hay (\$/ton)	40 units N	80 units N	40 units N	80 units N	40 units N	80 units N	40 units N	80 units N	40 units N	80 units N	40 units N	80 units N
0.65	40	(11)	(23)	(19)	(36)	(2)	(9)	(14)	(28)	9	10	(8)	(17)
	50	(6)	(15)	(16)	(31)	4	2	(10)	(21)	18	25	(2)	(7)
	60	(1)	(6)	(13)	(26)	11	13	(6)	(14)	27	40	3	2
	70	4	2	(10)	(20)	17	24	(2)	(7)	35	56	9	11
0.75	40	(15)	(31)	(23)	(44)	(6)	(17)	(18)	(36)	5	2	(12)	(25)
	50	(10)	(23)	(20)	(39)	0	(6)	(14)	(29)	14	17	(6)	(15)
	60	(5)	(14)	(17)	(34)	7	5	(10)	(22)	23	32	(1)	(6)
	70	(0)	(6)	(14)	(28)	13	16	(6)	(15)	31	48	5	3
0.85	40	(19)	(39)	(27)	(52)	(10)	(25)	(22)	(44)	1	(6)	(16)	(33)
	50	(14)	(31)	(24)	(47)	(4)	(14)	(18)	(37)	10	9	(10)	(23)
	60	(9)	(22)	(21)	(42)	3	(3)	(14)	(30)	19	24	(5)	(14)
	70	(4)	(14)	(18)	(36)	9	8	(10)	(23)	27	40	1	(5)

Note: Results are applicable for ammonium nitrate. For urea, use a lower response rating or a higher effective N cost to approximate volatilization losses.
 \$.65/unit N = \$435/ton AmmNit and \$600/ton urea
 \$.75/unit N = \$500/ton AmmNit and \$690/ton urea
 \$.85/unit N = \$570/ton AmmNit and \$780/ton urea

Assumptions

Cattle: Spring calving (late pregnancy in mid-winter); 30-cow herd.

Grazing: TDN = 65%; waste = 35%; application cost N = \$5/acre; labor cost = \$.06/cow/day with open access to entire pasture.

Feeding Hay: TDN = 55%; DMI = 2.0% hay + grain; waste = 35%; labor and machinery cost = \$.25/cow/day.

Nutrient Value of Hay: 50% of P and K effectively recycled into pasture; \$.57/lb P₂O₅; \$.52/lb K₂O.

Average dry matter response per lb N (80 lb application):

¹ 15.5 lb

² 9.9 lb; savings need to be balanced with potential loss of clover due to N applications.

³ 21.1 lb

⁴ 13.3 lb; savings need to be balanced with potential loss of clover due to N applications.

⁵ 28.8 lb

⁶ 17.8 lb; savings need to be balanced with potential loss of clover due to N applications.

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and hay (\$50/ton), applying nitrogen resulted in a net loss compared to feeding hay with a low nitrogen response rate for both pure fescue and fescue-clover stands. With a medium response rate applying nitrogen resulted in a net loss in fescue-clover stands and was about a break-even proposition in pure fescue stands. The high response rate resulted in net savings of \$14-17 per acre in pure fescue stands and a net loss in fescue-clover stands for these mid-range prices. Thus the only situation (at the most likely hay and nitrogen prices) in which applying nitrogen looks to be profitable this year is in pure fescue stands that have good to excellent soil moisture conditions. Note that even where potential cost savings in the fescue-clover stands exist with the high response rate (if you assume higher hay prices and lower nitrogen prices), this needs to be balanced with the potential loss of clover due to N applications.

Use Table 1 to determine which response function is most appropriate for your soil conditions and then use Table 2 to estimate potential savings (if any) based on your estimates for hay and nitrogen prices. *Make sure to use an appropriately lower nitrogen response rating if applications are to occur after mid-August.*

If you plan to use urea (without an effective urease inhibitor) as your nitrogen source, you should make adjustments in Table 1 to reflect volatilization losses

generally experienced at this time of year. There are two ways to do this:

- **Increase the effective price of the nitrogen.** An increase from \$.75 to \$.85 per unit N will approximate a 12 percent volatilization loss; an increase from \$.65 to \$.85 per unit N will approximate a 24 percent volatilization loss.
- **Use a response rating one level below what you would have otherwise.** This adjustment will approximate a 25 percent volatilization loss.

In either case, you will have to adjust the nitrogen application rates upward by the expected volatilization loss (e.g. if you expect a 33% loss multiply the rate by 1.33).

If your assumptions for waste rates, labor and machinery costs, nutrient recycling rates, etc. are much different than those used here, you will want to run your specific parameter estimates through the model. Contact the authors, and they will be happy to assist you.

Conclusions

Mostly pure fescue stands present limited opportunities for profitably applying nitrogen and stockpiling in 2011 with current nitrogen and hay prices. Hay prices at or above \$50 per ton offer moderate savings at the high response rate. Hay prices will need to be at or above \$70 per ton with the medium response rate in these pure fescue stands.

Cost savings did not occur in the mixed fescue-clover stands even with the best soil moisture conditions when evaluated at the most likely hay and nitrogen prices (\$50/ton and \$.75/unit respectively). Hay prices need to be around \$70 per ton, combined with an effective nitrogen price of \$.65/unit, before savings occur with the high response rate. In addition, any potential savings in the fescue-clover stands needs to be balanced against the potential loss of clover due to N applications. As a consequence, it does not appear that mixed fescue-clover stands would be good candidates for N applications this year.

Resources

- Stockpiling for Fall and Winter Pasture (AGR-162) <http://www.ca.uky.edu/agc/pubs/agr/agr162/agr162.pdf>
- Lime and Fertilizer Recommendations (AGR-1) <http://www.ca.uky.edu/agc/pubs/agr/agr1/agr1.pdf>
- Nitrogen Transformation Inhibitors and Controlled Release Urea (AGR-185) <http://www.ca.uky.edu/agc/pubs/agr/agr185/agr185.pdf>
- NRCS Online Soil Survey <http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>. (You may also access soil survey data at County Extension Office.)