Optimal Nitrogen Application Rates for Stockpiling Tall Fescue Pastures 2007 Guide

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Introduction:

Most of Kentucky has experienced harsh growing conditions for forage production in 2007. A severe April freeze followed by a dry spring and summer have cut hay and pasture growth by half in some cases. Many cattle producers, already short on pasture, are now worried about having enough hay to make it through the upcoming winter. Consequently, beef-cow quality hay that would normally be selling at $40-50 a ton during the winter is bringing more than twice that price in late summer in some locations. There has been wild speculation about what the price for this hay might be in January.

One opportunity that Kentucky cattle farmers have in reducing their hay demand is to apply nitrogen to select pastures and stockpile for fall and winter grazing. By increasing the total pasture production during this time period, the amount of hay required will be reduced. The challenge is to determine this optimal point given the economic and agronomic conditions present this summer. Since the response that a unit of nitrogen has on forage growth decreases as successive units are applied, there will be a point in which further applications of nitrogen will not pay. *Thus, at some point, adding additional grazing days will become more expensive than the traditional feeding option*.

A concern that farmers have expressed this year is that nitrogen may have limited response due to the dry soil moisture conditions present in much of the state. This is a valid concern and is accounted for in this analysis by using multiple response functions to simulate different soil moisture conditions. A practical implication is that those areas that have received more favorable rainfall in mid to late summer will offer the best opportunities for stockpiling. However, it is still possible that areas with low soil moisture levels may still offer cost savings. *The primary objective of this publication is to help farmers identify those situations where applying nitrogen to late summer pastures will reduce total feeding costs.*

There are two main sections in this publication: 1) “Agronomic Basics for Stockpiling Fescue”, and 2) “Potential Savings”. The first section provides the basics for applying nitrogen to late summer pastures and how to stockpile this forage for fall and winter grazing. The second section describes the methods used to determine the optimal nitrogen application rate, discusses assumptions used in this determination, and provides a summary of the optimal nitrogen rates and cost-savings given current prices and conditions.

<u>Agronomic Basics for Stockpiling Pastures</u>:

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, and 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 to moderate amounts of clover since clovers do not stockpile well and will reduce N response efficiency. 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 four to six weeks, but waiting 8 to 12 weeks before grazing is preferable.

The optimal time to apply N is in early to mid-August. Prior nitrogen applications may encourage the growth of weedy grasses like crabgrass. Waiting until September will reduce the efficiency of N conversion into plant growth. For example, one Kentucky study showed that N conversion efficiency (pounds of fescue growth per lb 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*. 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 will be somewhat of a gamble in terms of the response*. However, given the current situation, sourcing and paying for quality hay in January will also be a gamble.

Traditional “stockpiling” involves keeping cattle off the pasture until late fall, but this practice may be difficult when pasture production is low. There is no rule that states that N fertilized pastures cannot 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 the 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 lbs) increased forage production by over a ton and protein by 5 percentage points. In Ohio, nitrogen (90 lbs) increased protein by 9 percentage points and improved overall digestibility.

Another good 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 even in early March than the average hay (12% CP and 55% TDN). This attribute can be particularly beneficial for a late winter or spring calving cow-herd.

There are several forms of N 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 surface volatilization losses are minimized. Urea is generally a cheaper source of N, but the N can be completely lost under hot, humid conditions favoring volatilization. Typical urea losses for late summer applications range from 10-20%, but losses can approach 40-50% when there is no rainfall for several weeks after application. Fortunately, urease inhibitors have been recently developed to reduce volatilization losses with urea, but also add to the cost. Besides the application of N, it is important that stockpiled fields be limed and fertilized with P and K to acceptable levels to maximize forage production.

Where possible, stockpiled tall fescue fields should be strip grazed and stocked heavily enough to graze down the accumulated growth in each paddock in 7 to 10 days or less. This allows the forage to be efficiently utilized without excessive trampling and wastage. Since tall fescue does not regrow in the winter, a back fence is not essential when strip grazing stockpiled growth.

Greater detail of the stockpiling process can be found in the UK extension publication "Stockpiling for Fall and Winter Pasture" which can be found at http://www.ca.uky.edu/agc/pubs/agr/agr162/agr162.pdf or your county extension office.

Potential Savings:

The analysis presented here is based on a mathematical model that accounts for major factors that impact the optimal nitrogen application rate. The optimal rate occurs when the marginal cost of grazing (on a per day basis) from applying the last unit of nitrogen just equals the cost of feeding hay and concentrates. This rate will change depending on the price of N, the price of hay/concentrates, soil quality, soil moisture conditions, and other factors. For example, as the price of N increases, the optimal N rate will decrease. As the price of hay increases, the optimal N rate will increase. As soil moisture conditions or soil quality improves, the optimal N rate will increase. The model determines this optimal rate as well as the corresponding savings compared to feeding hay.

In order to compute the optimal application rate, a number of parameter values must be estimated that are representative of this year's conditions. Two of the most important values are the price of nitrogen and the price of hay. The price of nitrogen was evaluated on an elemental basis[1] between $.55-.65 per pound and hay values were evaluated on a per ton basis between $50-150. These values should capture most of the variability that could occur this year.

[1] To convert elemental N to urea: Multiply elemental value by 2.17. E.G. 100 lbs N = 100x2.17 = 217 lbs urea. To convert elemental N to ammonium nitrate: Multiply elemental value by 2.99. E.G. 100 lbs N = 100x2.99 = 299 lbs ammonium nitrate.

The application cost for spreading the nitrogen was set at $5/acre. Waste rates for both grazing and hay feeding (the latter includes both losses from weathering and feeding) were set at 35%. Machinery and labor costs were set to be representative of the average Kentucky cow-calf operation in both size and management intensity. This resulted in a labor cost of $.07 per cow day for grazing, and a machinery and labor cost of $.28 per cow day for hay feeding. The actual decision-aid allows the user to customize these costs based on a series of questions.

Finally, two nitrogen response rates were used in the analysis for Kentucky in 2007: low and medium. The high response rating was not evaluated because soil moisture conditions in most of the state are currently quite low. Consult Table 2 to determine which nitrogen response curve is most appropriate for your specific condition. The choice of 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 that included both wet and dry years. However, the study site was on very deep, fertile soil and would be representative of the best soil types in Kentucky. Thus adjustments need to be made from this base response rate depending on the soil quality and the specific soil moisture conditions present. University of Kentucky agronomists were consulted to help calibrate the response functions for various combinations of soil quality and moisture conditions (see Table 2).

In addition to the two response rates above, the model also separately evaluates pastures that are predominantly fescue, and stands that are a fescue-clover mix. "Fescue-clover" stands in the Missouri study had an average of 20-30% clover (mostly red). "Fescue" stands were on average about 95% pure. If you had a fescue-clover stand that contained 10-15% clover you would probably want to average the optimal nitrogen rate for the two stand types.

Results:

Table 1 summarizes the optimal nitrogen application rate and corresponding savings on a per acre basis. Net savings for the scenarios presented here ranged from a low of $0 (no nitrogen applied) to a high of $136 for the situation where nitrogen is priced at $.55/lb, hay is priced at $150/ton and we assume a medium-level production response to the nitrogen (a combined scenario that has a low probability of occurrence).

Using the mid-points for the nitrogen ($.60/lb) and hay ($100/ton) prices resulted in a savings of $31 (fescue) and $2 (fescue-clover) per acre assuming a low response to nitrogen. This corresponds to an optimal nitrogen application rate of 87 pounds[2] and 51 pounds[3] for the respective stand types. Assuming a medium response resulted in net savings of $67 (fescue) and $19 (fescue-clover) which corresponds to an optimal nitrogen application rate of 105 pounds[4] for fescue stands and 82 pounds[5] for fescue-clover stands.

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[2] Equivalent to 260 pounds of ammonium nitrate or 189 pounds of urea.
[3] Equivalent to 152 pounds of ammonium nitrate or 110 pounds of urea.
[4] Equivalent to 313 pounds of ammonium nitrate or 228 pounds of urea.
[5] Equivalent to 245 pounds of ammonium nitrate or 178 pounds of urea.

Use Table 2 to determine which response function is most appropriate for your soil conditions and then use Table 1 to estimate the optimal application rate 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 your assumptions for waste rates, labor and machinery costs, etc. are much different than those used here, you will want to run those specific parameter estimates through the model. Contact your county extension agent or the authors (contact information on the last page) and they will be happy to assist you.

Conclusions:
In general, there were cost savings estimated for most of the scenarios evaluated. For fescue stands, there were only two instances where it was not profitable to apply nitrogen. These occurred at the $50/ton hay price when nitrogen was priced at $.60/lb and .65/lb with a low response to nitrogen. Fescue stands with a medium response to nitrogen resulted in a net savings in all instances evaluated.

For fescue-clover stands, the results were mixed. With a low response to nitrogen about half of the scenarios resulted in cost savings. However, the medium response resulted in cost savings in all instances except with hay being priced at $50/ton.

It is possible however, that the actual response to nitrogen this year could be less than the low response used here. In areas with extremely low soil moisture levels and/or when nitrogen is not applied in a timely manner, this possibility needs to be considered. However, if hay ends up selling at $100-150 a ton, the response function could drop below the low level and still result in a net savings for stands that are primarily fescue.

Table 1 – Cost Savings of Applying Nitrogen to Late Summer Pastures Kentucky (2007)

		Fescue[1]		Fescue-Clover[2]		Fescue[3]		Fescue-Clover[4]	
		Low Response to Nitrogen				Medium Response to Nitrogen			
Price Nitrogen ($/lb)	Price Hay ($/ton)	Optimal N Rate (acre)	Savings ($/acre)	Optimal N Rate (acre)	Savings ($/acre)	Optimal N Rate (acre)	Savings ($/acre)	Optimal N Rate (acre)	Savings ($/acre)
$0.55	$50	45	$1	-	-	74	$15	-	-
$0.55	$75	75	$16	-	-	96	$42	66	$7
$0.55	$100	92	$36	61	$5	109	$72	89	$23
$0.55	$125	103	$57	80	$16	117	$104	103	$42
$0.55	$150	111	$80	94	$29	122	$136	114	$61
$0.60	$50	-	-	-	-	67	$12	-	-
$0.60	$75	68	$13	-	-	91	$38	57	$4
$0.60	$100	87	$31	51	$2	105	$67	82	$19
$0.60	$125	99	$52	73	$12	113	$98	98	$37
$0.60	$150	107	$74	87	$24	120	$130	109	$56
$0.65	$50	-	-	-	-	60	$8	-	-
$0.65	$75	62	$9	-	-	86	$33	48	$1
$0.65	$100	82	$27	-	-	101	$62	75	$15
$0.65	$125	95	$47	65	$9	110	$93	92	$32
$0.65	$150	104	$69	81	$20	117	$124	104	$51

Assumptions General: Spring Calving (late pregnancy in mid-winter).

Assumptions Grazing: TDN=65%; Waste=35%; Application cost N = $5/acre; labor cost = $.07/cow/day.

Assumptions Feeding Hay: TDN=55%; DMI=2.0% hay+grain; Waste=35%; labor and machinery cost=$.28/cow/day; Nutrient value of hay included.

Fescue[1]: 14 lb avg. dry matter response per lb N (100 lbs)

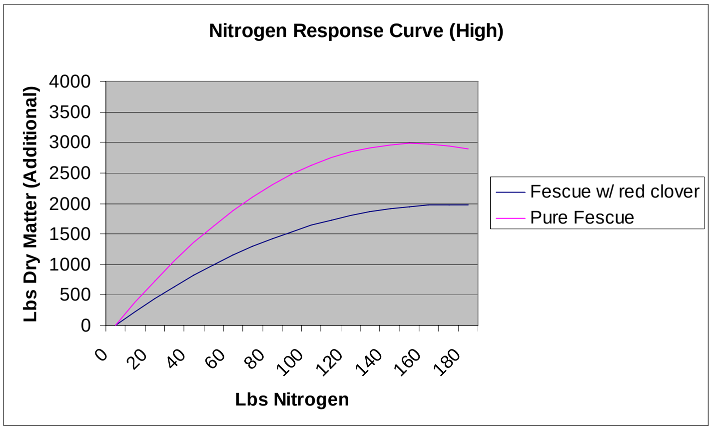
Fescue-Clover[2]: 9 lb avg. dry matter response per lb N (100 lbs)

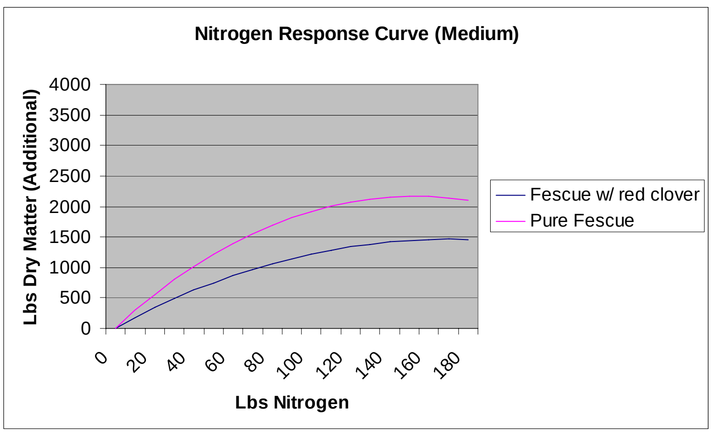
Fescue[3]: 19 lb avg. dry matter response per lb N (100 lbs)

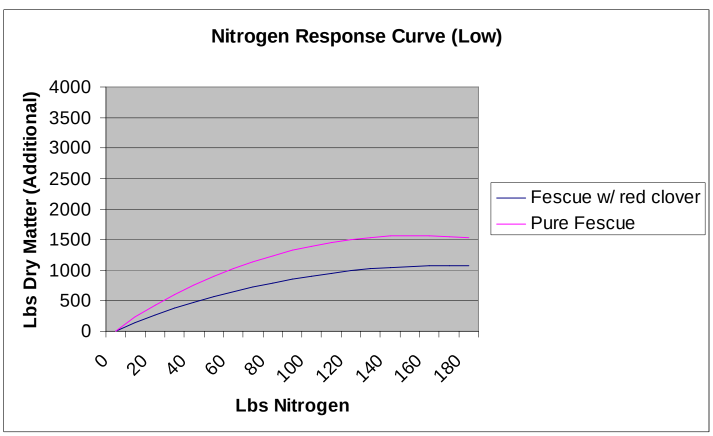
Fescue-Clover[4]: 12 lb avg. dry matter response per lb N (100 lbs)

Greg S Halich, University of Kentucky Department of Agricultural Economics; 859-257-8841; Greg.Halich@uky.edu

Table 2 – Recommended N Response Rating Based on Soil Type/Moisture Condition			
	Soil Moisture Conditions		
Soil Type	***Ideal***	***Avg.***	***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.*			
Based on consultations with faculty at the University of Kentucky, Department of Plant and Soil Sciences.			







Authors:

Greg Halich
Assistant Extension Professor
Farm Management Specialist
Agricultural Economics
(859) 257-8841
Greg.Halich@uky.edu

Ray Smith
Associate Professor
Forage Extension Specialist
Plant and Soil Sciences
(859) 257-3358
raysmith1@uky.edu

Additional Contributors:

Robert Kallenbach
Contributed data for response functions.
Associate Professor
University of Missouri
Plant Sciences
(573) 882-2801
KallenbachR@missouri.edu

Lloyd Murdock
Calibration of response functions for Kentucky conditions.
Extension Soil Specialist
Plant and Soil Sciences
(859) 257-9503 ext. 207
lmurdock@uky.edu

Garry Lacefield
Agronomic review.
Extension Professor and Forage Specialist
Plant and Soil Sciences
(270) 365-7541 ext. 202
glacefie@uky.edu

John Johns
Machinery and labor costs; nutritional requirements.
Extension Professor
Beef Nutrition and Management
Animal and Food Sciences
(859) 257-2853
jtjohns@uky.edu

Kenny Burdine
Text review.
Extension Specialist
Agricultural Economics
(859) 257-7273
kburdine@uky.edu

Publications and References (most are available at County Extension Offices):

AGR-162: Stockpiling for Fall and Winter Pasture
http://www.ca.uky.edu/agc/pubs/agr/agr162/agr162.pdf

AGR-1: Lime and Fertilizer Recommendations:
http://www.ca.uky.edu/agc/pubs/agr/agr1/agr1.pdf

NRCS Online Soil Survey (can also access soil survey data at County Extension Office):
http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

University of Kentucky
Department of Agricultural Economics
400 Charles E. Barnhart Bldg.
Lexington, KY 40546-0276

Phone: 859-257-5762
Fax: 859-323-1913
URL: http://www.uky.edu/Ag/AgEcon/