UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY—COLLEGE OF AGRICULTURE

Profitability of Spring Hayfield Nitrogen Applications 2008 Guide
(AEC 2008-02)

Introduction:

Most of Kentucky experienced harsh conditions for hay production in 2007. A severe April freeze followed by a dry spring, summer, and fall reduced hay and pasture growth by almost half in many cases. Due to the stressed pastures, hay feeding began earlier in the fall than is typical in Kentucky. Consequently, fall and winter hay prices increased significantly throughout the commonwealth due to both the shortfall in hay stocks and the increased feeding needs. Hay prices that are typically $40-60 per ton spiked to $125-200 per ton (and in some cases higher) during the 2007/2008 marketing season.

During this same time period, nitrogen fertilizer prices also increased significantly. As an example, urea nearly doubled from spring 2007 to late winter 2008. Hay producers who would normally apply nitrogen at green-up are currently having second thoughts due to the high prices.

However, the increases in nitrogen prices are to some extent counter-balanced by the potential increases in hay prices for 2008/2009 marketing season. The purpose of this publication is to formally evaluate this tradeoff, and to evaluate the potential profitability of applying nitrogen to hayfields this spring. While the price of nitrogen is known with a high degree of certainty at this point, the price that hay will sell for later this year is not. Consequently, a wide range of hay prices will be evaluated in this analysis. *The primary objective of this publication is to help farmers identify specific situations where applying nitrogen to spring hayfields in 2008 will prove profitable*.

There are two main sections in this publication: 1) "Agronomic Basics of Spring Nitrogen Fertilization", and 2) "Potential Profitability of Spring Nitrogen Applications". The first section provides basic guidance and information for applying nitrogen to hayfields in the spring. The second section describes the methods used to determine the profitability of applying nitrogen to spring hayfields, discusses assumptions used in this determination, and provides a summary of the potential profitability given various price scenarios. Three prices for nitrogen and five prices for hay are evaluated as well as multiple nitrogen response rates for tall fescue and orchardgrass hayfields.

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Agronomic Basics of Spring Nitrogen Fertilization:

Cool-season grasses can respond dramatically to nitrogen fertilization. If moisture and fertility (phosphorus and potassium) levels are adequate, nitrogen (N) will significantly increase growth during peak production periods. Research has shown that tall fescue and orchardgrass yields can be increased from around 1 ton/acre to over 4 tons/acre with 200 lbs of elemental (unit basis) nitrogen. One study in Kentucky showed that 40 lb/acre of N applied in mid-March increased tall fescue hay yields in May by 1.1 tons/acre. This meant that there was a 55 lb increase in forage yield for every 1 lb of added N. Tall fescue is generally slightly more responsive than orchardgrass. Higher nitrogen application rates will result in higher forage yield, but the efficiency of nitrogen use drops with progressively higher levels of nitrogen application. The most efficient use of nitrogen is at low to moderate rates when the grass is at peak growth. The highest nitrogen response levels will occur on better soils with good moisture holding capacity. Lower response rates will occur on fields with low yield potential due to shallow soil, rock outcroppings, etc.

There are several forms of nitrogen available for fertilization of spring hayfields, but the two most common types are ammonium nitrate and urea. Ammonium nitrate is an excellent form to use in late summer because surface volatilization losses are minimized. Urea, however, is generally a better choice for spring fertilization because it is cheaper and volatilization is generally not a problem at this time. Research in Kentucky has shown little difference among ammonium nitrate and urea for topdressing cool-season grasses during late winter and early spring.

Besides the application of nitrogen, it is important that hayfields be limed and fertilized with phosphorus (P) and potassium (K) to acceptable levels. Although cool-season grasses will survive at fairly low soil test levels of P or K, response to nitrogen will be poor. Therefore, soil test levels should be in the medium range for good production. This is especially important for hay production because large amounts of P and K are removed from the field with each successive hay crop. For example, a 3 ton/acre hay crop of orchardgrass or tall fescue will remove approximately 50 lb/acre of P_2O_5 and 150 lb/acre of K_2O. Cool-season grasses will grow over a wide range of soil pH levels, but optimal growth occurs in the 5.5 to 6.5 pH range. Ideally, pH should be at the high end of this range to optimize fertilizer efficiency.

Legumes, like clover and alfalfa, have the ability to "fix" nitrogen from the air into a useable form by the plant. As a general rule, when legumes comprise 25% or more of the stand, no nitrogen application is needed and additional N may actually lead to a loss of the legume component. The response rate for nitrogen will decrease as the legume content of the stand increases. Thus hayfields that are mostly pure grass stands should be targeted first for spring nitrogen applications.

Potential Profitability of Spring Nitrogen Applications:

The analysis presented here is based on a model that accounts for the major factors that impact the profitability of nitrogen applications including the price of nitrogen, price of hay, response rate of nitrogen, increased hay production costs, and increased nutrient removal. For example, as the price of nitrogen increases, the profitability of spring fertilization will decrease. As the price of hay increases, profitability will increase. As soil moisture conditions or soil quality improves, the response rate for nitrogen will increase and profitability will increase. The model determines the changes in net revenue from one-time nitrogen applications of 40 and 80 pounds (elemental or unit basis) compared to the no application situation.

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 basis[1] between $.50-.70 per pound ($460-644 per ton urea), which is representative of urea prices in late February 2008. Hay prices were evaluated on a per ton basis and were differentiated by 1200 lb round bales and 45 lb small square bales. Hay prices for the 2007/2008 marketing year are currently highly uncertain and thus a wide range of prices are evaluated. Prices of $50-150 per ton ($30-90 per roll) for round bales and $100-200 per ton ($2.25-$4.50 per bale) for small square bales are used in this analysis. Users of this publication need to use their best judgment for anticipated price(s) including those outside the range presented here. Keep in mind that orchardgrass hay generally sells at a premium over fescue hay, especially for small square bales.

The application cost for spreading the nitrogen was set at $5/acre. Machinery and labor costs of producing the extra hay were set to be representative of average Kentucky conditions.[2] This totaled $18.50 per 1200 pound bale (including moving to storage) and $1.65 per small square bale (including moving to storage).[3] It was assumed that the buyer would arrange for transportation. If you are selling at a delivery point off the farm, deduct these additional transportation costs from the hay prices used in this analysis.

Increased removal of P and K was also accounted for in the analysis. Approximately 18 lbs of P_2O_5 and 50 lbs of K_2O are removed for each ton of hay.[4] It was assumed that the cost of replacing P_2O_5 was $.75/lb and the cost of replacing K_2O was $.45/lb based on current prices.

Potentially the most influential factor used in this analysis is the response rate to nitrogen. Response rates were estimated from previous studies for both tall fescue and orchardgrass

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

[2] See Custom Machinery Rates Applicable to Kentucky (2008) http://www.uky.edu/Ag/AgEcon/pubs/ext_aec/2008-01.pdf

[3] Increased forage density results in some production cost efficiencies on a per bale basis. Improved efficiency factors of 33% and 25% were used for round and square bales respectively, the difference of which is primarily due to labor requirements.

[4] See AGR-1 http://www.ca.uky.edu/agc/pubs/agr/agr1/agr1.pdf

for application rates of 40 and 80 pounds per acre. Since the response rate will also vary according to soil moisture conditions and the general fertility level of the soil, multiple response rates were evaluated in this analysis, ranging from 26-65 lbs of dry matter per unit of nitrogen. Consult Table 3 to determine which nitrogen response rate is most appropriate given your soil fertility and soil moisture conditions. Since soil moisture levels are close to ideal in most of Kentucky as of late winter, only the medium and high response rates are evaluated for 2008. The choice of the response rate is an extremely important determinant in this analysis.

Results – Round Bale Production:

Table 1 summarizes the estimated net benefits of applying nitrogen compared to no application on a per acre basis for round bales. A net benefit of +$10 means that particular nitrogen application would be expected to increase net profit by $10 per acre. Net benefits for the scenarios presented here ranged from a low of -$73 to a high of +$122. In general, nitrogen applications became profitable once hay prices reached $100/ton. Where nitrogen applications were profitable, 40 lb applications generally showed higher net benefits than the 80 lb rate. For specific recommendations, use Table 3 to determine which response rate is most appropriate for your conditions and then use Table 1 to estimate the optimal application rate based on your estimates for hay and nitrogen prices.[5]

Results – Small Square Bale Production:

Table 2 summarizes the estimated net benefit of applying nitrogen compared to no application on a per acre basis for square bales. Net benefits for the scenarios presented here ranged from a low of -$51 to a high of +$150. In general, nitrogen applications started to become profitable once hay prices reached $125/ton ($2.80/bale) and were consistently profitable when hay prices reached $150/ton ($3.40/bale). As opposed to round bales, there were a number of situations where 80 lb applications were clearly superior to the lower rates. These occurred with the highest hay prices and the high response rates, primarily for tall fescue. Again, for specific recommendations use Table 3 to determine which response rate is most appropriate for your conditions and then use Table 2 to estimate the optimal application rate based on your estimates for hay and nitrogen prices.[6]

Conclusions:

Contrary to what one might initially think due to historically-high nitrogen prices, spring nitrogen applications to hayfields may prove profitable in 2008 for particular situations. In general, when hay prices are expected to reach $100/ton for round bales and $125-150/ton for square bales, nitrogen applications should prove profitable. Where hay prices are expected to reach $125-150 per ton for round bales and $175-200 per ton for square bales, nitrogen applications look to be extremely profitable in all the situations evaluated in this analysis.[7]

[5, 6, 7] Keep in mind that orchardgrass hay generally commands a price premium over fescue, especially for small square bales. Thus orchardgrass stands may be a better candidate for nitrogen applications, even though the nitrogen response rate is lower.

Table 1 - Net Benefits of Applying Nitrogen to Spring Hayfields 1200 Lb Round Bales Kentucky (2008)									
		Tall Fescue				*Orchardgrass*			
		Med Response to N[1]		*High Response to N[2]*		*Med Response to N[3]*		*High Response to N[4]*	
Price Nitrogen ($/lb)[5]	*Price Hay ($/ton)*	*40 Lbs N Net Benefit ($/acre)*	*80 Lbs N Net Benefit ($/acre)*	*40 Lbs N Net Benefit ($/acre)*	*80 Lbs N Net Benefit ($/acre)*	*40 Lbs N Net Benefit ($/acre)*	*80 Lbs N Net Benefit ($/acre)*	*40 Lbs N Net Benefit ($/acre)*	*80 Lbs N Net Benefit ($/acre)*
$0.50	*$50*	-$32	-$54	-$35	-$57	-$32	-$53	-$34	-$55
$0.50	*$75*	-$5	-$20	$2	-$12	-$7	-$24	$0	-$16
$0.50	*$100*	$22	$13	$38	$33	$19	$5	$33	$23
$0.50	*$125*	$50	$47	$74	$77	$44	$34	$67	$62
$0.50	*$150*	$77	$80	$111	$122	$69	$63	$100	$101
$0.60	*$50*	-$36	-$62	-$39	-$65	-$36	-$61	-$38	-$63
$0.60	*$75*	-$9	-$28	-$2	-$20	-$11	-$32	-$4	-$24
$0.60	*$100*	$18	$5	$34	$25	$15	-$3	$29	$15
$0.60	*$125*	$46	$39	$70	$69	$40	$26	$63	$54
$0.60	*$150*	$73	$72	$107	$114	$65	$55	$96	$93
$0.70	*$50*	-$40	-$70	-$43	-$73	-$40	-$69	-$42	-$71
$0.70	*$75*	-$13	-$36	-$6	-$28	-$15	-$40	-$8	-$32
$0.70	*$100*	$14	-$3	$30	$17	$11	-$11	$25	$7
$0.70	*$125*	$42	$31	$66	$61	$36	$18	$59	$46
$0.70	*$150*	$69	$64	$103	$106	$61	$47	$92	$85

Assumptions: Additional costs include production costs, nitrogen cost and application, and P & K removal from increased hay production.

Assumptions: Hay production costs for 1200 round bales are $15 for production and $3.50 for storage based on custom rates; 33% efficiency gain for inc. forage density.

Assumptions: Tall fescue and orchardgrass stands assumed to contain less than 10% legumes; 5% waste rate of additional forage produced due to rain damage, etc.

Fescue – Medium Response Rate[1]: 49 lb avg. dry matter response per lb N (40lbs) and 30 lb avg. dry matter response per lb N (80lbs)

Fescue – High Response Rate[2]: 65 lb avg. dry matter response per lb N (40lbs) and 40 lb avg. dry matter response per lb N (80lbs)

Orchardgrass – Medium Response Rate [3]: 45 lb avg. dry matter response per lb N (40lbs) and 26 lb avg. dry matter response per lb N (80lbs)

Orchardgrass – High Response Rate [4]: 60 lb avg. dry matter response per lb N (40lbs) and 35 lb avg. dry matter response per lb N (80lbs)

Nitrogen Price[5]: $.50/lb N = $460/ton urea; $.60/lb N = $552/ton urea; $.70/lb N = $644/ton urea

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

Table 2 - Net Benefits of Applying Nitrogen to Spring Hayfields Small Square Bales Kentucky (2008)									
		Tall Fescue				*Orchardgrass*			
		Med Response to N[1]		*High Response to N[2]*		*Med Response to N[3]*		*High Response to N[4]*	
Price Nitrogen ($/lb)[5]	*Price Hay ($/ton)*	*40 Lbs N Net Benefit ($/acre)*	*80 Lbs N Net Benefit ($/acre)*	*40 Lbs N Net Benefit ($/acre)*	*80 Lbs N Net Benefit ($/acre)*	*40 Lbs N Net Benefit ($/acre)*	*80 Lbs N Net Benefit ($/acre)*	*40 Lbs N Net Benefit ($/acre)*	*80 Lbs N Net Benefit ($/acre)*
$0.50	*$100*	-$15	-$33	-$12	-$29	-$16	-$35	-$13	-$31
$0.50	*$125*	$12	$1	$24	$16	$9	-$5	$21	$8
$0.50	*$150*	$40	$34	$61	$61	$34	$24	$54	$47
$0.50	*$175*	$67	$68	$97	$105	$59	$53	$88	$86
$0.50	*$200*	$94	$101	$133	$150	$85	$82	$121	$126
$0.60	*$100*	-$19	-$41	-$16	-$37	-$20	-$43	-$17	-$39
$0.60	*$125*	$8	-$7	$20	$8	$5	-$13	$17	$0
$0.60	*$150*	$36	$26	$57	$53	$30	$16	$50	$39
$0.60	*$175*	$63	$60	$93	$97	$55	$45	$84	$78
$0.60	*$200*	$90	$93	$129	$142	$81	$74	$117	$118
$0.70	*$100*	-$23	-$49	-$20	-$45	-$24	-$51	-$21	-$47
$0.70	*$125*	$4	-$15	$16	$0	$1	-$21	$13	-$8
$0.70	*$150*	$32	$18	$53	$45	$26	$8	$46	$31
$0.70	*$175*	$59	$52	$89	$89	$51	$37	$80	$70
$0.70	*$200*	$86	$85	$125	$134	$77	$66	$113	$110

Assumptions: Additional costs include production costs, nitrogen cost and application, and P & K removal from increased hay production.
Assumptions: Hay production costs per 45 lb square bales are $1.65 for production based on custom rates; 25% efficiency gain for inc. forage density.
Assumptions: Tall fescue and orchardgrass stands assumed to contain less than 10% legumes; 5% waste rate of additional forage produced due to rain damage, etc.
Fescue – Medium Response Rate[1]: 49 lb avg. dry matter response per lb N (40lbs) and 30 lb avg. dry matter response per lb N (80lbs)
Fescue – High Response Rate[2]: 65 lb avg. dry matter response per lb N (40lbs) and 40 lb avg. dry matter response per lb N (80lbs)
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Table 3
Recommended Nitrogen Response Rating Based on Soil Type and Moisture Condition

	Soil Moisture Conditions		
Soil Fertility Level[1]	***Ideal***	***Good***	***Low***
Excellent	High Response	Med/High Response	Low/Med Response
Good	High Response	Medium Response	Low Response
Fair	Med/High Response	Low/Med Response	Low Response

Note[1]: Fertility is defined as relative average productivity due to soil type, drainage, P and K levels, pH level, etc.

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

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

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

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/