# Profitability of Spring Hayfield Nitrogen Applications 2009 Guide

**(AEC 2009-02)**

## Introduction:

2008 was another challenging year for Kentucky hay producers. The first cutting was delayed in many areas due to wet conditions but yields were still decent. However, a second straight summertime drought reduced subsequent cuttings and many producers chose to graze hay fields in the fall. Consequently, the average seasonal yield of non-alfalfa hay was only 2.0 tons in 2008, down about 15% from the 2000-2006 state average of 2.34 tons.

Although the corresponding non-alfalfa acreage also decreased slightly in 2008, the overall result was a sizeable increase in the hay crop compared to the disastrous year in 2007. The combination of higher production levels and decreasing cow numbers in 2008 led to an increase in December 1 hay stocks. Thus hay supplies were less of a concern for beef producers during the 2008/2009 winter than during the previous year. Not surprisingly, hay prices retreated from the 2007 levels and returned to a more typical range.

Input prices also presented a challenge during 2008 as fertilizer and fuel prices were at historically high levels. This spring, prices of nitrogen and phosphorous have dropped, as well as fuel prices. However, potash prices are still significantly higher in 2009, which will offset some of these other input price reductions.

The purpose of this publication is to evaluate the potential profitability of applying nitrogen to hayfields this spring given the present market conditions. While the price of nitrogen is known with a relatively 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 identify specific situations where applying nitrogen to spring hayfields in 2009 will prove profitable*.

There are two main sections in this publication: 1) “Agronomic Basics of Spring Nitrogen Fertilization”, and 2) “Profitability of Spring Nitrogen Applications”. The first section provides basic guidance and information for applying nitrogen to spring hayfields. The second section describes the methods used in the profitability analysis, discusses assumptions, and provides a summary of the potential profitability given various 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.

## **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 nitrogen applied in mid-March increased tall fescue hay yields by 1.1 tons/acre when harvested in mid-May. This meant that there was a 55 lb increase in forage yield for every 1 lb of added nitrogen. Tall fescue is generally slightly more responsive to nitrogen applications than orchardgrass. Higher nitrogen application rates will result in higher forage yield, but the efficiency of nitrogen use drops with progressively higher levels of application. The most efficient use of nitrogen is at low to moderate rates when the grass is approaching peak growth rates. 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 urea and ammonium nitrate. Ammonium nitrate is an excellent form to use in late summer for stockpiling 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 in effectiveness between ammonium nitrate and urea for topdressing cool-season grasses during late winter and early spring. If urea is used during the warmer summer months, it is best to apply when rain is imminent or when a Urease inhibitor is used (most fertilizer dealers can do this for you).

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, the response to nitrogen will be poor. Therefore, soil test levels should be in the medium or high range for good production or be fertilized if the soil test is in the low range. This is especially important for hay production because moderate amounts of P and even larger amounts of 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 recommended and additional nitrogen may actually lead to a loss of the legume component in the stand. Moreover, the response rate for nitrogen will decrease as the legume content of the stand increases. Thus hayfields that are mostly pure grass should be targeted for spring nitrogen applications.

## **Profitability of Spring Nitrogen Applications:**

The analysis presented here 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, increased nutrient removal, and increased quality of nitrogen fertilized hay. This analysis determines the changes in net revenue from one-time spring nitrogen applications of 40 and 80 units (87 lbs and 174 lbs of urea respectively) 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 $.40-.50 per unit ($370-460 per ton urea), which is representative of urea prices in early March 2009. 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 2009/2010 marketing year are currently highly uncertain and thus a wide range of prices are evaluated. Prices of $40-100 per ton ($24-60 per 1200 lb bale) for round bales and $90-150 per ton ($2.00-$3.40 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 $12.42 per 1200 pound bale (including moving to storage) and $1.36 per small square bale (including moving to storage) after adjusting for efficiencies created by increased forage density.[3] It was assumed that the buyer would arrange for transportation from your storage facility. If you are selling at a delivery point off the farm, deduct these additional transportation costs from the hay price you expect to receive. If you sell square bales directly out of the field, add roughly $15/ton to the hay price you expect to receive. If you sell round bales directly out of the field, add roughly $5/ton to the hay price you expect to receive.

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 $.46/unit ($600/ton for 18-46-0) and the cost of replacing $K_2O$ was $.67/unit ($800/ton for 0-0-60). Two scenarios are presented for P and K removal: 1) 100% replacement, and 2) 50% replacement. The user should use their best judgment

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[1] To convert elemental N to urea: Multiply elemental value by 2.17. E.G. 40 lbs N = 40x2.17 = 87 lbs urea.
[2] See Custom Machinery Rates Applicable to Kentucky (2009). http://www.ca.uky.edu/cmspubsclass/tinymce/jscripts/tiny_mce/plugins/filemanager/files/ghalich/Custom%20Machinery%20Rates%20Applicable%20to%20Kentucky%20(2009).pdf
[3] Increased forage density results in production cost efficiencies on a per bale basis. Improved efficiency factors of 40% and 20% were used for round and square bales respectively, the difference between the two primarily being due to labor requirements. Original rates before accounting for these efficiencies were $20.70 and $1.70 per bale for round and square bales respectively.
[4] See AGR-1 http://www.ca.uky.edu/agc/pubs/agr/agr1/agr1.pdf

as to which scenario best represents their situation related to the soil test in the field and recommended applications of P and K. If the soil test is in the high range, no P or K application is recommended, at least in the short-term. If the soil test is in the medium range roughly a half-replacement application rate is recommended. Full replacement application rates are recommended in the low range. Keep in mind that even if you are in the high range and do not need to make applications in the current year that you are still to a certain extent mining the current "bank" of P and K, and this should be accounted for to some degree. Refer to AGR-1 for more detailed recommendations related to P and K fertilizations.[5]

Potentially the most influential factor used in this analysis is the response rate of grass to nitrogen. Response rates were estimated from previous studies for both tall fescue and orchardgrass in Kentucky with 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 (31-76 lbs of hay) per unit of nitrogen. Consult Table 5 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 2009. The choice of the response rate is an extremely important determinant in this analysis. When in doubt use the medium response rate as this will give you a more conservative result.

Finally, increased forage quality was accounted for in the analysis by assuming a 1.0 ton first cutting yield without nitrogen and valuing this hay less than the nitrogen fertilized hay. For round bales this value reduction was assumed to be $5 per ton and for square bales the reduction was assumed to be $10 per ton.

*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 assuming 100% replacement of P and K. A net benefit of +$10 means that particular nitrogen application would be expected to increase net profit by $10 per acre, compared to no nitrogen application. Net benefits for the scenarios evaluated here ranged from a low of -$80 to a high of +$38. In general, nitrogen applications became profitable once hay prices reached $85/ton. Where nitrogen applications were profitable, the 40 lb rate showed higher net benefits than the 80 lb rate in all cases.

Table 2 summarizes the estimated net benefits for round bales assuming 50% replacement of P and K. Net benefits for the scenarios evaluated here ranged from a low of -$43 to a high of +$73. In this case, nitrogen applications generally became profitable once hay prices reached $70/ton. The 40 lb application rate still showed higher net benefits than the 80 lb rate in almost all cases.

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

For specific recommendations for round bales, use Table 5 to determine which response rate is most appropriate for your conditions and than use either Table 1 or 2 to estimate the optimal application rate (if any) based on your estimates for hay and nitrogen prices.[6]

*Results – Small Square Bale Production:*

Table 3 summarizes the estimated net benefit of applying nitrogen compared to no application on a per acre basis for small square bales assuming 100% replacement of P and K. Net benefits for the scenarios evaluated here ranged from a low of -$56 to a high of +$59. In general, nitrogen applications started to become profitable once hay prices reached $120/ton ($2.70/bale). 40 lb applications were always more profitable then the 80 lb applications.

Table 4 summarizes the estimated net benefit of applying nitrogen for small square bales assuming 50% replacement of P and K. Net benefits for the scenarios evaluated here ranged from a low of -$25 to a high of +$96. In general, nitrogen applications became profitable once hay prices reached $105/ton ($2.35/bale). There were a limited number of instances where 80 lb nitrogen applications were more profitable then 40 lb applications. These occurred only with the highest hay price and the high response rate for tall fescue. However, the difference was minor, and as a general rule the 40 lb applications were more profitable.

For specific recommendations for small square bales, use Table 5 to determine which response rate is most appropriate for your conditions and then use either Table 3 or 4 to estimate the optimal application rate (if any) based on your estimates for hay and nitrogen prices.[7]

*Conclusions:*

The profitability of applying nitrogen to spring hayfield is not a sure bet in 2009. Consequently, you will need to evaluate your specific situation before determining if it will pay. In general, where hay prices are expected to reach $85/ton for round bales and $120/ton ($2.70/bale) for square bales, nitrogen applications should prove profitable. However, these profitability thresholds drop to $70/ton for round bales and $105/ton ($2.35/bale) for square bales if you assume less then full replacement of P and K. In situations where nitrogen applications proved profitable, 40 lb applications were more profitable than 80 lb applications in almost all the cases evaluated.

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

## Table 1 - Net Benefits of Applying Nitrogen to Spring Hayfields (2009)
## 1200 Lb Round Bales Kentucky - 100% Replacement P and K

| | | *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)* |
| *$0.40* | *$40* | -$41 | -$62 | -$49 | -$72 | -$39 | -$58 | -$46 | -$67 |
| *$0.40* | *$55* | -$24 | -$42 | -$27 | -$46 | -$24 | -$41 | -$26 | -$44 |
| *$0.40* | *$70* | -$8 | -$22 | -$5 | -$19 | -$9 | -$23 | -$6 | -$20 |
| *$0.40* | *$85* | $9 | -$2 | $17 | $8 | $7 | -$6 | $14 | $3 |
| *$0.40* | *$100* | $25 | $18 | $38 | $35 | $22 | $11 | $34 | $27 |
| *$0.45* | *$40* | -$43 | -$66 | -$51 | -$76 | -$41 | -$62 | -$48 | -$71 |
| *$0.45* | *$55* | -$26 | -$46 | -$29 | -$50 | -$26 | -$45 | -$28 | -$48 |
| *$0.45* | *$70* | -$10 | -$26 | -$7 | -$23 | -$11 | -$27 | -$8 | -$24 |
| *$0.45* | *$85* | $7 | -$6 | $15 | $4 | $5 | -$10 | $12 | -$1 |
| *$0.45* | *$100* | $23 | $14 | $36 | $31 | $20 | $7 | $32 | $23 |
| *$0.50* | *$40* | -$45 | -$70 | -$53 | -$80 | -$43 | -$66 | -$50 | -$75 |
| *$0.50* | *$55* | -$28 | -$50 | -$31 | -$54 | -$28 | -$49 | -$30 | -$52 |
| *$0.50* | *$70* | -$12 | -$30 | -$9 | -$27 | -$13 | -$31 | -$10 | -$28 |
| *$0.50* | *$85* | $5 | -$10 | $13 | $0 | $3 | -$14 | $10 | -$5 |
| *$0.50* | *$100* | $21 | $10 | $34 | $27 | $18 | $3 | $30 | $19 |

Assumptions: Additional costs include production, nitrogen/application, and P & K removal from increased hay production ($.46/unit $P_2O_5$ and $.67/unit $K_2O$).

Assumptions: Production costs for round bales are $20.70 based on custom rates (include move to storage); 40% efficiency gain for inc. forage density = $12.42 per bale.

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.

Assumptions: 1.0 ton/acre first-cutting yield without nitrogen application valued at $5/ton less then nitrogen fertilized hay.

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

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

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

Orchardgrass[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]: $.40/lb N = $370/ton urea; $.45/lb N = $415/ton urea; $.50/lb N = $460/ton urea; 40 lbs N = 87 lbs urea; 80 lbs N = 174 lbs urea.

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## Table 2 - Net Benefits of Applying Nitrogen to Spring Hayfields (2009)
## 1200 Lb Round Bales Kentucky - 50% Replacement P and K

| | | *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)* |
| *$0.40* | *$40* | -$18 | -$34 | -$18 | -$35 | -$17 | -$34 | -$18 | -$34 |
| *$0.40* | *$55* | -$1 | -$14 | $4 | -$8 | -$2 | -$16 | $2 | -$11 |
| *$0.40* | *$70* | $15 | $6 | $25 | $19 | $13 | $1 | $22 | $13 |
| *$0.40* | *$85* | $32 | $26 | $47 | $46 | $28 | $19 | $42 | $36 |
| *$0.40* | *$100* | $48 | $46 | $69 | $73 | $43 | $36 | $62 | $60 |
| *$0.45* | *$40* | -$20 | -$38 | -$20 | -$39 | -$19 | -$38 | -$20 | -$38 |
| *$0.45* | *$55* | -$3 | -$18 | $2 | -$12 | -$4 | -$20 | $0 | -$15 |
| *$0.45* | *$70* | $13 | $2 | $23 | $15 | $11 | -$3 | $20 | $9 |
| *$0.45* | *$85* | $30 | $22 | $45 | $42 | $26 | $15 | $40 | $32 |
| *$0.45* | *$100* | $46 | $42 | $67 | $69 | $41 | $32 | $60 | $56 |
| *$0.50* | *$40* | -$22 | -$42 | -$22 | -$43 | -$21 | -$42 | -$22 | -$42 |
| *$0.50* | *$55* | -$5 | -$22 | $0 | -$16 | -$6 | -$24 | -$2 | -$19 |
| *$0.50* | *$70* | $11 | -$2 | $21 | $11 | $9 | -$7 | $18 | $5 |
| *$0.50* | *$85* | $28 | $18 | $43 | $38 | $24 | $11 | $38 | $28 |
| *$0.50* | *$100* | $44 | $38 | $65 | $65 | $39 | $28 | $58 | $52 |

Assumptions: Additional costs include production, nitrogen/application, and P & K removal from increased hay production ($.46/unit $P_2O_5$ and $.67/unit $K_2O$).
Assumptions: Production costs for round bales are $20.70 based on custom rates (include move to storage); 40% efficiency gain for inc. forage density = $12.42 per bale.
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.
Assumptions: 1.0 ton/acre first-cutting yield without nitrogen application valued at $5/ton less then nitrogen fertilized hay.
Fescue[1]: 49 lb avg. dry matter response per lb N (40lbs) and 30 lb avg. dry matter response per lb N (80lbs)
Fescue[2]: 65 lb avg. dry matter response per lb N (40lbs) and 40 lb avg. dry matter response per lb N (80lbs)
Orchardgrass[3]: 45 lb avg. dry matter response per lb N (40lbs) and 26 lb avg. dry matter response per lb N (80lbs)
Orchardgrass[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]: $.40/lb N = $370/ton urea; $.45/lb N = $415/ton urea; $.50/lb N = $460/ton urea; 40 lbs N = 87 lbs urea; 80 lbs N = 174 lbs urea.
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## Table 3 - Net Benefits of Applying Nitrogen to Spring Hayfields (2009)
## Small Square Bales Kentucky - 100% Replacement P and K

| | | *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 $/ton and ($/bale)* | *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)* |
| *$0.40* | *$90 ($2.03)* | -$24 | -$43 | -$28 | -$48 | -$23 | -$41 | -$27 | -$46 |
| *$0.40* | *$105 ($2.36)* | -$8 | -$23 | -$7 | -$22 | -$8 | -$24 | -$7 | -$22 |
| *$0.40* | *$120 ($2.70)* | $9 | -$3 | $15 | $5 | $7 | -$6 | $13 | $1 |
| *$0.40* | *$135 ($3.04)* | $25 | $17 | $37 | $32 | $22 | $11 | $33 | $25 |
| *$0.40* | *$150 ($3.40)* | $42 | $37 | $59 | $59 | $37 | $29 | $53 | $48 |
| *$0.45* | *$90 ($2.03)* | -$26 | -$47 | -$30 | -$52 | -$25 | -$45 | -$29 | -$50 |
| *$0.45* | *$105 ($2.36)* | -$10 | -$27 | -$9 | -$26 | -$10 | -$28 | -$9 | -$26 |
| *$0.45* | *$120 ($2.70)* | $7 | -$7 | $13 | $1 | $5 | -$10 | $11 | -$3 |
| *$0.45* | *$135 ($3.04)* | $23 | $13 | $35 | $28 | $20 | $7 | $31 | $21 |
| *$0.45* | *$150 ($3.40)* | $40 | $33 | $57 | $55 | $35 | $25 | $51 | $44 |
| *$0.50* | *$90 ($2.03)* | -$28 | -$51 | -$32 | -$56 | -$27 | -$49 | -$31 | -$54 |
| *$0.50* | *$105 ($2.36)* | -$12 | -$31 | -$11 | -$30 | -$12 | -$32 | -$11 | -$30 |
| *$0.50* | *$120 ($2.70)* | $5 | -$11 | $11 | -$3 | $3 | -$14 | $9 | -$7 |
| *$0.50* | *$135 ($3.04)* | $21 | $9 | $33 | $24 | $18 | $3 | $29 | $17 |
| *$0.50* | *$150 ($3.40)* | $38 | $29 | $55 | $51 | $33 | $21 | $49 | $40 |

Assumptions: Additional costs include production, nitrogen/application, and P & K removal from increased hay production ($.46/unit $P_2O_5$ and $.67/unit $K_2O$).
Assumptions: Hay production costs for 45 lb square bales are $1.70 based on custom rates (include haul and store); 20% efficiency gain for inc. forage density = $1.36/bale.
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.
Assumptions: 1.0 ton/acre first-cutting yield without nitrogen application valued at $10/ton less then nitrogen fertilized hay.
Fescue[1]: 49 lb avg. dry matter response per lb N (40lbs) and 30 lb avg. dry matter response per lb N (80lbs)
Fescue[2]: 65 lb avg. dry matter response per lb N (40lbs) and 40 lb avg. dry matter response per lb N (80lbs)
Orchardgrass[3]: 45 lb avg. dry matter response per lb N (40lbs) and 26 lb avg. dry matter response per lb N (80lbs)
Orchardgrass[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]: $.40/lb N = $370/ton urea; $.45/lb N = $415/ton urea; $.50/lb N = $460/ton urea; 40 lbs N = 87 lbs urea; 80 lbs N = 174 lbs urea.
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## Table 4 - Net Benefits of Applying Nitrogen to Spring Hayfields (2009)
## Small Square Bales Kentucky - 50% Replacement P and K

| | | *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 $/ton and ($/bale)* | *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)* |
| *$0.40* | *$90 ($2.03)* | -$1 | -$15 | $2 | -$11 | -$2 | -$17 | $1 | -$13 |
| *$0.40* | *$105 ($2.36)* | $15 | $5 | $24 | $16 | $13 | $1 | $21 | $10 |
| *$0.40* | *$120 ($2.70)* | $31 | $25 | $45 | $42 | $28 | $18 | $41 | $34 |
| *$0.40* | *$135 ($3.04)* | $48 | $45 | $67 | $69 | $43 | $36 | $61 | $57 |
| *$0.40* | *$150 ($3.40)* | $64 | $65 | $89 | $96 | $58 | $53 | $81 | $81 |
| *$0.45* | *$90 ($2.03)* | -$3 | -$19 | $0 | -$15 | -$4 | -$21 | -$1 | -$17 |
| *$0.45* | *$105 ($2.36)* | $13 | $1 | $22 | $12 | $11 | -$3 | $19 | $6 |
| *$0.45* | *$120 ($2.70)* | $29 | $21 | $43 | $38 | $26 | $14 | $39 | $30 |
| *$0.45* | *$135 ($3.04)* | $46 | $41 | $65 | $65 | $41 | $32 | $59 | $53 |
| *$0.45* | *$150 ($3.40)* | $62 | $61 | $87 | $92 | $56 | $49 | $79 | $77 |
| *$0.50* | *$90 ($2.03)* | -$5 | -$23 | -$2 | -$19 | -$6 | -$25 | -$3 | -$21 |
| *$0.50* | *$105 ($2.36)* | $11 | -$3 | $20 | $8 | $9 | -$7 | $17 | $2 |
| *$0.50* | *$120 ($2.70)* | $27 | $17 | $41 | $34 | $24 | $10 | $37 | $26 |
| *$0.50* | *$135 ($3.04)* | $44 | $37 | $63 | $61 | $39 | $28 | $57 | $49 |
| *$0.50* | *$150 ($3.40)* | $60 | $57 | $85 | $88 | $54 | $45 | $77 | $73 |

Assumptions: Additional costs include production, nitrogen/application, and P & K removal from increased hay production ($.46/unit $P_2O_5$ and $.67/unit $K_2O$).
Assumptions: Hay production costs for 45 lb square bales are $1.70 based on custom rates (include haul and store); 20% efficiency gain for inc. forage density = $1.36/bale.
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.
Assumptions: 1.0 ton/acre first-cutting yield without nitrogen application valued at $10/ton less then nitrogen fertilized hay.
Fescue[1]: 49 lb avg. dry matter response per lb N (40lbs) and 30 lb avg. dry matter response per lb N (80lbs)
Fescue[2]: 65 lb avg. dry matter response per lb N (40lbs) and 40 lb avg. dry matter response per lb N (80lbs)
Orchardgrass[3]: 45 lb avg. dry matter response per lb N (40lbs) and 26 lb avg. dry matter response per lb N (80lbs)
Orchardgrass[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]: $.40/lb N = $370/ton urea; $.45/lb N = $415/ton urea; $.50/lb N = $460/ton urea; 40 lbs N = 87 lbs urea; 80 lbs N = 174 lbs urea.
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## Table 5
## 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.


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