Title:
ENVIRONMENTALLY SOUND HIGH IMPACT FORAGE MANAGEMENT RESEARCH BASED DEMONSTRATIONS FOR INCREASED LIVESTOCK PROFITABILITY BY INCREASING FORAGE PRODUCTION AND QUALITY

Investigators:
Todd Lorenz, Rich Hoormann, Wendy Flatt, Gene Schmitz, Joni Ross, Dustin Vendrely, Randa Doty and Rob Kallenbach

Objectives, including relevance of project to Missouri fertilizer/lime use:
Livestock producers and landowners read about basic forage plant, soil fertility, and animal management techniques that can improve pasture eco-systems, carrying capacity and ultimately farm profitability. However, many are not responsive to adopting these current forage management techniques. Many producers have not had access to research plots that demonstrate the short term and long term plant responses to fertility management changes. This project combines multiple demonstrations of University of Missouri research based forage fertility management practices on a strategically selected farmer field location that allows producers to follow changes in pasture eco-system and profitability per acre through on-site demonstrations and field days.

Procedure:
During the spring of 2007, a 5-acre field was identified and soil tested. Based on soil test results and discussions with Extension Specialists, fertilizer dealers and farmers, eight different fertilizer combinations were applied to field-scale plots containing primarily tall fescue (Table 1). Plot dimensions are 50 feet X 50 feet. Lime was applied as a sub-plot across all treatments. Fertilizer and lime were applied with commercially available fertilizer equipment. The legume fertilizer treatment was further split with red clover and lespedeza being hand seeded in 25 feet X 50 feet plots. A waste lime treatment was added in 2008.

Weather has impacted this research project. A late freeze in April 2007 may have reduced first cutting forage yields. 2008 was a very wet year, and yields may be higher than normal expectations due to very favorable moisture supplies throughout the growing season. For the months March through August 2008, 25.55 inches of rainfall were recorded at the research site. This was 8.36 inches more rainfall during 2008 compared to the same months during 2007. 2009 was also an extremely cool and wet year which may have impacted yields and forage quality.

Forage was harvested during May, August and October in 2007 and May, August and November in 2008 and 2009 with a mechanical forage harvester. Four replications per treatment were harvested. Harvested forage was weighed and subsamples were taken for nutrient analysis. Harvest area was measured and dry matter yield was calculated. Subsamples were weighed, dried and re-weighed to determine moisture content. Subsamples were then sent to a commercial lab for protein, fiber and mineral analysis.

Results – Yield, nutrient analysis, economic analysis and education and outreach:

Yield: As expected, full fertility based on University of Missouri soil test results for a yield goal of 3 tons of hay per acre produced the most forage during 2007 and 2008 (Tables 2 and 3). Clearly, increasing fertilizer increased forage yield. The question remains, is the value of forage production and quality offset by the increased cost of the fertilizer?

It is interesting to note the yield response of the plots to phosphorus (P) fertilizer in 2008. Our initial soil tests in the spring of 2007 report available P at 6 lbs/acre. When comparing 2008 yields with 2007 yields, the plots that received P fertilizer had yield increases of -162, 4009, 1933, 2472, 2965 and 2079 pounds dry matter per acre. The plots that received no P fertilizer had -814, 840 and 914 pounds dry matter per acre yield increases. The plot that received P fertilizer and had a yield reduction of 162 pounds per acre was the full fertility treatment, however it was the highest yielding treatment for both years. It also appears from the 2008 data, that we are beginning to see yield responses to fertilizer treatments containing blends of N, P and K compared to providing each of these elements alone.

Complete data from the 2009 growing season has not yet been received. Yield data from the first two harvests has been summarized. Yield and quality data have not yet been statistically analyzed. Comparison between the three years will be completed once all yield and nutrient analysis data has been received.

Nutrient Analysis: Nutrient analysis for protein, fiber and minerals has been completed for 2007, 2008 and the first two harvests for 2009. The 2009 nutrient analysis from the November harvest has not yet been received. In addition to yield, the production of nutrients, especially energy and protein, are important to beef cattle producers. We will further analyze the yield and quality data by estimating animal performance from each fertilizer treatment.

Statistical analysis will be completed on mineral concentrations to compare the treatments and possible mineral interactions and correlations. High concentrations of one mineral can negatively impact another, so the affected mineral is “tied up” and cannot be digested and utilized fully.

Economic Analysis: Preliminary economic analysis on yield and cost for 2007 are shown in Table 8 and in Table 9 for 2008. However, the economic impacts of forage fertilization involve more than the cost of fertilizer and the yield response. Forage quality and animal performance must also be evaluated. Economic analysis on these issues will be available in upcoming months.

It is important for producers to understand that if yield losses occur due to lack of fertilizer application, additional feed resources must be acquired. This can be accomplished by either renting or leasing more acres for hay harvest, purchasing

additional hay, protein or energy supplements or reducing livestock numbers to reduce feed needs. Table 5 lists the acres and costs needed to equal the highest yielding treatment. Total costs for the additional acreage are based on our per acre costs for each treatment in our study. A land charge of $28.71 is included in our budgets. The cost of additional hay land may vary from this cost and must be accounted for by each producer.

Livestock producers have to supply certain levels of nutrients to their livestock. Many times, it is cheaper to produce these nutrients on the farm rather than purchase them from an outside source. With this in mind, we calculated the total amounts of crude protein (CP) and total digestible nutrients (TDN, a measure of the energy content of a feedstuff) produced by each fertilizer treatment. Then, based on the amount of CP and TDN produced per acre, we calculated the amount and cost of soybean meal needed to meet the highest total CP production and calculated the amount and cost of corn needed to meet the highest total TDN production. The amounts of supplemental feed and the total cost to supply a certain amount of CP and TDN from forage alone or from forage plus supplement is listed in Tables 6 and 7.

These calculations show that high nutrient production can be obtained from fertilizer, 100-65-60 in 2007, or from high amounts of red clover, 0-65-60 with red clover in 2008. Based on this data, it is cheaper to produce these nutrients on the farm than to buy both fertilizer and supplemental nutrients in the form of corn or soybean meal. If adequate amounts of red clover cannot be obtained in hay fields, the extremely high fertilizer prices in 2008 indicate it may be cheaper to reduce, but not eliminate, fertilizer applications and buy supplemental nutrients in some instances.

Education and Outreach: Two educational workshops were held in our establishment year. On August 30, 2007, approximately 80 people from eight surrounding counties attended the first field day at the plots. Producers learned of the reasoning behind the fertility treatments, data that was being collected, how that data was going to be used and heard some preliminary data that had been obtained from earlier harvests.

Our second event was held in mid-November and approximately 30 people attended that event. Additional results were presented along with information about nutrient cycles in forage systems and winter feeding programs for beef cattle.

The third educational workshop was held in mid-June 2008. Twenty-five producers from the Montgomery County area toured the site and heard an update on research results.

Our fourth workshop was held on August 12, 2009. Eighty-four percent of survey respondents agreed or strongly agreed that greater attention to forage quality is needed in order to be profitable. Sixty-seven percent would like to see more information about variable rate fertilizer technology. Eight-six percent said they would consider attending future Extension field days. Ninety-five percent agreed or strongly agreed that it is important that Extension continues local field days and research plot work.

Forty-six percent of those in attendance had attended previous field days at the research site. Of these, 64 percent agreed or strongly agreed that their forage management changed because of attending the field day. Fifty-five percent agreed or strongly agreed that information from the last field day helped them change their pasture fertilization management and cope with high 2008 and 2009 fertilizer prices.

The regional specialists involved in the project continue to field questions and hear comments about the plots and the results being obtained there. Results being obtained from this study are highlighted at regional meetings, winter workshops and grazing schools.

Producers in central Missouri have readily accepted this multi-disciplinary, local research/education approach. To date, over 200 producers from eight counties have attended four on-site workshops. Extension agronomy specialists present plot data on yield and discuss fertilizer management. Nutrient yield and quality differences between fertility treatments as they apply to beef cattle feeding programs are discussed by Extension livestock specialists. Extension agriculture business specialists highlight the economics of forage production. Producers see the impact of a particular fertilizer program by comparing plots. They learn to incorporate forage quality information into economical beef cattle feeding programs. Producer survey responses include: “You brought up points I hadn’t thought about.” and “You guys always hit the nail on the head.”

Summary points from this research/demonstration project to date are:

- Aggressive harvest management can lead to high yields and high forage quality.
- Producers must decide how to deal with potential reduced yields if the forage fertility program is reduced.
- Producers may need to change fertilizer strategies and target apply fertilizer when forage is needed and can be harvested in a timely manner, rather than blanket fertilizer applications over all their acres.
- Producers need to consider and compare the costs of supplemental feeds with the cost of fertilizer application to increase tons of hay and pounds of nutrients produced on the farm.
- Producers have changed their forage management as a result attending a project field day.
- Producers have changed their forage fertilizer practices as a result of this project.
- A vast majority of producers attending our field days feel it is important Extension specialists continue doing local research and demonstration projects.

Table 1. Plot layout and treatment identification.

	N only 50-0-0	Synergy 50-30-0	P only 0-30-0	K only 0-0-30	Dealer 50-30-30	Check 0-0-0	Soil Test 100-65-60	Legume 0-65-60	Legume 0-65-60	Waste Lime
Rep 1 No lime	101	201	301	401	501	601	701	801 rcl	901 lesp	111
Rep 1 Lime	102	202	302	402	502	602	702	802 rcl	902 lesp	112
Rep 2 No lime	103	203	303	403	503	603	703	803 rcl	903 lesp	113
Rep 2 Lime	104	204	304	404	504	604	704	804 rcl	904 lesp	114
Rep3 No lime	105	205	305	405	505	605	705	805 lesp	905 rcl	115
Rep 3 Lime	106	206	306	406	506	606	706	806 lesp	906 rcl	116
Rep 4 No lime	107	207	307	407	507	607	707	807 lesp	907 rcl	117
Rep 4 Lime	108	208	308	408	508	608	708	808 lesp	908 rcl	118

rcl= Red Clover, lesp = Lespedeza

Table 2. 2007, 2008 and 2009 Yield Results, lbs dry matter per acre.

Treatment	May `07	May `08	May `09	Aug `07	Aug `08	Aug `09	Oct `07	Nov `08	Total `07	Total `08
0-0-0	3097^{b}	960^{e}	3130	3354^{bc}	3936^{d}	3907	752^{bc}	1502^{cde}	7203^{b}	6399^{e}
0-0-30	1950^{d}	920^{e}	3502	3443^{bc}	4404^{cd}	3984	564^{cd}	1547^{cde}	5957^{cd}	6872de
0-30-0	1541^{d}	1279de	5104	3666^{b}	4707^{bc}	4396	333^{e}	1633^{cd}	5541^{d}	7619^{cd}
0-65-60 lesp	3168^{b}	1724^{cd}	4072	2761^{e}	5465^{a}	4246	586^{cd}	1798^{c}	6515^{bc}	8988^{b}
0-65-60 rcl	3092^{b}	3473^{b}	4021	3233^{cd}	5269^{ab}	3897	926^{b}	2518^{b}	7251^{b}	10,945^{a}
100-65-60	6332^{a}	4550^{a}	5437	4421^{a}	4319^{cd}	3839	1239^{a}	2961^{a}	11,992^{a}	11,830^{a}
50-0-0	3086^{b}	2006^{c}	3619	2591^{e}	3745^{d}	3710	500de	1266^{e}	6145^{cd}	7018de
50-30-0	2514^{c}	3037^{b}	4040	2926de	4442^{cd}	4378	352^{e}	1314de	5792^{cd}	8793^{b}
50-30-30	3327^{b}	3095^{b}	4617	3178^{cd}	4151^{cd}	3963	633^{cd}	1825^{c}	7138^{b}	8551^{bc}
Waste lime	--	5010	5580	--	3810	3739	--	1819	--	10,639

Means in columns with different superscripts are different (P<.05)
November 2009 harvest data is not included.
Statistics on 2009 harvest data have not yet been completed.

Table 3. Yield Ranking, lbs. dm/acre

Treatment	2007 Yield Ranking	2008 Yield Ranking	Yield difference (`08 vs.`07)
100-65-60	1	1	-162
0-65-60 rcl	2	2	4009
0-0-0	3	9	-814
50-30-30	4	3	1933
0-65-60 lesp	5	4	2472
50-0-0	6	7	840
0-0-30	7	8	914
50-30-30	8	5	2965
0-30-0	9	6	2079

Table 4. Income Ranking, $/acre

Treatment	`07 Income Ranking*	`08 Income Ranking**	Income difference (`08 vs.`07)
100-65-60	1	7	-$119.23
0-0-0	2	4	-$26.93
0-65-60 rcl	3	1	$77.30
50-30-30	4	5	$11.78
0-65-60 lesp	5	8	$4.35
0-0-30	6	6	$17.93
50-0-0	7	9	$11.88
0-30-0	8	2	$54.41
50-30-0	9	3	$66.88

* = 2007 yield and 2007 fertilizer prices
** = 2008 yield and 2008 fertilizer prices

Table 5. Acres and Cost to Produce the Highest Yield, 2007 and 2008.

	2007	**2007**	**2008**	**2008**
Treatment	**Acres**	**Total cost**	**Acres**	**Total cost**
0-0-0	1.67	$145.67	1.85	$161.38
0-0-30	2.01	$199.25	1.72	$197.33
0-30-0	2.16	$221.44	1.55	$189.92
0-65-60 lesp	1.82	$233.19	1.32	$267.80
0-65-60 rcl	1.65	$211.41	1.09	$221.14
100-65-60	1.0	$178.13	1.0	$292.88
50-0-0	1.95	$228.60	1.69	$231.92
50-30-0	2.07	$263.78	1.35	$226.17
50-30-30	1.68	$225.67	1.38	$262.24

Table 6. Soybean Meal (SBM) or Corn Needed to Equal Highest CP and TDN Produced, 2007 and 2008.

	Tons SBM needed to equal highest CP production	Tons SBM needed to equal highest CP production	Bushels corn needed to equal highest TDN production	Bushels corn needed to equal highest TDN production
Treatment	**2007**	**2008**	**2007**	**2008**
0-0-0	1.1	1.3	78.0	61.2
0-0-30	1.3	1.1	97.2	56.0
0-30-0	1.3	1.0	101.7	49.0
0-65-60 lesp	1.3	0.8	87.0	28.7
0-65-60 rcl	1.1	0	77.2	4.0
100-65-60	0	0.6	0	0
50-0-0	1.3	1.2	95.3	49.2
50-30-0	1.4	0.9	100.7	23.1
50-30-30	1.2	0.9	81.5	22.5

Table 7. Cost to Provide Nutrients Equal to the Highest CP and TDN Produced, 2007 and 2008.

	Total cost to equal highest CP production (1801 lbs.)*	Total cost to equal highest CP production (1633 lbs.)*	Total cost to equal highest TDN production (7813 lbs.)*	Total cost to equal highest TDN production (5664 lbs.)*
Treatment	**2007**	**2008**	**2007**	**2008**
0-0-0	$429.98	$475.01	$340.94	$286.24
0-0-30	$489.51	$458.97	$415.07	$296.67
0-30-0	$499.14	$430.30	$433.11	$281.82
0-65-60 lesp	$518.14	$449.99	$411.09	$296.22
0-65-60 rcl	$467.53	$202.88	$379.13	$215.91
100-65-60	$178.13	$474.49	$178.13	$292.88
50-0-0	$526.97	$494.87	$427.04	$296.98
50-30-0	$556.15	$439.20	$454.7	$242.64
50-30-30	$492.71	$454.63	$399.14	$263.27

*Based on January 2009 cost estimates of corn at $3.25/bushel and soybean meal at $310/ton in Central Missouri. Numbers in parenthesis represent the highest nutrient production from a fertility treatment each year.

Table 8. 2007 Forage Budget.

2007 Forage Budget - Clifton City Forage Plot

		N only	Synergy	P only	K only	Dealer	Check	Soil Test	Red Clover	Lespedeza
		50-0-0	50-30-0	0-30-0	0-0-30	50-30-30	0-0-0	100-65-60	0-65-60	0-65-60
Estimated Income/Acre										
May yield	lbs/acre	3084	2550	1578	1988	3357	3124	6370	3198	3125
August yield	lbs/acre	2591	2926	3667	3443	3178	3354	4421	2762	3234
October yield	lbs/acre	500	352	334	564	633	752	1239	586	926
Total yield	lbs/acre	6175	5828	5578	5994	7168	7230	12030	6546	7285
Income/acre	**$70.59 per ton**	**$217.94**	**$205.69**	**$196.87**	**$211.57**	**$253.00**	**$255.17**	**$424.58**	**$231.04**	**$257.11**
Operating costs/acre										
N - Urea (46% N)	$0.50	25.00	25.00	0.00	0.00	25.00	0.00	50.00	0.00	0.00
P - Phosphate	$0.34	0.00	10.20	10.20	0.00	10.20	0.00	22.10	22.10	22.10
K - Potash	$0.23	0.00	0.00	0.00	6.90	6.90	0.00	13.80	13.80	13.80
Application charge	$5.00/acre	5.00	5.00	5.00	5.00	5.00	0.00	5.00	5.00	5.00
Fertilizer cost/Acre		***$30.00***	***$40.20***	***$15.20***	***$11.90***	***$47.10***	***$0.00***	***$90.90***	***$40.90***	***$40.90***
Crop supplies		4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45
Custom hire & rental		13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50
Machinery fuel		4.94	4.94	4.94	4.94	4.94	4.94	4.94	4.94	4.94
Machinery repairs & maintenance		6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66
Operator & hired labor		6.38	6.38	6.38	6.38	6.38	6.38	6.38	6.38	6.38
Operating interest @ 8.75% x 1/2 year		3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79
Total Operating Costs/Acre		**$69.72**	**$79.92**	**$54.92**	**$51.62**	**$86.82**	**$39.72**	**$130.62**	**$80.62**	**$80.62**
Income Over Operating Cost/Acre		**$148.22**	**$125.77**	**$141.95**	**$159.95**	**$166.18**	**$215.45**	**$293.96**	**$150.42**	**$176.49**
Ownership Costs/Acre										
Farm business overhead		2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
Machinery overhead		7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86
Machinery depreciation		8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31
Real estate charge		28.71	28.71	28.71	28.71	28.71	28.71	28.71	28.71	28.71
Total Ownership Cost/Acre		**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**
Income Over Total Cost/Acre		**$100.71**	**$78.26**	**$94.44**	**$112.44**	**$118.67**	**$167.94**	**$246.45**	**$102.91**	**$128.98**

Hay yields and hay price are on a 100% dry matter basis. Hay valued at $70.59 dry matter basis equals $60 per ton as-fed at 85% dry matter.
Prepared by Randa Brunkhorst, MU Extension Agricultural Business Specialist

Table 9. 2008 Forage Budget.

2008 Forage Budget - Clifton City Forage Plot

		N only	Synergy	P only	K only	Dealer	Check	Soil Test	Red Clover	Lespedeza
		50-0-0	50-30-0	0-30-0	0-0-30	50-30-30	0-0-0	100-65-60	0-65-60	0-65-60
Estimated Income/Acre										
May yield	lbs/acre	2006	3037	1279	920	3095	960	4550	3473	1724
August yield	lbs/acre	3745	4440	4707	4404	4098	3936	4319	5269	5465
November yield	lbs/acre	1266	1314	1633	1547	1825	1502	2961	2518	1798
Total yield	lbs/acre	7017	8791	7619	6871	9018	6398	11830	11260	8987
Income/acre	**$70.59 per ton**	**$247.67**	**$310.28**	**$268.91**	**$242.51**	**$318.29**	**$225.82**	**$417.54**	**$397.42**	**$317.20**
Operating costs/acre										
N - Urea (46% N)	$0.90	45.00	45.00	0.00	0.00	45.00	0.00	90.00	0.00	0.00
P - Phosphate	$1.01	0.00	30.30	30.30	0.00	30.30	0.00	65.65	65.65	65.65
K - Potash	$0.75	0.00	0.00	0.00	22.50	22.50	0.00	45.00	45.00	45.00
Application charge	$5.00/acre	5.00	5.00	5.00	5.00	5.00	0.00	5.00	5.00	5.00
Fertilizer cost/Acre		***$50.00***	***$80.30***	***$35.30***	***$27.50***	***$102.80***	***$0.00***	***$205.65***	***$115.65***	***$115.65***
Crop supplies		4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45	4.45
Custom hire & rental		13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50
Machinery fuel		4.94	4.94	4.94	4.94	4.94	4.94	4.94	4.94	4.94
Machinery repairs & maintenance		6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66	6.66
Operator & hired labor		6.38	6.38	6.38	6.38	6.38	6.38	6.38	6.38	6.38
Operating interest @ 8.75% x 1/2 year		3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79	3.79
Total Operating Costs/Acre		**$89.72**	**$120.02**	**$75.02**	**$67.22**	**$142.52**	**$39.72**	**$245.37**	**$155.37**	**$155.37**
Income Over Operating Cost/Acre		**$157.95**	**$190.26**	**$193.89**	**$175.29**	**$175.77**	**$186.10**	**$172.17**	**$242.05**	**$161.83**
Ownership Costs/Acre										
Farm business overhead		2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63
Machinery overhead		7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86	7.86
Machinery depreciation		8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31	8.31
Real estate charge		28.71	28.71	28.71	28.71	28.71	28.71	28.71	28.71	28.71
Total Ownership Cost/Acre		**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**	**$47.51**
Income Over Total Cost/Acre		**$110.44**	**$142.75**	**$146.38**	**$127.78**	**$128.26**	**$138.59**	**$124.66**	**$194.54**	**$114.32**

Prepared by Dustin Vendrely, MU Extension Agricultural Business Specialist

ENVIRONMENTALLY SOUND HIGH IMPACT FORAGE MANAGEMENT RESEARCH BASED DEMONSTRATIONS FOR INCREASED LIVESTOCK PROFITABILITY BY INCREASING FORAGE PRODUCTION AND QUALITY

Supplemental and Waste Lime overlay Progress Report

A low management pasture with high visibility was selected for the demonstration site in 2007. The original forage experiment is a replicated split plot design with lime and no lime on the main plots and treatments to include a control check, soil test recommended fertility, a typical retailer recommended pasture fertility package, 30 lbs P only, and 50 lbs N only. The affects of the "Easter" freeze of 2007 has given us concern about the total yield potential and has reduced our legume stand in our establishment year. The legume portion of the plot area will be over-seeded with legumes again for 2008 in order to simulate ergovaline dilution recommended practices. In addition to improving data quality in our first study, extending this study an additional year will allow us to add this supplemental experiment that will include treatments with Ag lime and various available waste lime products. Generating data by tracking soil pH and plant response (yield and plant composition) of applications of waste lime over time is critical to demonstrating the profitability of applying certified Ag lime materials.

Plots will be harvested three times annually to follow annual forage response to management changes and long term economic impact from increased productivity and quality. Forage analysis will be conducted on each of the treatments during each of the harvest to show forage quality variations in a year round forage production system. Statistical analysis of data collected will be performed and compared to other research areas. Field days will be conducted twice annually for the duration of the grant to provide demonstrations of proven research based concepts. These concepts will include but not be limited to: soil testing, liming, fertilizer materials, fertilization timing, grazing heights, extended grazing using legumes, grazing frequency, environmental quality and economic benefit of implementing these practices.

2008 Results

Monthly rainfall totals measured 8.36 inches greater than those recorded for the previous year on this same location. April through August rainfall totals were greater than the 30 year average.

Waste lime was applied on May 7, 2008 to the appropriate plots in this supplemental overlay. Three forage harvests were conducted (May 13, August 5, and November 11). Yearly yield totals reflected an increase of .2 ton/acre in the Agricultural Limestone application when compared to the Waste Lime (10,849 pounds per acre vs. 10,432 pounds per acre respectively). Even with this separation in the year of application, we expect this variation to widen with more reaction time in 2009.

2009 Results

There appears to be no differences in measured parameters in 2008 and for the two harvests in 2009 that we have received quality data. We have not yet run statistical analysis on the data, but treatment means do not show large differences in yield or forage quality parameters that would make us believe there were statistical differences. We did not analyze for trace minerals in 2009. Our lab results from the last harvest in 2009 have not yet been received. Total yields and quality differences between treatments will be analyzed when we have the complete data set. Data for 2008 and 2009 are listed in Table 10 below.

Table 10. Yield and Quality Differences Between Waste Lime and Agricultural Lime, 2008 and 2009.

Year	2008							2009			
Harvest date	5-13		8-5		11-4			5-21		8-10	
Treatment	Waste Lime	Ag Lime	Waste Lime	Ag Lime	Waste Lime	Ag Lime		Waste Lime	Ag Lime	Waste Lime	Ag Lime
DM Yield, lbs/acre	4815	5206	3883	3737	1732	1906		5698	5461	3772	3707
CP,%	16.8	16.4	11.1	11.3	9.2	10.1		10.0	9.9	9.3	8.1
TDN, %	67.9	66.8	61.7	62.2	67.9	67.6		58.2	58.4	59.1	59.8
Ca, %	.68	.66	.67	.70	.71	.83		.41	.40	.80	.66
P, %	.38	.37	.67	.70	.22	.23		.24	.24	.19	.21
Mg,%	.19	.19	.34	.33	.33	.28		.19	.18	.26	.23
K,%	2.59	2.53	1.25	1.25	1.01	1.34		1.95	1.88	1.20	1.44
Zn, ppm	23	23	24	29	22	23					
Cu, ppm	9	8	10	13	8	8					
Fe, ppm	117	210	83	91	77	137					
Mn, ppm	79	72	91	63	133	97					