FORAGE QUALITY MANAGEMENT: A KEY TO SUCCESSFUL CATTLE NUTRITION PROGRAMS

Dr. Jim Spain
Department of Animal Sciences
S134 Animal Science Research Center
University of Missouri - Columbia
Columbia, MO 65211
314-882-6452

In 1992, the USDA reported 59.6 million acres were harvested for hay with an average yield per acre of 2.5 ton per acre. These values gave a projected total yield of 149.1 million tons of harvested hay. Using an average market price of $72.10 per ton, total value of hay produced exceeded 10.5 billion dollars. Also in 1992, alfalfa production represented over 50 percent of the forage harvested with 79.6 million tons produced. In addition to stored forage, pasture is also a significant source of forage for cattle. USDA projected a population of 75 to 80 million roughage consuming animal units on farms in 1992. There is a tremendous market potential for value-added feeding of forages through livestock. However, to achieve fullest return on the inputs invested, the management of forages in cattle diets must be understood and optimized.

Study of forage quality has long been a focus of ruminant nutrition research. A primary focus of forage quality and production interaction has been the influence of forage maturity. Harrison and coworkers at Washington State University discussed the influence of forage maturity on forage quality in a review paper dealing with the utilization of grass silage. One table referenced in the review illustrates the decline in quality as orchardgrass becomes mature. In short, as the forage becomes more and more mature, the fiber (cellulose) and indigestible fiber (lignin) increase. The most important line to consider is the decline in digestibility. More fiber is present in the plant and as a result it has a lower digestibility.

Item (%)	4/23	5/5	5/17	5/29	6/6
Protein (%)	22.5	19.3	15.6	12.5	11.5
Cellulose	24.0	29.0	31.6	33.8	35.3
Lignin	5.4	6.6	7.0	8.7	9.6
In situ cellulose digestibility	69.5	71.9	65.5	61.0	53.8

Adapted from Harrison and coworkers (J. Dairy Science 77(10):3209).

Understanding Forage Quality

If you visualize what happens to the forage plant itself as it matures, the impact of maturity on plant development and therefore utilization of the plant by the animal becomes clearer. With growth, the plant becomes taller and prepares to bloom and form seed. This development requires the plant to become more fibrous as the stem develops so that it

may support this weight at the top. As these changes take place, the plant becomes more fibrous. The increase in stem gives a producer or nutritionist one other benchmark used to visually appraise forage quality: **the leaf to stem ratio**. Just as the stem grows to support the bloom and seed, the ratio of leaf to stem declines. Therefore, as forage matures and has fewer leaves relative to stems, the forage becomes of lower quality for the cow. more to the point, the plant material becomes less digestible by the rumen microbes.

The inclusion of poor quality, fibrous forages can result in decreased feed intake. If we evaluate the digestibility of forages, the underlying cause is more apparent. Researchers in Europe described the different rates and extents of digestion for leaf and stem material from small grain crops. The take home message from the table below is two-fold. First, the leaf should be conserved as it affords the animal with the highest nutrient content. The rate of digestion can be very different and may influence intake due to rumen fill of plant residues that are more slowly digested.

Digestibility of Forage Fractions

	WHEAT		BARLEY	
Characteristic	Leaf	Stem	Leaf	Stem
48 h Degradation (%)	61.5	33.0	70.5	28.4
Potentially Degraded (%)	73.4	44.8	85.3	37.7
Rate (/hour)	4.2	2.6	3.8	2.5

Adapted from Orskov (1991)

Its quite simple, the impact of forage quality on animal performance is through the animal's inability to be most efficient when digesting poor quality, high fiber forages. Given the slower rate of digestion, the forage matter is held in the rumen longer. This extends the periods between meals given the longer interval the forage residue remains in the rumen for a longer period of time.

All cattle operations have on farm forage inventories that vary in quality. Numerous factors influence forage quality. Some of these factors, such as maturity at harvest, can be managed by farm managers while other factors must be 'managed around.' Weather, however, can cause tremendous variation of the forage supply one by influencing timing of harvest but also by influencing plant growth and composition. Van Soest reported the effects of weather on forage plant composition. In the spring of 1983, the northeast U.S. experienced cool weather while in 1986 temperatures were much warmer. In contrast to spring weather conditions, growing conditions during the summer were cooler during 1986 compared to 1983. As illustrated in the Table below, these weather trends lead to differing plant composition of forages over time.

Effect of season and growing conditions by year on alfalfa composition. (Adapted from Van Soest, 1995; proceedings of the Twenty-fifth National Alfalfa Symposium).

1983		Cold Spring			Hot Summer	
Harvest Date	5/30	6/10	6/20	6/30	7/12	7/19
% Crude protein	22	21	20	19	19	19
NDF %	31	35	41	45	43	46
ADF%	24	28	34	38	36	39
TDN%	69	65	59	55	56	53
1986		Warm Spring			Cool Summer	
Harvest Date	5/30	6/10	6/20	6/30	7/12	7/19
% Crude protein	19	19	18	19	21	20
NDF %	39	43	46	48	35	41
ADF%	33	36	39	40	28	34
TDN%	60	56	53	51	65	59

Therefore, factors associated with the environment that the forage is produced in and the management factors applied to that system (i.e.. time of harvest impact forage quality) will impact forage quality and utilization of the plant by the animal. One factor often overlooked is the interface between the plant and soil. Patterson and others included in their review of the impact of forage quality on production summarized the effects of fertilization of pastures on forage quality and utilization. Results form nitrogen fertilization have been variable. However, these scientists concluded N fertilization of warm season grasses may improve crude protein content which would improve the low protein attributes of these forages. In addition to N fertilization, the use of S and P also improved animal performance. Animal responses were mostly attributed to increased forage availability. In some cases, however, forage dry matter and fiber digestibilities were improved by S fertilization. Sodium fertilization of pastures altered plant composition and pasture production. Sodium fertilization increased the sodium content of the herbage. In addition to altering Na content, forage content of Mg and Ca was increased with Na application. In contrast potassium was lower in the forage from unfertilized control pastures. Chiy and Phillips (Grass and For. Sci., 1993, 48:189) also reported increased dry matter digestibility with increased Na fertilization. In a companion paper, these same investigators reported increased milk yield in cows grazing the Na fertilized pastures. These results indicate the importance of evaluating the overall management of the soil-plant-animal interface.

Managing Forage Quality.

The first step to managing your forage quality is to forage test. By testing the forages, the producer can inventory forage by quality and amounts. Transition across forage qualities can be made easier by having this information and using it. A former college instructor always reminded the class,

'If you don't measure it, you can't manage it.'

The second step to managing forage quality is to allocate forages to production groups based on quality of the forages. The highest producing herds may not report production grouping. So why do we discuss or recommend it? In high producing herds two things are usually the same. These operations have excellent quality forages with little variation in this quality. These top farms also have a very consistent group of cows with less variation of production level across the herd. Many herds should still consider grouping cows. Not only is there the advantage of forage allocation, but the supplement can be more closely balanced for the animals' needs. This management strategy requires advanced planning and production grouping. A common response of many producers to low quality forages is to feed more grain. However, the additional grain could drive feed costs up without a comparable increase in milk production. The illustration below shows the interaction between the forage maturity/quality and grain supplementation. The results clearly show the importance of forage quality, and the opportunity to group and supplement for maximum production efficiency.

Effect of Stage of Alfalfa Maturity and F:C Ration on Production (4% FCM; lb/d)

	Forage:Concentrate Ratio			
Maturity	80:20	60:37	46:54	29:71
Pre-bloom	79.6	83.2	87.1	86.0
Early bloom	68.0	69.1	77.2	77.2
Mid-bloom	57.2	62.5	64.7	64.7
Full bloom	52.1	55.4	69.5	69.5

As referenced by C. C. Staples, Large Dairy Herd Management, 1992

In the case of grazing cattle, pasture renovation to improve forage quality should be considered. One Example is the use of interseeded legumes such as clover. Wilkins and co-workers (Grass and Forage Sci. (1994), 49:465) reported milk production responses of cattle grazing pastures containing increased levels of clover with increasing concentrate supplementation. Milk production was increased by the presence of clover in the pasture herbage and was further enhanced by grain supplementation. Milk fat and protein yields were also higher for cattle grazing pastures containing clover.

Milk production responses of cows grazing pastures with increased legume content (Clover)

Item	Clover Content								
	Low/Control			Moderate			High		
	0	2	4	0	2	4	0	2	4
Milk (kg/d)	20.6	23.2	25.5	22.8	27.1	26.2	25.4	25.9	26.3
Fat %	3.6	3.6	3.9	3.6	3.8	3.8	3.9	3.9	3.9
Protein %	2.8	2.8	2.8	2.8	2.8	3.0	2.9	3.0	3.0

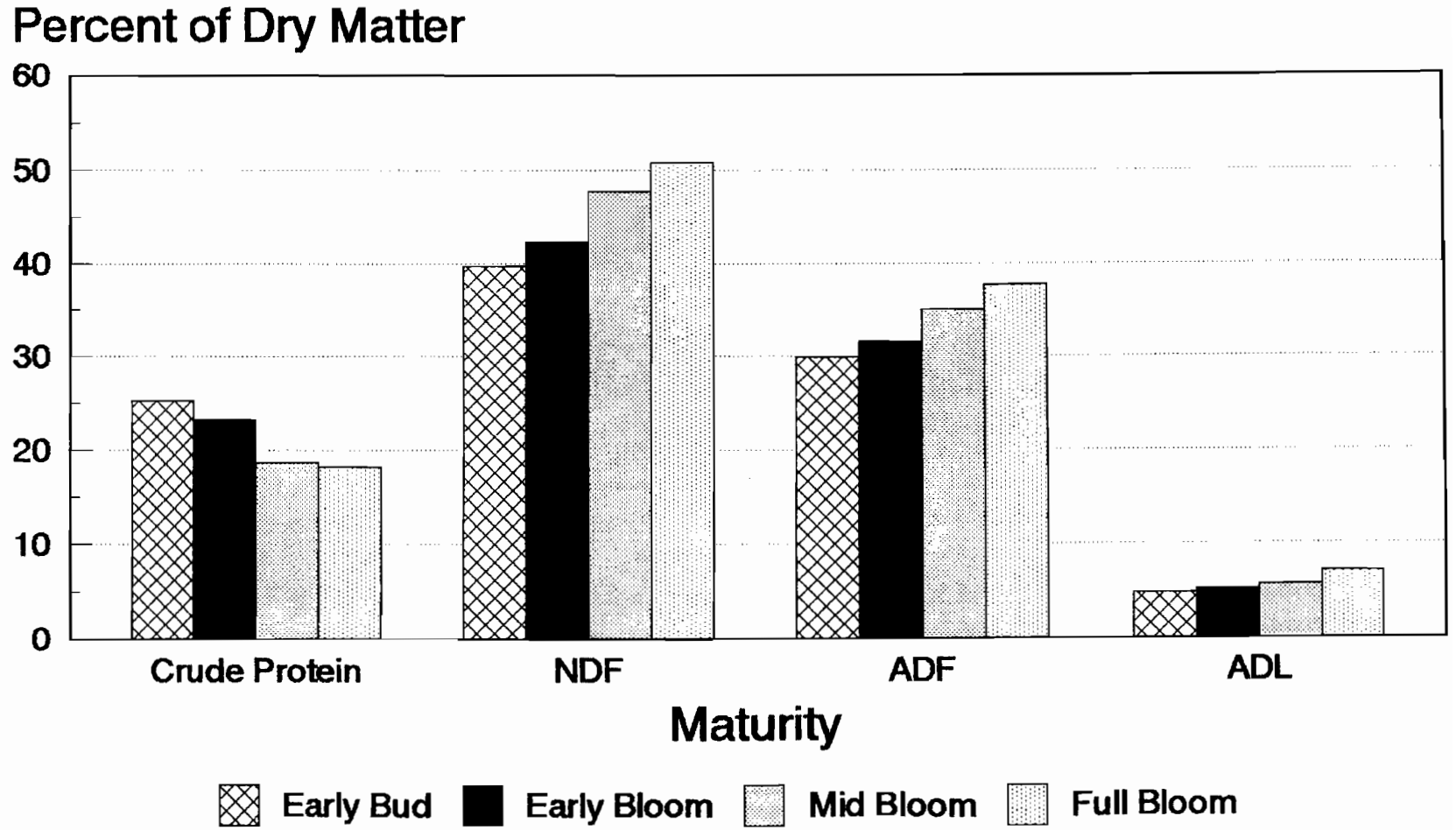
Adapted from Williams et al. (1994) Grass and Forage Sci. 49:465.

Summary

Forage quality is a management challenge facing all cattle farm managers and their professional nutritionist. What does poor quality forage mean on the dairy farm. First it is less digestible and more poorly utilized by the animal. Second, even additional grain does not change a poor quality forage into a better feed for the herd. Therefore, producers and nutritionist must forage test and inventory the forages to allocate based on forage quality and the animals needs. In the event forages are poor, causes that contributed to the harvest of poor quality forage must be identified and when possible corrected. This approach to forage quality management is critical to achieving and maintaining profitable and efficient production of milk and meat from cattle.

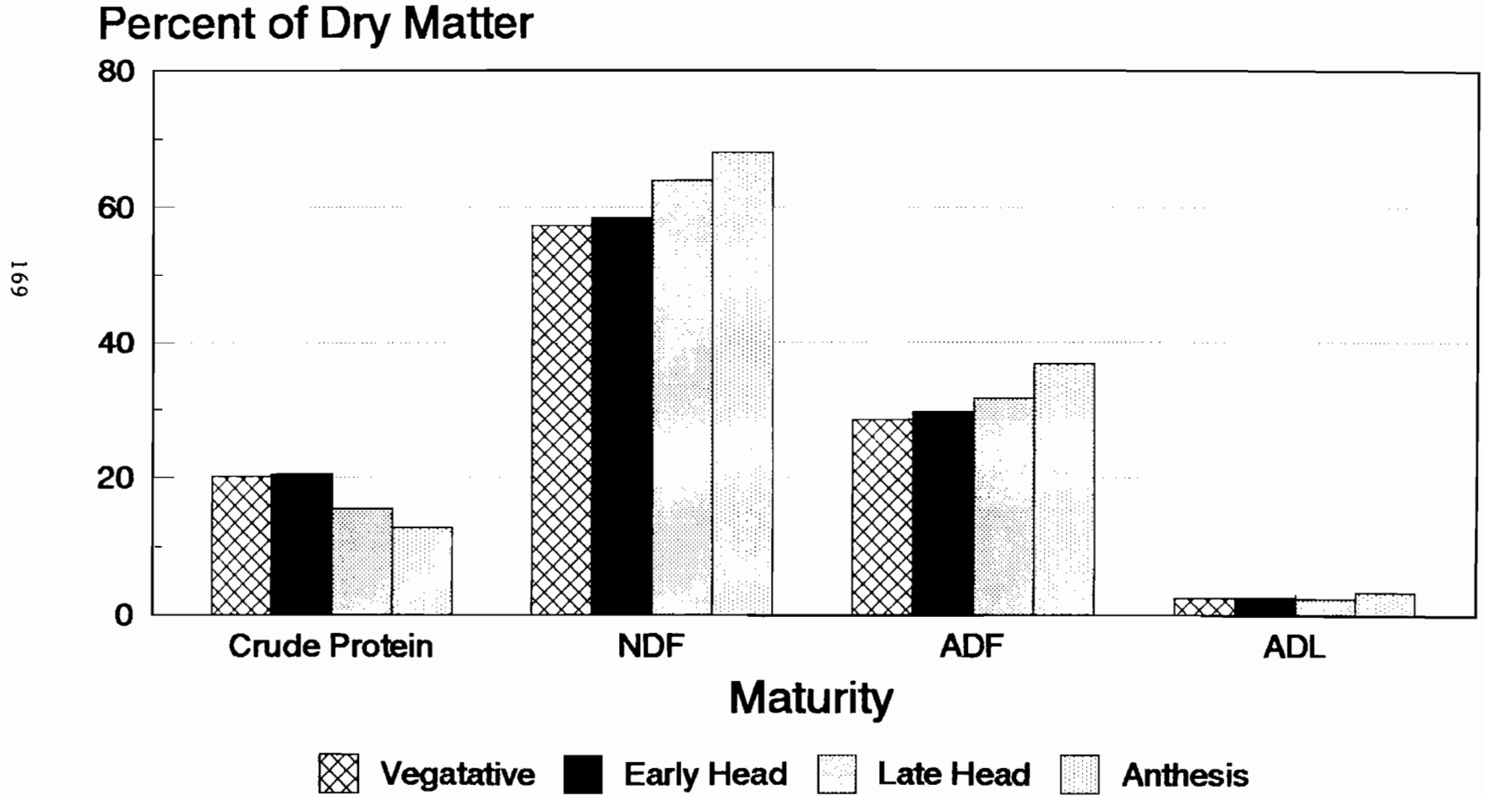
Forage Analysis

Changes in Forage Quality by Maturity (Alfalfa)



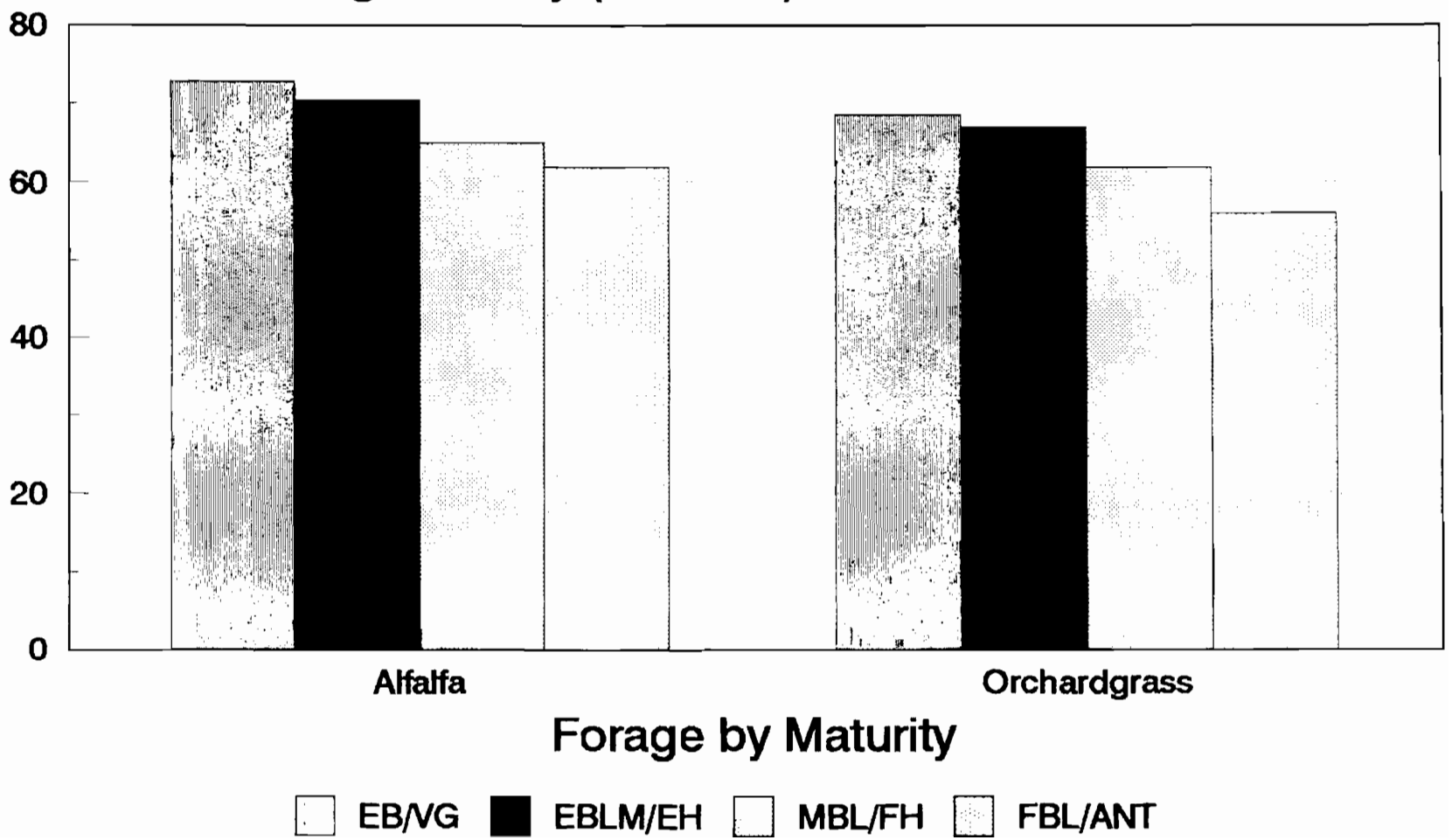
Forage Analysis

Changes in Forage Quality by Maturity (Orchardgrass)



Dry Matter in situ Degradability

Influence of Forage and Forage Maturity



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Program Chairman and Editor:

Dr. George Rehm
University of Minnesota
Dept. of Soil, Water and Climate
439 Borlaug Hall
1991 Upper Buford Circle
St. Paul, MN 55108-6028