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Small Grain Forage Variety Testing in Virginia, 2010

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A forage production trial of commercial barley, oat, rye, triticale, and wheat cultivars has been conducted yearly from 1994-2010 at the Northern Piedmont AREC, Orange. Long-term results were published in 2004 and are available on the web at http://pubs.ext.vt.edu/418/418-019/418-019.html

This report presents the weather and results from this trial in the 2009-10 growing season.

Management and Weather

Preplant fertilizer of 25-64-0 ((25 lb N/acre, 64 lb P_2O_5/acre, 0 lb K_2O/acre) was applied on September 24, 2009. Plots were planted on Oct. 7, 2009 and were seven, seven inch rows wide by 16 feet long, trimmed to 12 feet for harvest. Tillers were counted and ground cover was estimated on March 24, 2010. Nitrogen as UAN at a rate of 60 lb of N per acre was applied on March 8, 2010. The plots were harvested for forage yield at the boot (GS 45) and soft dough (GS 85) stages for barley, triticale, and wheat and at the boot and flowering stages for rye and oats. Two rows, the entire length of the plots (12 feet) were harvested with a 12-inch Jari sickle-bar mower and weighed with an electronic hanging scale.

Small grain plantings in early fall proceeded at a rapid pace due to favorable conditions but soon slowed because of wet weather (Figure 1). Cold, wet weather in late November and December slowed growth dramatically and waterlogging in parts of some fields resulted in dead spots. As of December 15, the wheat crop was rated 36% fair and 47% good. Barley was estimated to be in better condition with 67% of the crop rated as good. Soggy, cold conditions persisted throughout the winter. Many producers had difficulty being timely with late winter nitrogen and herbicide applications due to snow and wet fields (Figure 2). However by late March, fieldwork was back in full swing. On April 10, the wheat crop was rated 55% good and 36% fair. April was warmer and drier than normal, allowing crop growth to progress favorably.

But hot, dry, and windy conditions prevailed and by May 10, approximately 70% of the wheat crop had headed, compared to a 5-year average of 38% by this date. Dry and unseasonably warm weather persisted during pollination and reduced both forage and grain yields statewide.

Figure 1. Deviation of 2009-10 monthly average temperatures from 30-yr mean.
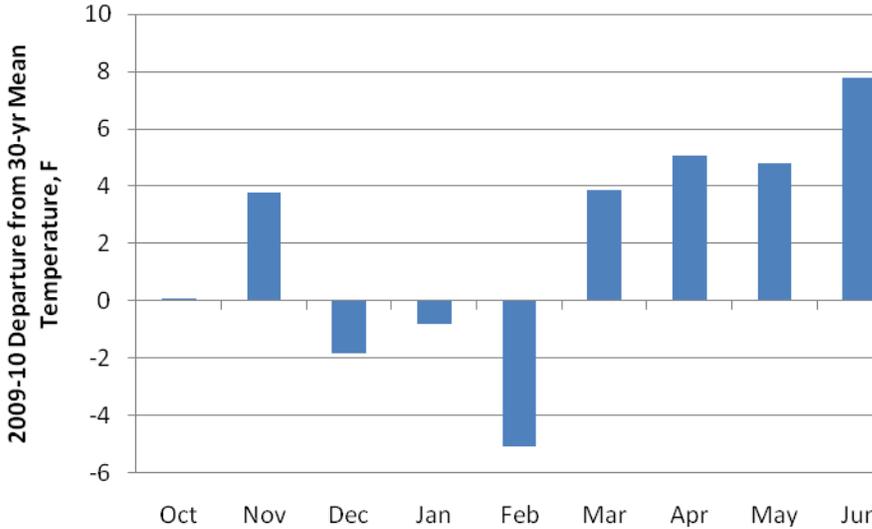
Figure 2. Cumulative daily precipitation, 2009-10 season and 30-yr mean.
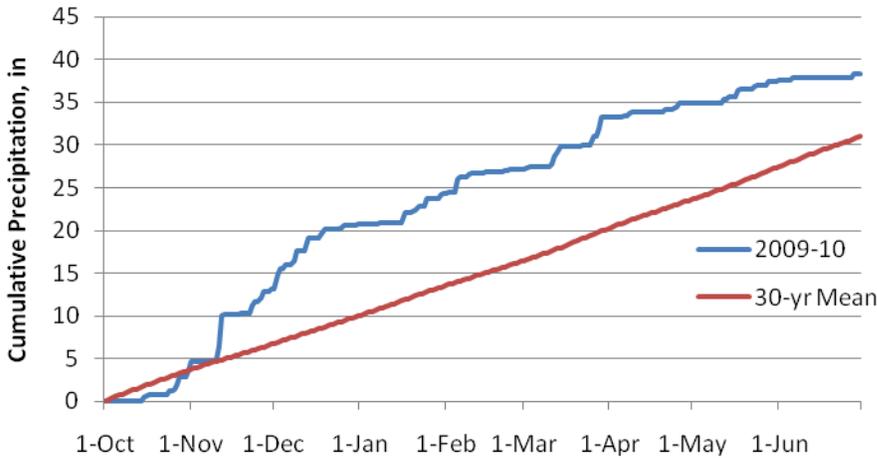
Results

Results are reported for 35 percent dry matter (DM) yield, DM yield, and nutritive value for oats, wheat, barley, rye, and triticale crops.

Experimental plots vary in yield and other measurements due to their location in the field and other factors which cannot be controlled. The statistics given in the tables are intended to help the reader make valid comparisons between cultivars. The magnitude of differences that may

have been due to experimental error has been computed for the data and listed at the bottom of columns as the LSD (.05) (least significant difference with 95 percent confidence). Differences must be greater that the LSD to be believed to truly exist.

Table 1. Small Grain Forage Variety Test, Northern Piedmont AREC, Orange, Va 2009-2010, Boot Stage Harvest.

Cultivar	Species[†]	Harvest Date	Zadoks Maturity	Height (inches)	% Ground Cover	Lodging %	% Crude Protein	ADF %	NDF %	TDN %	35% DM Yield (tons/ac)	DM Yield (tons/ac)
Nomini	B	4/19	46	28	90	0	12.00	25.77	48.37	73	7.30	2.56
Thoroughbred	B	4/23	46	28	90	0	14.33	26.83	49.97	71	7.22	2.53
Wheeler	R	4/27	45	46	100	0	16.90	28.13	53.27	70	6.48	2.27
Early Grazer	R	4/9	45	34	100	0	19.10	25.47	48.93	71	4.24	1.48
RSI 202718	T	4/28	44	40	93	0	14.47	32.43	58.20	68	12.19	4.27
TRICAL 342	T	4/19	45	29	90	0	14.37	25.23	47.37	74	10.87	3.80
RSI 04T90141	T	4/28	44	39	90	0	13.67	32.07	57.13	69	10.52	3.68
TRICAL 2700	T	4/28	44	38	90	0	12.07	31.17	56.27	70	10.06	3.52
NCT05-2651	T	4/19	45	27	100	0	15.80	27.43	50.10	71	10.02	3.51
TRICAL 308	T	4/19	45	28	93	0	15.10	26.80	48.37	72	9.14	3.20
RSI 09TF 3047	T	4/19	45	28	90	0	15.57	26.83	49.63	72	9.00	3.15
TRICAL 336	T	4/27	45	31	97	0	14.93	29.37	54.73	71	8.90	3.11
NCPT01-1433	T	4/23	45	28	100	0	14.93	28.83	52.93	70	8.76	3.07
RSI 09TF 4244	T	4/23	45	32	90	0	16.50	27.67	49.37	71	8.23	2.88
RSI 09TF 7246	T	4/27	46	35	93	0	15.87	27.27	50.77	72	8.02	2.81
TRICAL 815	T	4/27	45	31	93	0	15.33	29.10	53.97	71	7.88	2.76
RSI 05TF125	T	4/27	44	28	93	0	19.27	27.33	49.07	71	6.63	2.32
Featherstone 176	W	4/23	45	25	90	0	14.60	25.57	47.17	73	7.76	2.72
VA 05-258	W	4/27	45	29	90	0	14.67	26.93	49.27	73	7.69	2.69
NC04-20814	W	4/27	46	29	90	0	13.73	27.53	51.53	72	7.47	2.61
SS MPV 57	W	4/27	45	31	90	0	13.30	26.60	49.13	72	7.40	2.59
Merl	W	4/27	46	28	90	0	14.07	26.47	49.37	72	6.90	2.41
Sisson	W	4/23	45	27	90	0	15.00	24.60	43.90	74	6.78	2.37
Jamestown	W	4/23	45	24	90	0	15.20	25.07	45.53	73	6.60	2.31
LSD 0.05							2.66	1.64	2.71	2	2.40	0.84

[†] B - Barley, R - Rye, T - Triticale, W- Wheat

Compared to 2009, overall 35% DM forage yield at the boot state was approximately 1.6 ton/ac less and crude protein (CP) was 6% lower in 2010. This is likely due to very warm temperatures in April that accelerated crop development. The highest yielding entry at the boot stage harvest was 'RSI 202718' and the triticale entries as a group produced the greatest tonnage.

Table 2. Small Grain Forage Variety Test, Northern Piedmont AREC, Orange, Va 2009-2010, Soft Dough Stage Harvest.

Cultivar	Species[†]	Harvest Date	Zadoks Maturity	Height (inches)	Lodging %	% Crude Protein	ADF %	NDF %	TDN %	35% DM Yield (tons/ac)	DM Yield (tons/ac)
Small Grain Forage Variety Test											
Northern Piedmont AREC, Orange, Va 2009-2010											
Soft Dough Stage											
Thoroughbred	B	5/21	85	36	0	8.20	35.23	61.03	68	16.01	5.60
Nomini	B	5/14	85	36	0	8.10	33.00	58.40	69	12.62	4.42
Early Grazer	R[‡]	4/28	63	65	0	12.37	35.60	61.00	67	12.75	4.46
Wheeler	R	5/14	68	67	0	11.07	36.90	65.00	66	12.73	4.46
RSI 202718	T	6/8	85	62	0	6.37	42.50	68.60	61	24.88	8.71
RSI 09TF 4244	T	6/4	84	53	0	7.33	40.20	69.30	59	21.11	7.39
NCPT01-1433	T	6/4	86	47	0	6.50	38.40	62.90	64	21.07	7.37
RSI 05TF125	T	6/8	84	43	0	8.07	40.63	68.20	62	20.49	7.17
RSI 09TF 3047	T	6/4	86	50	0	6.90	39.30	66.47	59	20.08	7.03
RSI 04T90141	T	6/8	85	59	0	7.17	40.80	68.60	61	19.99	7.00
TRICAL 336	T	6/4	84	46	0	7.37	38.93	65.37	61	19.90	6.96
TRICAL 2700	T	6/8	85	56	0	6.17	40.03	67.13	60	19.10	6.69
TRICAL 815	T	6/8	85	46	0	6.67	40.83	68.60	60	18.98	6.64
NCT05-2651	T	6/4	86	46	0	6.73	40.27	68.37	58	18.50	6.48
TRICAL 308	T	6/4	86	38	0	6.77	40.10	68.30	58	18.50	6.48
TRICAL 342	T	6/4	84	54	0	6.03	41.13	67.53	58	18.39	6.44
RSI 09TF 7246	T	6/8	85	50	0	6.73	39.00	65.20	61	18.03	6.31
NC04-20814	W	5/28	85	37	0	7.53	38.00	61.33	65	17.46	6.11
Featherstone 176	W	5/28	86	39	0	6.70	37.87	61.57	64	16.84	5.89
VA 05-258	W	5/28	85	40	0	8.60	33.47	57.43	68	16.79	5.88
SS MPV 57	W	5/28	84	37	0	7.73	35.43	58.43	65	15.88	5.56
Jamestown	W	5/28	85	35	0	7.47	36.33	58.77	66	15.25	5.34
Sisson	W	5/28	84	35	0	8.07	34.87	56.80	68	14.28	5.00
Merl	W	6/1	86	34	0	6.83	36.50	59.90	62	13.36	4.68
LSD 0.05						1.53	2.83	4.27	3	3.63	1.27

[†] B - Barley, R - Rye, T - Triticale, W - Wheat
[‡] - Rye was harvested at flowering

The highest yielding entry harvested at the soft dough stage was RSI 202718 triticale. Over all entries, 35% DM yield was approximately 1.5 tons/ac less than in 2009. Crude protein over species averaged 7.6% which is 2.3% below the long-term mean for CP at this stage.

Using Crabgrass on Feeding Sites as a Summer Cover Crop

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Most livestock operations have at least a few highly concentrated feeding areas that become denuded of forage cover over the winter and turn into a nursery for unwanted weeds and soil erosion the following summer. Weeds such as spiny amaranth (spiny pigweed), pigweed, ragweed, and common lambsquarters, just to mention a few, typically populate these areas and provide a weed bank for many years thereafter. One solution to help suppress weeds and make

these feeding areas more productive is to use crabgrass as a summer "cover" crop to help suppress weed growth and provide additional summer forage.

In late April after cattle have started their pasture rotations and hay feeding has been ceased, excess manure and old hay should be removed from the feeding areas. After removing the manure and leveling out the area, crabgrass can be broadcast seeded at the rate of 6-8 pounds of seed per acre. This seeding rate is about double the normal pasture rate but a thick cover is desired to help crowd out weed seedlings and establish a thick forage cover. After seeding, a light drag can be pulled across the area to lightly incorporate the seed. Crabgrass germination should initiate when the soil temperature reaches approximately 70 degrees. Because of the available plant nutrients usually present is these feeding areas, crabgrass should grow very vigorously from late June through August.

The pictures below show the difference in a hay feeding areas where crabgrass was planted compared to planting fescue.

This hay feeding site was cleaned on April 20th and crabgrass was planted on April 30th. On July 24th in a low moisture, drought environment, the crabgrass was over 20" tall and completely covered the entire feeding area. The thick crabgrass stand almost completely smothered out all broadleaf weed competition.

This hay feeding site was cleaned and re-seeded in early April with fescue. Note the lack of weed suppression. Although the fescue did germinate, the entire site was covered with ragweed and lambsquarter on July 24th.

Managing Nitrates and Prussic Acid in Forages

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Nitrates can accumulate to toxic levels in commonly grown forages. This most often occurs when heavy nitrogen fertilization is followed by drought. Nitrates are taken up by the plant, but not utilized since plant growth is restricted by the drought. Any factor that slows plant growth in combination with heavy nitrogen fertilization can result in nitrate accumulation. Some plants tend to accumulate nitrates at greater rate; these include, but are not limited to commonly used summer annual grasses, corn, crabgrass, small grains, annual ryegrass, bermudagrass, johnsongrass, tall fescue, and some annual and perennial weeds commonly found in pastures and hayfields.

In contrast to nitrates, prussic acid or hydrogen cyanide can be formed in commonly used sorghum species such as forage sorghum, sorghum-sudangrass hybrids, sudangrass, and johnsongrass. Under normal conditions these forages contain little free cyanide. However, when freezing, drought stress, wilting, or mechanical injury damages plant tissue, an enzymatic reaction occurs and free cyanide is produced. Being aware of the factors that can result in accumulation of nitrates or the formation of prussic acid and using alternative forages during these periods will reduce chances of livestock losses.

Nitrates

In cattle, nitrate is converted to nitrite in the rumen, and the nitrite is absorbed into the blood stream. Nitrite interferes with the blood's ability to carry oxygen. Symptoms of nitrate poisoning include trembling, staggering, rapid and labored breathing, rapid pulse, frequent urination followed by collapse, coma, and death. The onset of symptoms and death is rapid and usually occurs within one to two hours. Most often, animals are simply found dead. In animals affected by nitrate poisoning, the blood will take on a brownish chocolate color, giving the nonpigmented skin and mucus membranes a muddy brown color.

The following practices can help to reduce nitrate accumulation in forages and manage the risk associated with feeding high nitrate forages:

Split nitrogen applications. Applying smaller applications of nitrogen throughout the growing season will reduce the risk of nitrate accumulation in forages.

Delay harvest or grazing after a drought ending rain. Nitrates are often the highest just after plant growth resumes. Grazing or harvesting should be delayed for 7 days after a drought ending rain.

Raise cutting or grazing height. Nitrates tend to accumulate at higher concentrations near the base of the plant. Raising your cutting or grazing height from 2-4 inches to 6-8 inches can significantly reduce nitrate concentrations in the forage tissue that is being conserved or ingested. For corn silage and forage sorghum, raising the cutting height to even more (12-16 inches) can help avoid high levels of nitrates. This can also increase the feed quality of the harvested forage.

Test all suspect forages. All forages that may contain high levels of nitrates should be tested at a qualified lab. Contact your local veterinarian or Extension agent for information on recommended labs.

Segregate all forages high in nitrates.   Once identified, forages high in nitrates should be clearly marked and separated from low nitrate forages if possible.

Harvest forage as silage if possible. Ensiling high nitrate forage can reduce nitrates by 40 to 60%. Silage should be tested before feeding to confirm nitrate levels.

Nitrates are stable in hay. Nitrates do NOT decrease over time in dry hay. This means that you can kill livestock months or even years later. If you suspect nitrates in your hay, make sure to test it.

Avoid feeding high nitrate forage to susceptible animals. Feeding high nitrate forage to animals that are in poor condition and under stress, or are pregnant, lactating, or sick is especially risky and should be avoided.

Limit the intake of high nitrate forages. Guidelines for feeding high nitrate forages can be found in Table 1. The best way to feed high nitrate forages is in a total mixed ration. This reduces the animal's ability to select individual components. If feeding a total mixed ration is not possible, then limit access to the high nitrate hay in a manner that allows livestock to consume 50% or less of their total daily dry matter requirement. A high energy supplement that is balanced for the ration should be fed PRIOR to hay feeding.   Simply unrolling one bale of low nitrate hay and one bale of high nitrate hay is NOT an adequate way to feed high nitrate hay.

Supply free access to clean, nitrate-free water. In addition to clean water, make sure to provide access to high quality mineral and vitamin supplement.

Nitrates and horses. Horses, monogastrics with a functional cecum, tend to be more tolerant of nitrates in forage tissue. Although no threshold levels have been officially established, forages are generally considered safe for horses if the nitrate concentration in the plant material is below 1.5 to 2.0%. An accurate nitrate test is needed to make this assessment. Local veterinarians should be consulted before feeding high nitrate forage materials to horses.

Hay Feeding and Nutrient Imports to Pasture

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Before the cold weather sets in this year, it might be a good time to reevaluate how we feed out hay. Unless you can graze all year, most livestock producers must allocate land to feed hay in winter. For convenience, hay is often fed in a confined location like a small pasture or sacrifice lot. Feeding this way has advantages, but it may contribute to soil compaction, soil erosion, weed invasion and water quality degradation. It also may be a poor use of nutrients contained in the hay itself.

At the Virginia Tech Shenandoah Valley AREC at Steeles Tavern, VA, we have been studying the impact of confined hay feeding areas on pasture function. As part of this study, we have also been monitoring hay for nutrient content. The cows used in this study were divided into 12 groups for experimental purposes. Each group (7 or 8 cows) was fed hay in a 2-acre pasture designated for this purpose. Last winter, hay was fed for an average 105 days across the 12 pastures. This amounted to about 2500 lbs of dry hay fed per cow.

From sample analysis, we estimated the hay brought in an equivalent of 200 lbs N/acre, 20 lbs phosphorus (P)/acre and 190 lbs potassium (K)/acre to each pasture. We can easily assume that 80% of these nutrients were returned back to pasture in the form of hay wastage, manure deposition and urine. Since we are "fertilizing" such a small area, however, it is questionable whether this is an efficient use for these nutrients.

From an environmental perspective, we also need to be concerned about nutrient loss from these confined feeding areas. We estimated that each pasture in our study received about 3,600 lbs of manure (dry weight) over the '08-'09 winter. Since confined hay feeding areas also tend to be compacted from cattle trampling, nutrients within the manure could easily wash away with heavy rains. Not only would this waste valuable nutrients, but it may also contribute to water quality degradation. Overall, moving away from confined hay feeding should make better use of the nutrients imported in hay and protect the environment at the same time.

Stockpiling for Winter Grazing in Drought Years: A Leap of Faith

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As I am writing this article, tropical storm Bonnie is poised to make land fall in south Florida and I am praying that its remnants loop up to the mid-Atlantic region, bringing us some much needed, widespread rainfall. After a wet start to the year we have dried out and burnt up in Southside Virginia. We had the sixth driest June ever recorded at our research station and the hottest! We had 19 days over 90° F and two over 100° F. Reaching 100° F in June is very rare. The end result is significantly reduced late spring and summer forage production. This has left many producers grasping at straws when it comes to feeding their cows this winter.

Stockpiling tall fescue is one the cheapest and best ways to provide winter grazing for livestock in the mid-Atlantic region. In good years, tall fescue pastures top-dressed with 60 to 80 lb nitrogen/A in mid-August can produce 1-2 ton/A hay equivalent. The question in drought years is does this recommendation work for dried up, overgrazed pastures. No pasture will respond to nitrogen until it rains. In addition, pastures that have been overgrazed have the least potential for fall growth. Applications of nitrogen for stockpiling should target pastures that have not been overgrazed or overgrazed the least.

The next question is when and how much nitrogen to apply. Ideally nitrogen for stockpiling should be applied in mid-August at a rate of 60 to 80 lb/A. In a drought year there are several approaches to stockpiling. The first is to apply nitrogen in mid-August at normal rates and then pray for rain. The second is to delay applications until rain looks like a sure thing. This option requires more planning since nitrogen needs to be applied prior to the impending rain. As the application date becomes later decrease the amount of nitrogen since the grass will have less time to grow before frost and cool temperatures set in. Research at the Southern Piedmont AREC has shown that a third option may exist. This option applies one-half of the nitrogen in August and one-half after it rains. If it doesn't rain then you don't make the second application.

Research at the Southern Piedmont AREC has shown that not all nitrogen sources are created equal when it comes to stockpiling. Three years of data found that the most effective nitrogen sources for stockpiling in late summer were ammonium nitrate and ammonium sulfate. Using urea or urea ammonium nitrate (30% solution) resulted in significantly lower yields. Organic nitrogen sources such as broiler can be used for stockpiling, but tends to yield lower because not all of the nitrogen is immediately available at application.

In drought years, winterfeed is often tight, so maximizing the utilization of stockpiled grass is essential. Strip grazing stockpiled fescue can increase grazing days by 30 to 40%. Allocate only enough pasture for 2-3 days of grazing. This is easily accomplished by using a forward

temporary electric fence. No back fence is required since plants are dormant. During wet periods feed hay in a sacrifice area to avoid wasting stockpiled grass and damaging pasture sod.

Stockpiling in drought years is a leap of faith. There is no guarantee that is going to rain, but if you are a betting man (or woman), the odds are pretty good that you will get some winter grazing in most years. A little rain and timely fertilization can produce a tremendous amount of winter grazing. Sometimes you just have to take that leap of faith!

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To Seed or Not Seed, Fertilize or Not Fertilize Forages?

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That is the million dollar question right now. Some producers have already gone ahead and seeded and/or fertilized and the results are in question. For those who have not and are looking for a recommendation, my suggestion is to not do either at the present time.

We have now beyond what Elmer Dengler, NRCS State Grazing Specialist, and I consider the recommended late summer planting dates – August 1 to September 1 for the higher elevations of Western Maryland and August 10 to September 10 for the rest of the state. We recognize that these dates differ from the recommended time periods for hay and pasture seedings given in the present Code 512 standard. However we feel that those dates are inappropriate and plan to revise them in the coming months as we review and update the standard. The primary reason for moving the dates earlier is the effect of planting date on fall and spring plant vigor. Research both in Maryland and Pennsylvania has shown that seedings made during the August and early September period have much more seedling vigor and late winter/early spring growth than seedings made beyond the cutoff dates above. Early seedings produce a lot more growth and are much more competitive against weeds than later seedings. Later seedings may survive mild winters but they are much less vigorous and productive the following year.

There was some rain in most areas the weekend of September 11-12 but the amount was not sufficient to make any significant difference in soil moisture. Planting into dry soil conditions has at least two risks. The first is that a light rainfall, such as received this weekend, may moisten the soil surface and enable germination of seed that is in the ground, but if there is not rainfall to follow and keep the surface moist, the seedlings are not likely to survive. Another risk is if we seed and it remains dry, the seed sits there and we end results are the same as a late seeding.

Rather than gambling on perennial hay and pasture seedings right now, consider seeding winter annuals (small grains, annual ryegrass, brassicas, etc.) for possible late fall grazing and then grazing or silage harvest next spring (brassicas will not overwinter). The perennial hay and pasture seedings can then be made in late winter (mid-March to early May, depending upon location) or the winter annuals followed with sorghum-sudangrass, millets, teff, etc. for summer grazing or harvest and the hay and pasture seedings made next August/early September. Late winter seedings should be made as early as conditions permit to allow adequate root development for seedlings to survive should dry weather occur in early summer. Early seeding is also advantageous to reduce weed development. Early seeding allows for more grass and legume growth and development which provide more competition to suppress warm-season annual weed seed germination and development later in the spring. Seed should normally be in the ground by mid-April for most of Maryland, late April/early May for the higher elevations of Western Maryland.

In terms of fertilizing hay and pasture fields, if producers were watching the weather forecasts and applied fertilizer ahead of the rains 3-4 weeks ago, they should a ahead of those that did not. For those that have not yet applied the late summer application, I would suggest waiting until there is reasonable promise of at least a good ½- to ¾ -inch of soaking rain before applying any nitrogen fertilizer. Urea or urea-containing fertilizers applied on the surface will have considerable nitrogen volatilization losses as long as the material lies on top of the ground. Thus, I would not apply nitrogen until there is a reliable forecast of significant soaking rain. We are quickly running out of 'growing' season unless we have an abnormally mild fall, especially for timothy and orchardgrass. Thus at this point, I'm inclined to reduce the late summer N application rate, from the normal recommendation rate of 50 to 60 lb N/acre to 25 to 30 lb N/acre. I'm still in favor of applying some N, especially to orchardgrass, mainly to stimulate root growth this fall. Research at Virginia Tech showed a beneficial effect of late summer/early fall N application on grasses. If we look at the turf industry, this is the primary time that N applications are recommended and it is mainly to promote root growth that occurs in the fall.

The late summer/fall growth of tall fescue for fall and winter grazing has already been impacted and if it doesn't soon rain the amount of growth that we can expect from it will be severely limited, even though fescue grows at cooler temperatures than orchardgrass, timothy, etc. Again I would wait until there is a reliable forecast of soaking rain and reduce the late summer application rate to half or less than normally applied (normal rate on fescue with less than 25% legumes is 60 to 75 lb N/acre).

This has been a very challenging year for forage producers. Some areas had a cloudy, wet spring and early summer which was good for pasture growth but quite difficult for hay making, resulting in a lot of rain damaged and/or over mature hay. Other areas were dry during late spring and early summer which reduced hay yields from the start. And most all areas were dry in late summer and continue to be dry, severely limiting fall cutting yields. Can anyone remember when we have had something close to a 'normal' year?

Metabolic Stress Associated with Nutrient Partitioning in US Cattle with High Genetic Merit for Milk Yields: Metabolic Profiles as windows for Reproductive Inefficiency

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Introduction

Fifty to seventy five years of selection for increased milk production in dairy cattle has been accompanied by problems in early lactation energy balance and an erosion of reproductive efficiency in post postpartum cows. Heavy lactation results in moderate to severe nadirs in negative energy balance during early lactation as energy drains outpace energy intakes. Imbalances between energy intake and energy outflow through heavy lactation drains are covered primarily by mobilization of adipose tissue (fat) and to a lesser extent, muscle tissue.

Changes in tissue mass are widely known as loss in body condition score (BCS) with adipose (fat) tissues being the pool of energy that waxes and wanes with changes in energy stress. Several key hormones like somatotropin [growth hormone (GH)], insulin, insulin like growth factor -1 (IGF-1), and leptin regulate the flow of dietary energy into storage (fat), lactation and reproductive functions. Genetic selection for high milk yields has produced cows with enormous genetic ability and predisposition to mobilize fat stores in support of lactation. Differences between cows with high and low genetic merit for heavy lactation also are associated with widely divergent differences in the ability to mobilize fat and partition energy toward milk production and away from fat stores and reproductive functions in the early lactation period. The rate, depth, and duration of adipose mobilization (and change in BCS) in early lactation has been associated with the genetic ability to partition energy toward lactation demands and away from reproductive function. Even under conditions designed to maximize post partum energy intake, modern dairy cows tend to partition added energy more towards generation of milk rather than restoration of adipose mass or reproductive function. This pattern of partitioning is typical of North American dairy cows where pressure of genetic selection strived to maximize milk yields.

The reproductive inefficiency that accompanied increased genetic merit for milk production was tolerated because U.S. dairymen breed cattle year round. Genetic selection pressures for milk yields in pasture based dairies of New Zealand, however, needed to sustain efficient reproductive function because of short breeding windows (140 DIM). Open cows in pasture systems tend to be culled after the breeding window closes. Accordingly, these cattle were selected to partition energy toward reproductive function as well as lactation needs. Consequently, they exhibit different patterns of energy partitioning by GH, insulin, IGF-1 and leptin than the typical North American dairy cow. For all cattle later in lactation, priorities in energy partitioning shift to direct more dietary energy into fat stores and reproductive function. Later in lactation, cows reconstitute BCS and reproductive efficiency.

Physiology of Adipose Tissue in Lactating Cows

Lactating cows are genetically programmed to retain a certain amount of energy as fat reserves. Hormone expression and tissue sensitivity to hormones are altered to increase fat mobilized from fat stores in response to energy deficits of early lactation. Fat breakdown (lipolysis) in early lactation is heavily influenced by genetic traits linked to high milk production and energy intake. The genetic drive controlling the rate of fat mobilization (decrease BCS) early in lactation occurs without regard to nutrient intake. Other physiologic factors controlling lipogenesis (fat deposition) and restoration of BCS in later lactation are primarily regulated by energy intake and nutritional factors. That is to say, diet may have minimal effects on lipid mobilization during early lactation but can modify the depth (nadir) of BCS loss and subsequent restoration of BCS later in lactation. Thus, diet steers physiologic mechanisms partitioning energy to build-up fat reserves in late gestation. It has been proposed that evolutionary trends installed physiologic safeguards to guaranteed newborn nutritional needs and adult reproductive functions by partitioning energy toward these functions. These functions insured survival and procreation of the species by governing patterns of energy balance and partitioning at the time of late gestation and parturition. Advances in modern bovine genomics offer the opportunity through marker assisted genetic selection, to genetically alter these paths to increase energy storage, while partitioning greater energy needs toward reproduction functions while sustaining high lactation yields. Leptin has been one of the principle genetic candidates of marker assisted selection because this hormone governs the intake of energy stores and partitioning of energy stores into adipose and other tissues.

Energy storehouses exist as adipose tissue with triglycerides serving as the principle form of fat storage. Biogenesis is the buildup of triglycerides in adipose whereas lipolysis is the removal of triglycerides from adipose. The buildup of fat in adipose occurs by synthesis triglycerides from rumen derived acetate or the uptake of non-esterified fatty acids (NEFA) absorbed from the intestine or generated by other tissues. Lipolysis or the removal of triglycerides from fat stores results in the release of non-esterifies free fatty acids (NEFA) into the blood for transport to other organs such as the liver, muscle or mammary gland. NEFA mobilized into the mammary gland can be utilized in synthesis and secretion of milk fat. In the liver and muscle, NEFA are degraded by oxidative processes into energy sources. Heavy mobilization of peripheral fats into the liver leads to excessive oxidation of NEFA into breakdown products the liver releases back into the circulation as acetate (ketone bodies). These ketone bodies serve as energy for many tissues deprived of glucose that is preferentially consumed for milk production in the mammary glands. Alternatively, NEFA delivered to the liver but not oxidized for energy and ketone body production can be re-synthesized into triglycerides, secreted back into the blood for storage in adipose tissues. Unfortunately, the cow's ability to clear newly synthesized triglycerides from the liver is sufficiently inefficient so that triglycerides (fat) easily accumulate in the liver. In moderation, triglyceride accumulation (fat storage) in the liver is non-problematic and expected in post partum cows. Excessive hepatic storage of triglycerides however, is hepatotoxic and results in chronic liver failure widely regarded by producers and veterinarians as fatty liver syndrome.

Hormonal Events in Lipid Metabolism of the Cow

Growth hormone (GH, somatotropin): GH is released in large quantities at parturition and drives the release of energy from fat stores by breakdown of triglycerides into NEFA. Greater post partum energy deficits are associated with greater amounts of circulating GH that drive for lipolysis. GH also targets the liver by stimulating synthesis and secretion of insulin-like growth factor 1 (IGF-1). Early in lactation, GH triggered hepatic IGF-1 synthesis falls off as the liver become less responsive to the presence of GH. This phenomenon is referred to as a "disconnected somatotropic axis" at the time of parturition. Liver derived IGF-1 is an important growth stimulant of tissues involved in folliculogenesis and fetal growth immediately after conception. Deep nadirs in negative energy balance exacerbate the drop in GH mediated IGF-1 secretion. Moreover, hepatotoxic effects of post partum fat deposition in the liver can further diminish hepatic synthesis of IGF-1. The loss of hepatic sensitivity to GH coupled with fatty deposition in the liver can severely compromise hepatic synthesis of IGF-1. Low amounts of IGF-1 can lead to failure of folliculogenesis, an-ovulatory heats, weak estrous behavior and increased early embryonic death. These are all hallmarks of reproductive failure associated with energy deficits. GH also decreases the sensitivity of fat stores to insulin so the post partum cow is considerably more prone to mobilize fat, increase amounts of circulating NEFA, ketone bodies and fat challenges to the liver during the post partum period.

Insulin and insulin resistance in dairy cattle: Insulin impacts lipid metabolism by stimulating lipogenesis in adipose stores. Insulin mediated triglyceride synthesis antagonizes and reverses GH mediated NEFA release into the blood. Insulin levels normally drop as GH levels rise in the post partum period. Adipose tissues of modern, high producing dairy cows are also much more resistant to the lipogenic effects of insulin. Accordingly, modern dairy cattle are much more prone to increased NEFA amounts in the post partum blood. Part of the insulin resistance may be mediated by the impact of high levels of GH on adipose tissues.

Insulin also impacts blood glucose levels by enhancing glucose uptake in most tissues like muscle, fat and liver. Mammary uptake of glucose for lactation however, occurs in the absence of insulin in what has been proposed as an evolutionary mechanism to sustain milk production for neonate survival. In dairy cows, insulin resistance in early lactation occurs because muscle, liver and adipose tissues become insensitive to insulin stimulated uptake of glucose. The evolutionary advantage of insulin resistance in cows would be to spare glucose consumption by most tissues leaving greater availability of glucose for use in milk production. Genetic selection for high milk yields has been inadvertently selected for greater amounts insulin insensitivity in muscle, fat, liver, reproductive organs in early lactation. The production advantage of inadvertent selection for greater insulin insensitivity in peripheral tissues of modern cattle would spare greater amounts of glucose for lactation. Thus selection for increased insulin insensitivity in liver, muscle and fat would have the desired effect of driving greater amounts of glucose into milk production to sustain higher milk yields.

Unfortunately, genetically selected insulin insensitivity also antagonizes NEFA uptake and synthesis into triglycerides in fat. NEFA levels therefore, tend to rise very quickly in insulin resistant cows. Some of the NEFA enter the mammary gland for milk fat synthesis while tissues like liver are forced to use NEFA instead of glucose for energy. NEFAs not used for energy by

the liver, are broken into ketone bodies or re-synthesized into triglycerides in the liver. Insulin resistance in modern dairy cows has genetically predisposed them to easily and rapidly mobilize adipose tissue, and elevate NEFA and ketones in the post partum blood. These genetically driven events have also increased the modern cow's propensity to store triglycerides in the post partum liver. Indeed, most modern post partum cattle experience some increased amount of fat storage in the liver.

Genetic differences between holsteins of North American and those of New Zealand have revealed some fascinating information about fat mobilization and insulin resistance in dairy cattle. North American cattle are considered to have higher genetic merit for milk production than New Zealand holsteins. The higher merit for milk production in North American cattle is accompanied by poorer reproductive efficiency, a greater propensity to mobilize triglycerides from fat stores and therefore rapidly lower BCS. Moreover, nadirs in BCS are deeper and rate of BCS recovery are slower in North American cattle because of higher genetic drives for milk production. These differences are also associated with greater amounts of insulin resistance in North American compared with New Zealand holsteins. The genetic effect is to partition greater amounts of NEFA and blood glucose into mammary milk production and less into uses for energy and energy storage in the adipose, liver and reproductive systems. As a result, North American holsteins experience more fatty liver problems, delayed, defective or interrupted folliculogenisis, anovulation or delayed ovulation, less than adequate steroidogenisis leading to increased frequency of twinning, anestrus, weak estrus silent estrus and increased frequency of multiple ovulations per estrus (twinning).

Leptin: The so-called lipostatic model of regulating voluntary feed intake might be interesting to dairy producers. Basically, the model states genetic and environmental factors dictate the size of adipose stores in animals. Animals regulate dry matter intake to maintain a genetically predetermined mass of energy stored in adipose tissues. Any deviations in adipose energy stores away from these amounts are addressed by appropriate changes in dry matter intake. Leptin, a hormone produced by adipose tissues serves as an important physiologic mediator of the relationship between adipose mass and dry matter intake. Leptin is produced almost exclusively by adipose tissue, dampens the appetite and diminishes dry matter intake with increased energy storage in adipose tissue. As fat stores fill with triglyceride, leptin synthesis is increased in fat cells. On the other hand, short or long term energy challenges are met by mobilization of fat out of adipose tissues and reductions in leptin synthesis and secretion by fat depleted cells. Lowered leptin synthesis removes the dampening effect of leptin on voluntary feed intake. Like insulin, the amount of leptin in the blood decreases with deepening nadirs in energy balance immediately post partum.

Although milk yields historically drove genetic selection in dairy cattle, other physiologic events unintentionally accompanied increased genetic merit for milk yields. Modern cattle with superior milk yields also developed lowered insulin levels and greater insulin resistance in association with heavier lactation (Chagas et al., 2009). Indeed, dairy cattle are described as type II diabetics because peripheral tissues (adipose) are poorly responsive to insulin mediated glucose uptake. Post partum insulin unresponsiveness compounds the problems associated with the low levels of insulin that already exist in the blood of post partum cattle. Insulin resistance is problematic in that insulin normally drives triglyceride synthesis and storage (lipogenesis) in fat

tissues. With the unintended selection of insulin resistance that accompanied gains in milk yields, adipose tissues of modern dairy cows have slowed lipogenesis in favor of triglyceride breakdown and release of NEFA (lipolysis). NEFA secretion into the blood (rather than removal from the blood) dominates events in fat stores of modern, post partum dairy cattle.

BCS, Lipid Metabolism and Lactation Energy Balance

There will always be some elevation of NEFA and beta hydroxybutyrate in the blood of early lactating cows because genetic selection for high milk yields has resulted in insulin resistance and the associated propensity for lipolysis in peripheral fat. Simply stated, some elevation in amounts of beta hydroxybutyrate and NEFA in the blood is a normal sequel of lactation in dairy cattle. Assuming BCS reflects the mass of energy storage in adipose tissue, then loss in BCS could be expected to be associated with increased NEFA and beta hydroxybutyrate in the blood. A practical way to think about the state of the BCS in any cow is to think of BCS as reflective of the net balance between rates of lipogenesis and lipolysis. Considerable amounts of evidence exist showing cattle are genetically programmed to decrease the mass of adipose tissue as they pass from gestation into lactation. This probably occurs because fat stores in early lactation become insulin resistant and do not respond to the lipogenic effects of insulin. Since the early lactation onset of insulin resistance is controlled by genetic events, then it follows the rate of lipolysis and BCS decline in early lactation is heavily influenced by genetics and less by ration. The genetic factors are manifest through their effect on growth hormone, insulin and leptin on fat breakdown early in lactation. Indeed early studies showed the anticipated loss in BCS very early in lactation was not influenced substantially by feeding readily available, high energy nonstructural carbohydrates early in the post partum period.

There is some data indicating insulin resistance and hormonal profiles driving energy partitioning away from storage and reproductive functions and more toward lactation in early lactation can be partially overcome if enough non-structural carbohydrates are fed in the diet. The effect would shift the balance between fat mobilization and fat deposition more in favor of fat deposition and increase in BCS. However, more work is needed to clarify this issue. Thus, over all losses in BCS can be impacted by feeding regimens as they change the overall duration of BCS loss. As lactation proceeds, loss of BCS later in lactation was impacted by dietary amounts of nonstructural carbohydrate as the balance between lipolysis and lipogenesis favored lipogenesis. Reversed loss of BCS is associated with a reversal in the state of insulin resistance that tips metabolic events in favor of lipogenesis. Adipose tissues become more responsive to insulin, insulin amounts in the blood rise and lipogenesis replaces lipolysis as the dominant event in lipid metabolism.

Monitoring BCS in various stages of the production cycle is an important tool to manage ration and nutrition programs. Evidence indicates BCS (size of adipose mass) is inherited and cows eat to reach their genetically determined BCS. Regardless of feeding regimes (component, pasture or TMR), maximized milk yields per parity occur when BCS at calving is 3.5. Moreover, cows should never lose more than 0.5 -1.0 BCS during heavy lactation.

Assuming dry matter intake of well prepared and balanced rations varies in part to sustain predetermined adipose energy stores (and therefore BCS), and then cattle with low BCS at

calving could be expected to consume greater amounts of dry matter per lb milk. Likewise, cows with very high BCS could be expected to consume less dry matter per lb milk. Indeed, some evidence exists in support of this contention. Dry matter intake in thin, underweight cows (BCS ≤ 2.5) tends to be high per lb milk production. Dry matter intake in fat, over weight cows (BCS ≥ 3.5) tends to remain low after parturition while energy mobilization out of adipose tissue reduces the mass of adipose tissue (and BCS) toward normal.

Simply stated, fat mobilization occurs in obese cows with dampened voluntary feed intake. In practice, two cows with heavy lactation strain and negative energy balance could be expected to mobilize peripheral energy stores: the thinner cow may mobilize less adipose tissue because of greater dry matter intake while the obese cow would mobilize more adipose tissue because of lower dry matter intake. Accordingly, both cows could be expected to show elevated NEFA and ketones early in lactation but the obese cow could be expected to show the higher amounts. Ration, management, and environmental problems limiting dry matter intake could be expected to compound NEFA and ketone in spite of very divergent amounts of dry matter intake.

What do the Physiologic Events Affecting Lipid Metabolism and BCS have to do with Metabolic Profiles?

Metabolic profiles were originally designed to generate "snap-shots" of laboratory evidence about the metabolic state in cattle. Thirty years ago metabolic profiles were a popular tool for veterinarians attempting to diagnose nutritional and metabolic problems in dairy cattle. Experimental data however, indicated too many herds lacking clinical problems presented with abnormal metabolic profiles indicative of clinical problems (low specificity). Part of the specificity problem stemmed from sampling cows in the wrong stage of lactation, use of dry cows as a measure of uniformly normal metabolic standards and over interpretation of results far beyond laboratory data.

Moreover, newer data has proven old assumptions about the metabolic status of dry cows and cows in early and peak lactation were incorrect. What appeared to be a lack of specificity or inability to distinguish normal animals and herds from problematic animals and herds eventually disfavored further use of this tool. A combination of expense and lack of specificity rendered metabolic profiling unpopular.

Recently, improvements in laboratory tests, their application and interpretation have ignited more interest in metabolic profiles (table 1). Profiles can be performed on a subsample of cow's representative of one or more physiologic groups in a herd. For example, one might sample 7-10 cows in the far off, close up and early (2-40 DIM) post partum groups. R. J. Van Saun (2008) has proposed an alternative strategy to reduce profile costs by pooling blood samples within physiologic groups. Pooled samples of blood from 10-12 animals 40-50 days pre-partum, 3-21 days pre-partum and 10-12 cows 3-30 days post partum can be employed in a herd-based diagnostic or screening approach. In this case, only 3 samples would be evaluated in the metabolic profile.

The limitation of screening pooled samples is a lack of accurate information about any one individual. Concerns for the single animal would require metabolic tests of that particular cow

because individual variation is lost to some degree in the pooled sampling approach. The most important diagnostic tests regarding energy status would include serum albumen, total blood protein, NEFA, beta hydroxyl butyrate (BHB) and cholesterol. Amounts of BHB and NEFA in the blood generally reflect energy status although BHB levels can also rise by direct absorption form rumen fermentation of poor quality forages.

So in light of all the preceding metabolic discussion, when are elevated amounts of NEFA and BOHB important clinically? Since most lactating cattle descend into negative energy balance in early lactation, fat mobilization with elevated levels of NEFA and BHBA can be expected in most post partum cows. Excessive elevation of NEFA amounts in close up ($\geq$ 0.4mEq/L) or early lactation cows ($\geq$ 0.6mEq/L) indicate negative energy problems associated with excessive lipolysis, loss in BCS and increased risk for peri-parturient disorders. Excessive amounts of NEFA are not a directly indicative of reproductive efficiency but are key indicators of deep nadirs in negative energy balance and loss of BCS mass that are associated with reproductive inefficiency.

Accordingly, elevated blood NEFA ($\geq$0.27mEq/L) 2-14 days pre-partum are indicative of pre-partum fat mobilization and a 20% reduction in pregnancy rate 120 days later in milk (DIM). Amounts of blood NEFA 2-14 days post partum $\geq$ 0.72mEg/L were also associated with 16% erosion in pregnancy rates 120 DIM (Ospina et al., 2010). Negative energy balance also increases amounts of circulating ketone bodies (often derived from NEFA degradation by the liver). Subclinical ketosis and increased risk for post partum diseases occurs when amounts of BHB in the blood range between 1.4 and 2.6 mmol/L (Van Saun, 2008). Clinical ketosis is apparent with blood amounts of BHB $\geq$ 2.6mmol/L. Blood amounts of BHB are not direct measures of reproductive efficiency but reflect the status of negative energy balance and the lipolytic erosion of BCS that are associated with reduced reproductive efficiency. Accordingly, BHB blood amounts $\geq$ 10 mg/dL were associated with a 13% decrease in pregnancy rates 120 DIM (Opsina et al., 2010). Thus, threshold amounts of BHB and NEFA in the blood provide valuable information about energy balance or the extensive lack of energy balance in a herd even though cows are genetically programmed to mobilize adipose and elevate NEFA and ketones in the blood.

Table 1. Analyte blood amounts indicative of increased risk of metabolic and reproductive problems in a herd.

Blood parameter	Cut off	Risk
NEFA (dry cow)	$\geq$ 0.4 mEq/L	Ketosis, anovulation, anestrus, delayed ovulation, silent estrus, lowered pregnancy rates 120 DIM
NEFA (early fresh cow)	$\geq$ 0.7 mEq/L	Ketosis, anovulation, anestrus, delayed ovulation, silent estrus, lowered pregnancy rates 120 DIM
BHB	$\geq$ 1.4 mmol/L	Ketosis, anovulation, anestrus, delayed ovulation, silent estrus, lowered pregnancy rates 120DIM
Cholesterol	$\leq$ 80-90 mg/dl	Fatty liver, severe ketosis, reproductive failure

Conclusion

North American dairy cows selected for high genetic merit in milk yields are also genetically programmed to mobilize energy from fat stores and lose body condition early in lactation. Fat mobilization can be expected to elevate blood levels of beta hydroxybutyrate and non-esterified fatty acids. Loss of BCS can be expected to last 7-8 weeks post partum. The metabolic problem is cows with high genetic merit for production are also insulin resistant and possess an imbalanced or disconnected growth hormone (somatotropic hormone) axis. The hormonal problems persist through the same 3-4 months when efficient reproductive function is desired.

In contrast to their counterparts selected for moderate milk yields and sustained reproductive function, North American cow's partition energy heavily toward lactation at the expense of energy stores and reproductive function. By 120DIM, the endocrine disturbances driving these patterns of energy partitioning correct themselves but not before there has been a serious erosion of reproductive function. Conflicting data indicates nutrition strategies designed to maximize dry matter and energy intake inconsistently hasten return of hormonal imbalances back to those favoring energy use for reproductive function and fat storage.

In some cases however, increased energy intake only increased milk yields creating greater energy imbalance in cows with high genetic merit for milk yield. In other cases, increased energy intake was associated with return of the endocrine and energy disturbances favoring reproductive efficiency. Metabolic profiles, when used with a carefully designed strategy can help evaluate energy problems and provide laboratory data supporting other ongoing management tools such as monitoring BCS, milk fat and protein and key reproductive indices.

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Temple Grandin and Fred Provenza to Speak at the 2011 Winter Forage Conferences in Virginia

Essential Topics in Animal Agriculture: What Farmers Need to Know is the theme for the Virginia Forage and Grassland Council (VFGC) and Virginia Cooperative Extension winter forage conferences. This is an ideal opportunity for all livestock producers to gain an understanding of animal psychology and behavior leading to: reduced stress and injury to animals and people; higher quality animal products; a safer work environment; improved animal welfare; and lower total costs of production.

This year's keynote speaker is Dr. Temple Grandin, Professor of Animal Science at Colorado State University and internationally known expert on animal behavior. She is listed in the 2010 TIME 100, Time magazine's annual list of the 100 most influential people in the world. Dr. Grandin will provide research-based insights and knowledge into animal behavior and how to improve transportation, handling, and working facilities to reduce stress and improve animal welfare.
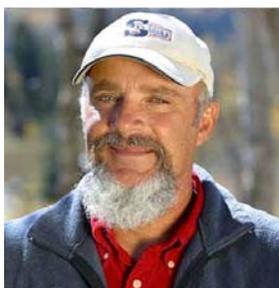
Participants will also hear from Dr. Fred Provenza, Professor Emeritus in the Department of Wildland Resources at Utah State University and Dr. John Anderson, Livestock Economist for the American Farm Bureau Federation. Dr. Provenza will help famers understand the practical science behind grazing behavior and how to train animals to enhance the environment. Dr. Anderson will provide insights into the global economics of animal agriculture and what that means for individual farm profitability.

The daylong conference will be repeated at three locations and will run from 8:30 am to 3:00 pm.

- Tuesday, January 18, in Wytheville at the Wytheville Meeting Center
- Wednesday, January 19, in Madison Heights at the Madison Heights Community Center
- Thursday, January 20, in Weyers Cave at the Weyers Cave Community Center.

Please visit the VFGC web site (http://vaforages.org) for additional details and registration information.

The U.S. Department of Agriculture Natural Resources Conservation Service is also a sponsor.

The 8th Mid-Atlantic Dairy Grazing Conference and Organic Dairy Field to be held in Wytheville, VA on October 11-13. Information is also posted on the Virginia Forage and Grassland Council site: http://vaforages.org/

The program starts at the Wytheville Meeting Center with registration at 3:00 p.m. on Monday October 11th. The first afternoon include a farm visit to the Crowgey dairy farm where they have recently re-entered the dairy business as a seasonal pasture-based dairy with a new swing milking parlor after having left a confinement dairy system a few years ago. With a combination of on-farm (Mon and Tue afternoons) and featured topics at the Meeting Center, this 3-day event has lots to offer for both experienced and new graziers. Lunches will be provided on Tue and Wed and a supper provided Tue evening at Rural Retreat High School to be followed by a dairy grazier panel discussion. The event concludes with a speaker panel discussion on Wed afternoon, October 13th at 2:15 p.m.

Notices and Upcoming Events

November 16-18, 2010
Mid-Atlantic Crop Management School, Ocean City, MD. Contact Dr. Bob Kratochvil at 301-405-6241 or visit the website www.mdcrops.umd.edu

January 17-20, 2011
Delaware Ag Week, Harrington, DE. Contact Dr. Cory Whaley at 302-856-7303 or email: whaley@udel.edu
    Delaware—Maryland Hay and Pasture Day, Evening Program for Part-time Hay and Pasture Producers, Equine Pasture Management, and Agronomy/Soybean Day

January 19, 2011
Southern Maryland Hay & Pasture Conference, Waldorf, MD. Contact Ben Beale at 301-475-4481 or email: bbeale@umd.edu The program will be available in late fall at: http://www.mdforages.umd.edu

January 20, 2011
TriState Hay and Pasture Conference, Location yet to be determined. Contact Willie Lantz at Email: wlantz@umd.edu Again, the program will be available in late fall at: http://www.mdforages.umd.edu

January 18, 2011
2011 Winter Forage Conferences in Virginia, Wytheville Meeting Center, Wytheville, VA. Please visit the VFGC web site (http://vaforages.org) for additional details and registration information

January 19, 2011
2011 Winter Forage Conferences in Virginia, Madison Heights Community Center, Madison Heights, VA. Please visit the VFGC web site (http://vaforages.org) for additional details and registration information

January 20, 2011
2011 Winter Forage Conferences in Virginia, Weyers Cave Community Center, Weyers Cave, VA. Please visit the VFGC web site (http://vaforages.org) for additional details and registration information

Newsletter Web Address

The Regional Agronomist Newsletter is posted on several web sites. Among these are the following locations:

http://www.grains.cses.vt.edu/ Look for Mid-Atlantic Regional Agronomy Newsletter

or

www.mdcrops.umd.edu   Click on Newsletter

Photographs for Newsletter Cover

To view more of Todd White's Bucks County photographs, please visit the following web site:

www.scenicbuckscounty.com