Mid-Atlantic Regional Agronomist Quarterly Newsletter

December 2008

Dr. Richard W. Taylor, Editor
rtaylor@udel.edu
University of Delaware

Supporting Agronomists:
Dr. Wade Thomason, Va Tech
Dr. Bob Kratochvil, University of Maryland
Dr. Greg Roth, Penn State
Dr. Peter Thomison, Ohio State University
Dr. Chris Teutsch, Va Tech

To subscribe or unsubscribe, please send your request to the editor at rtaylor@udel.edu
Comments, suggestions, and articles will be much appreciated and should be submitted at your earliest convenience or at least two weeks before the following dates: February 28, May 30, August 30, and November 30. The editor would like to acknowledge the kindness of Mr. Todd White who has granted us permission to use his scenic photographs seen on the front cover page. Please go to www.scenicbuckscounty.com to view more photographs.

Contributors for This Issue

Kristin Fisher, Hood College, UMD

Dr. Bob Kratochvil, UMD

Dr. Wade Thomason, Va Tech

Dr. Mark Alley, Va Tech

Dr. Peter R. Thomison, OSU

Allen B. Geyer, OSU

Rich Minyo, OSU

Bert Bishop, OSU

David Lohnes, OSU

Dr. Chris Teutsch, Va Tech

Dr. Gordon Groover, Va Tech

Dr. Ben Tracey, Va Tech

Dr. Robert Dyer, UD

Table of Contents

Issue 3; Number 4

Establishing Cereal Cover Crops – What is the Best Method?

Kristin Fisher
Graduate Student - Hood College
Email: kfisher515@hotmail.com

and

Dr. Bob Kratochvil
Extension Specialist – Grain and Oil Crops
University of Maryland
Email: rkratoch@umd.edu

Maryland pays participating farmers who plant cover crops with a tier-based system that encourages early planting dates. A variety of planting techniques [no-till drill into either previous crop residue or tilled soil; broadcast seed and lightly incorporate; broadcast seed and chop residue (generally corn stalks); and aerial seed into growing crop] are recognized for establishing cover crops. Opinions vary about the agronomic, economic, and nutrient management benefits for each of these planting techniques. Farmers are primarily concerned about the input costs and time associated with planting while nutrient regulatory agencies are concerned about adequate stand establishment to absorb excess nutrients.

In 2007, Maryland Grain Producer's Utilization Board funded a project to evaluate cover crop planting techniques. Wheat and rye cover crops were planted using many of the aforementioned planting techniques plus treatments that broadcast seed with no other operation at two Maryland locations on two planting dates (prior to October 1 [early planting] and late October/early November [late planting]). Weekly seedling emergence counts tracked stand establishment for each treatment. The 2007 cover crop planting season was highlighted by extremely dry soil conditions with no substantial rain until late October. Even though dry soil conditions prevailed for the first planting date, no-till drilled wheat and rye had 20 seedlings/ft^2 emerged within 1-2 weeks post-planting. Broadcast wheat followed by light disking had a mixed response with no emergence until late October at one location while the other location had 30 seedlings/ft^2 two weeks post-planting. Seedling emergence rates were slower for the second planting date reflecting the cooler temperatures that accompany early November. Again, the no-till drilled wheat and rye had the best response, 25 seedlings/ft^2 emerged by three weeks post-planting. Broadcast wheat with a light disking did better during the second planting (approximately 20 seedlings/ft^2 three-weeks post-planting) reflecting the better soil moisture conditions following the late October rains. And, as observed with the early planting date, the other broadcast planting treatments had seedling emergence rates at 3-4 weeks post-planting that ranged between 7-15 seedlings/ft^2.

Biomass samples to estimate nitrogen (N) uptake were collected in April of 2008. At both sites and for both planting dates, **the drilled treatments consumed the most N**. For the first planting date, no-till drilled wheat consumed an average of 40 lb N/acre by April while the drilled rye consumed 42 lbs N/acre by the same date. For the second planting date, drilled rye and wheat both consumed only 18 lb/acre or approximately 44% of the N consumption that occurred with the early planting date. Wheat no-till drilled on October 9, a date that simulated an average planting date for commodity grain production, consumed 31 lb/acre of N by April.

As expected, the broadcast treatments had lower N consumption for both planting dates. The broadcast treatment that showed the most promise was wheat followed by a light disking, an operation that provided seed to soil contact. This treatment consumed 30 lb/acre N by April. The poorest performing broadcast treatments were broadcast wheat with either a rolling operation after broadcast or no other operation. Both those treatments for the early planting date only consumed 17 lb/acre N by April. Similar to the outcome for no-till drilled wheat and rye, all the late planting date broadcast treatments consumed 50% or less N compared to the early planting date.

The first year results for this research indicate that early planting of cover crops using a tillage operation (drilling or light disking) that provides seed to soil contact will establish acceptable stands and consume more N than broadcast operations with no method of incorporating the seed into the soil. This research is continuing during 2008-2009 with funding support from the Maryland Grain Producer's Utilization Board.

Wheat Nitrogen Management in 2009

Dr. Wade Thomason
Extension Specialist – Grain Crops
Virginia Tech
Email: wthomaso@vt.edu

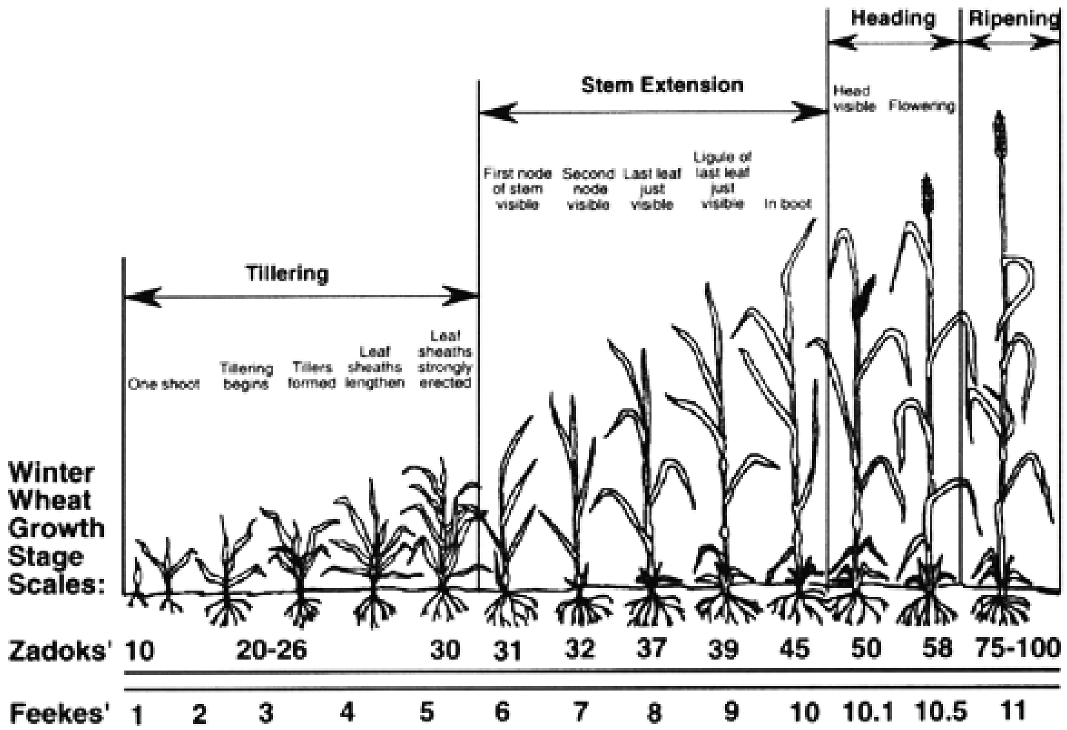
and

Dr. Mark Alley
W. G. Wysor Professor of Agriculture
Virginia Tech
Email: malley@vt.edu

The high price of nitrogen (N) fertilizer at the time of wheat planting resulted in many farmers choosing to forego preplant N. However, insufficient N availability to wheat plants results in low yields and significantly reduced profits compared to a properly fertilized crop.

A harvest objective with current wheat varieties grown in the mid-Atlantic should be 60-70 heads/sq. ft. with at least 30 kernels/head. This means that the wheat plant must develop near 100 tillers by the end of vegetative growth to reach optimum yields (see Figure 1). Nitrogen fertilizer rate and timing are the major tools available after planting to manipulate wheat to produce higher yields per acre. Nitrogen affects heads/sq. ft., seeds/head, and kernel size.

Figure 1. Zadoks scale for wheat development.



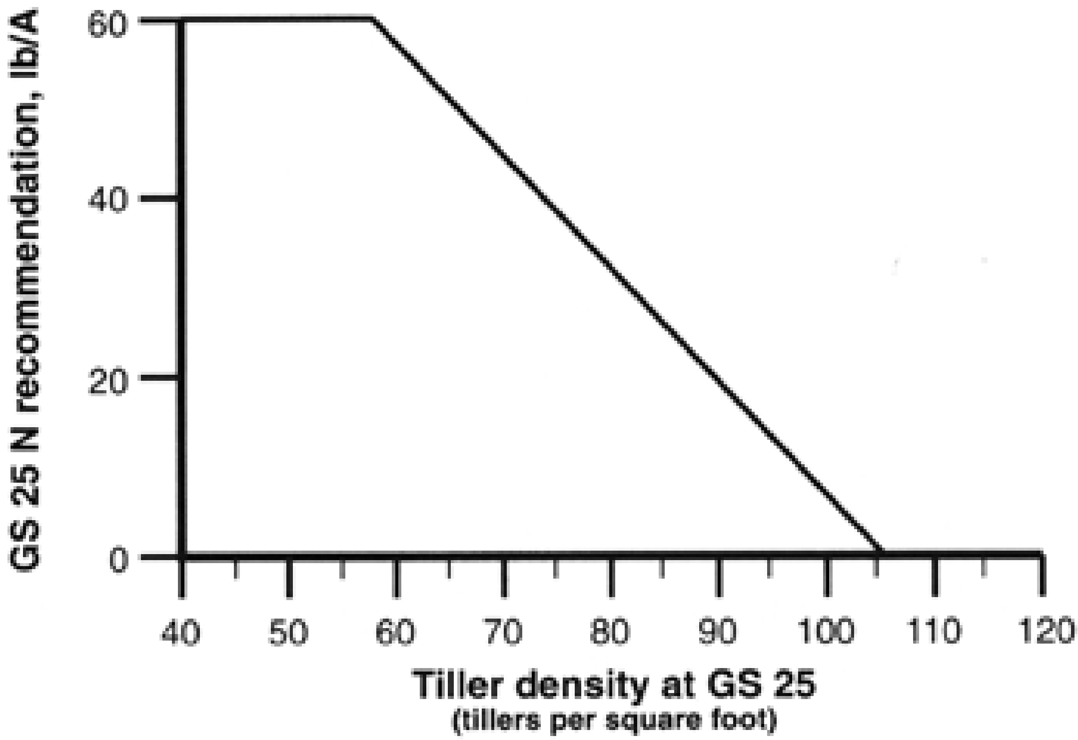
Typically, the first in-season N application occurs at Zadoks growth stage (GS) 25 and is based on wheat tiller density (Figure 1). The purpose of the first N application in a split is to stimulate formation of additional tillers when such stimulation is necessary to achieve optimum tiller density. The main nutritional needs of the crop will be supplied by the second application in the split.

To measure tiller density,

1. cut a dowel rod to a 3-foot length
2. lay the dowel down next to an average-looking row and count all tillers with three or more leaves that are found in the 3-foot length; record this number
3. repeat this count in at least five other locations that are well-spaced around the field
4. average all tiller counts from the field
5. calculate tiller density (in tillers per square foot) with the following equation: tiller density=average tiller count x 4 / row width (in inches)

Figure 2 shows the recommended N rate in response to tiller density at GS 25. If tiller numbers are low, 50/sq. ft. or less, N fertilization at this time is critical for the crop to develop any reasonable yield potential. Fields with low tiller counts should be fertilized before fields with more tillers, if possible. If tiller numbers are high, 100/sq. ft. or more, no N application is needed at this time. When winter rainfall/precipitation is above average and may have lowered the level of residual soil N, you should consider adjusting the recommendation upward.

Figure 2. Recommended GS 25 N rate based on tiller density.



The appropriate rate for the second application (GS 30) is best determined by tissue N content. See http://www.ext.vt.edu/pubs/grains/424-026/424-026.html for more information.

Total spring N applications (growth stage 25 plus growth stage 30) should not exceed a total of 120 lbs. N/acre in order to avoid problems with lodging and yield loss. For example, if 40 lbs. N/acre was applied at growth stage 25, and tissue test results give a recommendation of 100 lbs. N/acre at growth stage 30, only 80 lbs. N/acre should be applied at growth stage 30.

2008 Ohio Corn Performance Test – Have Triple and Quad Stacks Become the New "Conventional" Hybrids?

Dr. Peter R. Thomison
Professor—OSU Extension State Corn Specialist
The Ohio State University
Email: thomison.1@osu.edu

Allen B. Geyer
Research Associate—Horticulture and Crop Science
The Ohio State University
Email: geyer.9@osu.edu

and

Rich Minyo—Research Associate
Research Associate—Horticulture and Crop Science
The Ohio State University

"Traited" hybrids (i.e hybrids with transgenic traits for Bt insect resistance and herbicide tolerance) now dominate the Ohio Corn Performance Test (OCPT) and more than 71 percent of the entries are triple or quad stacks (contain three or four transgenic traits). In the 2002 test, less than 15 percent of the hybrid entries were traited. In 2007, over 80 percent of the entries were traited. This year over 92 percent of the entries were traited. Of these traited hybrids, 172 hybrids are triple or quad stacks, 27 are double stacks, and 23 contain a single trait. This trend in the Ohio Corn Performance Test reflects the increasing adoption of transgenic hybrids by farmers in Ohio and across the nation. As recently as 2005, less than 20 percent of corn acreage in the state was planted to transgenic corn hybrids. However this year, the USDA-Economic Research Service (http://www.ers.usda.gov/data/biotechcrops/) estimates that two thirds of the state's corn acreage was planted to transgenic corn hybrids (37 percent of total acreage planted to stacked trait hybrids, 17 percent to herbicide tolerant hybrids, and 12 percent to some type of Bt hybrid). Many corn agronomists in the past used the term "conventional" to characterize hybrids without transgenic traits (non-GMO). However, if conventional also implies commonly grown corn hybrids, it's no longer applicable to non-transgenic hybrids.

In the OCPT summary of hybrids evaluated in western Ohio (five test sites), seven of the top ten yielding hybrids are triple or quad stacks and one contains a single trait (Bt corn borer resistance). However, non-transgenic hybrids with high yield potential are available and two of the top ten hybrids are non-transgenic. Stacked traits don't ensure high yields. Of the bottom ten hybrids, eight are triple stacks.

2008 Ohio Corn Performance Test results are now available online at: http://www.oardc.ohio-state.edu/corntrials/ or http://agcrops.osu.edu/~perf/ .

2008 Ohio Corn Performance Test: An Overview

Dr. Peter R. Thomison
Professor—OSU Extension State Corn Specialist
The Ohio State University
Email: thomison.1@osu.edu

and

Rich Minyo—Research Associate
Allen Geyer—Research Associate 1
Bert Bishop
David Lohnes
The Ohio State University

In 2008, 242 corn hybrids representing 33 commercial brands were evaluated in the Ohio Corn Performance Test. Testing was conducted in three regions of Ohio - Southwestern/West Central (SW/WC), Northwestern (NW), and North Central/Northeastern (NC/NE), with three test sites established within each region. Testing was also conducted at Coshocton, an area with high gray leaf spot incidence. Entries in the regional tests were planted in either an early or full season maturity trial. These test sites provided a range of growing conditions and production environments.

Environmental conditions varied greatly across Ohio during the 2008 growing season, especially with regard to the amount and distribution of precipitation. At most test sites, rainfall from planting through the mid to late vegetative stages of corn development was above normal. It was the wettest June on record in many areas of Ohio. Excessively wet soils in May and June limited early season root development and resulted in shallow root systems. Dry weather conditions persisted from the late vegetative stages through maturity at most sites. Water deficits were especially severe in the Northwestern region especially at the Hoytville test site. At other test sites, water stress was limited by timely rains and adequate soil moisture. On September 14, record high winds associated with hurricane Ike caused severe root and stalk lodging at the test sites in SW/WC region and at the Hoytville test site in NW region. Slower than normal crop development in parts of northern Ohio contributed to higher than normal harvest grain moisture at the Beloit and Bucyrus test sites. Disease and insect pests were not a significant factor at most test sites. However, the western corn rootworm variant was observed for the first time in the hybrid performance trial at S. Charleston (which followed soybean) and caused considerable root lodging among hybrids without the Bt rootworm resistance trait.

Although growing conditions were drier than normal during the grain fill period and stalk and root lodging was greater than normal, excellent yields were recorded at several test sites. Yields, averaged across hybrid entries, exceeded 200 bu/acre at S. Charleston, Washington C.H., and Greenville in the SW/WC region; Bucyrus in the NC/NE region; and Coshocton.

Tables 1 and 2 provide an overview of 2008 hybrid performance in the early maturity and full season hybrid trials by region. Complete results are available online at:

http://www.oardc.ohio-state.edu/corntrials/ and http://agcrops.osu.edu/~perf/ . Averages for grain yield and other measures of agronomic performance are indicated for each region. In addition, the range in test sites averages is shown in parentheses.

Table 1. A regional overview of the early maturity 2008 Ohio Corn Performance Test.

Region	Entries	Grain Yield (bushel/acre)	Moisture (%)	Lodging (%)	Emergence (%)	Final Stand (plants/acre)	Test Wt. (lbs/bu)
SW/WC	51	235 (201-258)	15.8 (13.8-18.5)	25 (3-82)	95 (90-98)	31000 (28500-34100)	58.6 (56.0-62.9)
NW	69	159 (142-183)	17.3 (14.8-21.3)	33 (3-73)	96 (88-98)	32900 (27600-41000)	58.3 (55.0-62.5)
NE/NC	56	193 (175-212)	19.7 (14.8-24.2)	14 (2-58)	96 (88-99)	31400 (25900-40000)	56.4 (52.0-60.1)

Table 2. A regional overview of the full season 2008 Ohio Corn Performance Test.

Region	Entries	Grain Yield (bushel/acre)	Moisture (%)	Lodging (%)	Emergence (%)	Final Stand (plants/acre)	Test Wt. (lbs/bu)
SW/WC	67	230 (201-250)	17.1 (14.7-20.1)	31 (3-92)	95 (88-98)	31400 (26600-36400)	57.9 (54.1-60.7)
NW	87	156 (125-177)	18.7 (16.2-22.8)	41 (14-65)	96 (89-100)	32200 (28400-36800)	56.9 (53.4-61.3)
NE/NC	56	193 (156-212)	23.2 (18.8-28.3)	10 (1-78)	96 (92-99)	31200 (27200-36800)	53.8 (50.1-58.5)

Key Steps in Corn Hybrid Selection in 2009

Dr. Peter R. Thomison
Professor—OSU Extension State Corn Specialist
The Ohio State University
Email: thomison.1@osu.edu

One of the most important management decisions a corn grower makes each year is the selection of corn hybrids for spring planting. During the past 40 to 50 years, there has been continuous improvement in the genetics of corn hybrids which has contributed to steady increases in grain yield potential ranging from 0.7 to 2.6 percent per year. To stay competitive, growers must introduce new hybrids to their acreage on a regular basis.

Growers should choose hybrids best suited to their farm operation. Corn acreage, previous crop, soil type, tillage practices, desired harvest moisture, and pest problems determine needs for such traits as drydown, insect and disease resistance, early plant vigor, plant height, etc. End uses of corn should also be considered - is corn to be used for grain or silage? Is it to be sold directly to the elevator as shelled grain or used on the farm? Are there premiums available at nearby elevators or from end users for identity-preserved (IP) specialty corns such as food grade or non-GMO corn? Capacity to harvest, dry and store grain also needs consideration. The following are some steps to follow in choosing hybrids that are best suited to various production systems.

STEP 1.

Select hybrids with maturity ratings appropriate for your geographic area or circumstances. Corn for grain should reach physiological maturity or "black layer" (maximum kernel dry weight) one to two weeks before the first killing frost in the fall. Use days-to-maturity and growing degree day (GDD) ratings along with harvest grain moisture data from performance trials to determine differences in hybrid maturity. Because fossil fuel prices have risen significantly, corn producers should give careful attention to moisture differences between hybrids when evaluating grain yield. Grain drying represents a major portion of the energy requirement for corn production. It may be preferable to select short to mid season hybrids than full season hybrids for grain, especially if planting is delayed until late May. Results of the 2008 Ohio Corn Performance Test results indicate that the average yields of hybrids entries in the early maturity test were similar to those in the late maturity test but that the average grain moisture of hybrid entries in the early test was 1.5 to 3.5 percentage points lower than those in the full season test.

STEP 2.

Choose hybrids that have produced consistently high yields across a number of locations. The 2008 Ohio Corn Performance Test indicates that hybrids of similar maturity varied in yield potential by as much as 60 bu/acre depending on test site. Choosing a hybrid simply because it's a "triple stack" or "quad stack" or possesses appealing cosmetic traits, like big "flex" ears, will not ensure high yields; instead, look for yield consistency across environments. Hybrids will perform differently, based on region, soils and environmental conditions, and growers should not rely solely on one hybrid characteristic or transgenic traits to make their product selection. Just as was the case for conventional (non-traited) hybrids in the past, there is considerable variation in yield potential for hybrids with transgenic traits. The 2008 Ohio Corn Performance Tests revealed that stacked trait hybrids not only produced the highest grain yields in the trials but also the lowest. Several non-transgenic hybrids suitable for non-GMO grain production produced yields that were not significantly different from the highest yielding triple/quad stack entries.

When planting fields where corn rootworm (RW) and European corn borer (ECB) are likely to be problems (in the case of RW - continuous corn, presence of the rootworm variant, and in the case of ECB - very late plantings), Bt traits offer outstanding protection and may mitigate the impact of other stress conditions.

STEP 3.

Plant hybrids with good standability to minimize stalk lodging. This is particularly important in areas where stalk rots are perennial problems, or where field drying is anticipated. In 2008, severe lodging was present in many corn fields in western Ohio due in large part to the high winds associated with hurricane Ike on Sept. 14. However, severe water stress in July and August in parts of Ohio may have also predisposed the crop to stalk rots. Major differences in lodging were evident among hybrid entries in the 2008 Corn Performance Test with percentage plant lodging ranging from less than 5 percent to over 90 percent at certain test sites. If a grower has his own drying facilities and is prepared to harvest at relatively high moisture levels (>25 percent), then standability and fast drydown rates may be somewhat less critical as selection criteria. There are some hybrids that have outstanding yield potential but are more prone to lodging problems under certain environmental conditions after they reach harvest maturity. Traits associated with improved hybrid standability include resistance to stalk rot and leaf blights, genetic stalk strength (a thick stalk rind), short plant height and ear placement, and high "staygreen" potential. Staygreen refers to a hybrid's potential to stay healthy late into the growing season, after reaching maturity, and should not be confused with late maturity. European corn borer (ECB) Bt resistance minimizes ECB stalk injury that can promote stalk rot in corn. However, the Bt trait is not a substitute for good stalk quality and tolerance to stalk rots. Bt rootworm resistance can significantly limit root lodging caused by western and northern corn rootworm and thereby minimize yield losses where rootworm pressure is heavy.

STEP 4.

Select hybrids with resistance and/or tolerance to stalk rots, foliar diseases, and ear rots. Consult the Ohio Field Crops Diseases web page online at http://www.oardc.ohio-state.edu/ohiofieldcropdisease/ for the most common disease problems of corn in Ohio. In recent years, several diseases have adversely affected the corn crop - including northern corn leaf blight, Stewart's bacterial leaf blight, and diplodia ear rot. Corn growers should obtain information from their seed dealer on hybrid reactions to specific diseases that have caused problems or that have occurred locally.

STEP 5.

Never purchase a hybrid without consulting performance data. Results of state, company, and county replicated hybrid performance trials should be reviewed before purchasing hybrids. Because weather conditions are unpredictable, the most reliable way to select superior hybrids is to consider performance during the last year and the previous year over as wide a range of locations and climatic conditions as possible. However, multi-year data for hybrids is becoming increasing difficult to obtain. In the 2008 Ohio Corn Performance Test only 14 percent of the hybrid entries had been entered in the test for two years and only 6 percent of the entries for three year. Therefore, if limited to single year data, it's important to try to evaluate a hybrid's performance across a range of different growing conditions, for example compare the hybrid's performance at test sites where rainfall was adequate with those where rainfall was limited and stress conditions may have occurred. To assess a hybrid's yield in 2008 averaged across multiple Ohio test sites look at the "Combined regional summary of hybrid performance" tables. These tables and other results for the 2008 Ohio Corn Performance Trial are available online at http://www.oardc.ohio-state.edu/corntrials/ and http://agcrops.osu.edu/~perf/ . Since assessment of a hybrid performance is enhanced by using a number of test sites, corn growers farming along our borders with neighboring states should check results of the Purdue, Kentucky, Michigan State, Pennsylvania, and West Virginia Corn Test results. The University Crop Testing Alliance web site (http://www.agry.purdue.edu/pcpp/UCTA/index.html) provides links to corn hybrid test results from state universities across the Corn Belt.

Effect of Nitrogen Rate on Corn Hybrid Performance

Dr. Bob Kratochvil
Extension Specialist – Grain and Oil Crops
University of Maryland
Email: rkratoch@umd.edu

Corn is highly dependent upon nitrogen (N) to maximize production. Response to N can vary depending upon a number of factors including soil type, previous crop, manure use, weather, pest management, and tillage system. With the advent of biotechnology, there are now corn hybrids that are genetically resistant/tolerant to insects and some herbicides. The inclusion of these traits has farmers asking if they improve stability (ability of a hybrid to perform well at different locations) and if that stability imparts improved utilization of N.

A replicated study that included eight corn hybrids evaluated at five N rates was conducted at three Maryland locations during 2008. The hybrids were selected based upon their 2007 stability reported in the 2007 Maryland Corn Hybrid Performance tests (www.mdcrops.umd.edu). Stability ranged from high (performed well at all locations) to low (performed poorly at all locations). Nitrogen treatments (with the exception of the 0 level) were supplied as side-dress applications less 20 percent as a starter at planting. The five N rates tested were 0, 75, 125, 175, and 225 lb/acre.

The three locations provided different growing conditions as evidenced by the average location yield, 212 bu/acre at Keedysville where adequate and timely rainfall was received during the growing season; 126 bu/acre at Beltsville; and 121 bu/acre at Wye, locations where dry conditions existed during August. Yield performance differed among the hybrids at each location but the hybrids did not respond differently to the N rates. In other words, the response to N for a particular hybrid was similar to the response averaged over the eight hybrids.

Response to N rates also differed by location with corn at Keedysville producing no yield differences across the five rates. Keedysville likely had high soil nitrate concentration at side-dress time and did not respond to the additional N supplied by the side-dress application. The outcome at Keedysville supported the value of the use of the PSNT (pre sidedress nitrate test). This test likely would have indicated that no additional N was needed to optimize yield. The response to N rates at Beltsville and Wye was similar. Regression analysis was used to create a response curve for each location. Using this curve, agronomic optimum yield response (maximum yield) to N at Beltsville was predicted to occur at 211 lb N/acre while at Wye the optimum was attained at 192 lb N/acre.

Given the cost of N and the small increase in yield that occurred above 150 lb N/acre at these two locations, it is obvious that supplying the amount of N needed to maximize yield was not economical. The economically optimum N rate (EONR) was calculated for each location using \$3.50/bu corn and a N cost of \$0.75/lb. The EONR for Beltsville was calculated at 140 lb N/acre while at Wye it was calculated at 156 lb N/acre. As input costs increase, attention to the economic return realized for each unit of input becomes increasingly important. And, as indicated earlier, response to N by different hybrids is likely to be quite similar.

Benefit of Urease and Nitrification Inhibitors with UAN for Corn Sidedress Applications

Dr. Bob Kratochvil
Extension Specialist – Grain and Oil Crops
University of Maryland
Email: rkratoch@umd.edu

Corn is highly dependent upon nitrogen (N) to maximize production. Utilization of N by corn is influenced by numerous factors including weather. Weather can impact the amount of nitrogen loss that can occur following application.

The two primary loss pathways for sidedress applications of UAN (urea-ammonium nitrate solution) are volatilization and leaching. The common formulation used in Maryland is 30% UAN which is a solution of urea (33 percent) and ammonium nitrate (42 percent) in water (25 percent). Ammonia forms of N are easily derived from the components of UAN. Ammonia is subject to volatilization loss. If UAN is surface applied to the soil (i.e. a dribbled sidedress operation) during hot, dry weather, some of it can easily be lost via volatilization, a process speeded up by an enzyme, urease, that converts ammonium to ammonia. Less ammonia-N is lost if a rain event (approximately 0.5 inch) occurs within a few days after application. This loss pathway is the reason the University of Maryland recommends UAN be injected into the soil. When UAN is injected, it is able to attach to the soil.

However, once UAN is bound to the soil, it becomes the target of another N loss pathway, leaching. Leaching is the movement through the soil profile of the highly soluble nitrate form of N. Since much of UAN is in the ammonium-N form, it serves as food for the nitrification bacteria found in all soils. As these bacteria consume the ammonium, it is converted to nitrate-N. As temperature increases, the rate of consumption (called nitrification) by the bacteria increases. Corn sidedressing occurs during early to mid-June, a period that coincides with rapidly warming air and soil temperatures. With rapid generation of nitrate-N during this period, it becomes vulnerable to leaching when excessive rainfall is received after a sidedress application.

Nitrogen stabilizer products have been developed and are promoted for their ability to reduce N loss via volatilization and leaching. Volatilization is reduced by inhibiting/slowing the activity of urease. The best known urease inhibitor is Agrotain®. Leaching inhibitors work by slowing the consumption rate of ammonium by nitrification bacteria. N-Serve® fits in this category. Some products (Nutrisphere-N® and Agrotain Plus® claim N reductions for both loss pathways.

A Maryland Grain Producer's Utilization Board funded replicated study was established at three locations (Poplar Hill, Beltsville, and Clarksville) in 2008 to evaluate the effectiveness of these N stabilizer products. The stabilizer products (added to UAN and dribble applied at sidedress) were compared to UAN injected and UAN dribbled. Three N rates were included: a standard total N application of 160 lb N/acre; two rates that were 10 and 20 percent less than the standard; and a check treatment of no N. Nitrogen treatments (with the exception of the 0 level) were supplied as sidedress applications less 20 percent as a starter at planting.

The three locations provided different growing conditions and different results. Average yield at Clarksville was 182 bu/a with no yield differences observed among the four N rates. The lack of N response at Clarksville was the result of the high soil nitrate concentration present at sidedress. This outcome at Clarksville supported the value of using the PSNT (pre sidedress nitrate test).

The N-rate response at the other two locations was different than observed at Clarksville but similar for those two locations. There was significantly less yield (83 bu/acre averaged over the two sites) for the 0 N treatment and a significant yield response for the standard N rate (152 bu/acre) compared to the 10 percent (146 bu/acre) and 20 percent (145 bu/acre) rate reductions.

Averaged over the three N rates and across the three locations, there were no differences in yield observed among the four stabilizer products and the UAN injected and UAN dribbled treatments. However, the true benefit from the use of a stabilizer product occurs if a reduction in N-rate compared to the standard rate (160 lb N/acre for UAN injected) results in either similar or more grain yield. This would indicate that the cost of the stabilizer product (~ $25/acre for each of the products) would be covered by either the additional grain or by the cost savings from using less N. In our study, the use of stabilizer products (none stood out as superior) at the 20% reduced N rate produced similar yield to the injected UAN at 160 lb N/acre indicating that at least a break even situation would have occurred.

It is too early to endorse any or all of the stabilizer products as a method to either improve yield or reduce input costs. Future research needs to be done with these products including greater reductions in N-rate (i.e. 20-40 percent reductions) in order to determine if N input savings with their use will occur. This research will be continued during 2009.

Building Stronger Nutrient Cycles in Virginia's Pastures: The Role Grazing Management

Dr. Chris Teutsch
Associate Professor
Southern Piedmont AREC
Blackstone, VA
Email: cteutsch@vt.edu

The good news is that the cost of nitrogen (N) has decreased significantly since the last issue of the *Forager*. As of this writing time, urea is coming in around $600 per ton, which equates to around $0.65 per pound of actual N. I think it is a sad statement on our current situation when we start to get excited about $600 urea, which is twice as much as it cost just a few short years ago. At any rate, the role of grazing management in building stronger nutrient cycles in pastures is often discounted. However, as fertilizer prices stay high, how we manage grazing and its impact on nutrient distribution within pastures becomes even more important.

Grazing animals removing only small quantities of nutrients. Nutrients are removed from grazing systems as animal product and amounts will vary with livestock class (Table 1). One cow-calf pair stocked at 2 acres of pasture per year will remove approximately 3.5 lb P_2O_5 and < 1 lb K_2O per acre per year.

Table 1. Nutrient imports (+) and exports (-) for different livestock classes and hay (Adapted form the Missouri Grazing Manual)

Livestock Class	Nitrogen	Phosphorus	Potassium
	lb N*	lb P_2O_5	lb K_2O
Cow on grazing dairy	-84	-34	-28
Cow on conventional dairy	+148	+113	+73
Cow-calf pair	-10	-7	>-1
Stocker calf	-10	-7	>-1
One ton hay	-45	-15	-50

*, *To adjust to an acre basis, divide nutrient removal per animal by your stocking rate (acres per animal) and multiple nutrient removal per ton hay by hay yield (ton per acre).*

Grazing animals will redistribute nutrients in pastures. Overtime grazing animals can move nutrients from one area of the pasture to another through urine and dung deposition. This problem is the worst in large continuously grazed pastures where animals go out and graze then come back to shade and water areas were they urinate and defecate, thereby increasing the nutrient concentrations in these areas.

Increasing stocking density improves nutrient distribution. Subdividing pastures and utilizing rotational stocking results in a more uniform deposition of urine and dung within a grazing system. Research conducted at the University of Missouri found that under continuous stocking it would take more than 25 years for a dung pile to be deposited in every square yard of the pasture compared with 8 years for a pasture that was rotated on a 14-day schedule. Rotating on a 2 and 4-day schedule resulted in a dung pile being deposited in every square yard of pasture in 2 and 4.5 years, respectively. I truly hope that everyone appreciates the contributions of the poor graduate student who worked on this project!

Healthy pastures are more efficient at harvesting rainfall and using nutrients. Allowing pastures to rest between grazing events helps to maintain a healthy and vigorous sod with a strong root system. This increases water infiltration, reduces erosion, and allows plants to more efficiently utilize soil nutrients.

Buying and feeding hay and concentrates imports nutrients into grazing systems. Each ton of hay contains N, P, and K along with organic matter (Table 1). At today's fertilizer prices these nutrients are worth than $75 per ton of hay. Buying hay and feeding it on your worst paddocks may be a cost effective way to build fertility in your grazing system.

Hay feeding can be used to redistribute nutrients within a grazing system. Hay can be produced on paddocks or in fields that contain high levels of nutrients and then fed in areas that are low in fertility. Over time nutrients can be transferred from areas of high concentration to areas of low concentration.

One of the most exciting things about ruminant livestock production is the sustainability of well-managed grazing systems. In comparison to crop and hay production, relatively small quantities of nutrients are removed, better insulating graziers from the wide variations in fertilizer prices. It is always important to remember that change within a grazing system comes slowly. So develop a long-term grazing plan, implement it, and be patient!

Photo 1. The Scoop on Poop: Grazing livestock recycle approximately 90% of the nutrients that they consume.

To Hay or Not to Hay?[1]

Gordon Groover
Extension Economist, Farm Management
Department of Agricultural and Applied Economics
Virginia Tech
E-mail: groover@vt.edu

All Shakespearian puns aside, "To Hay or Not to Hay?" is a good question and centers clearly on long-term versus short-term costs. More specifically, how much capital should you invest in fence and water systems, and how much in machinery and equipment? The answer is a very clear, "It depends!" Don't you just hate economists who will not give a definite answer to a definite question, and the answer will hold for the next 20 years? Sorry; you will all need to push a pencil or start up the computer to solve this problem so that you can make an informed decision.

Consider the following - a farmer wants to know should she invest in rotational grazing, stockpiling fescue, and purchase any hay needed for winter feeding or follow her neighbors and less intensively graze her farm and make surplus hay for winter feeding?

To keep the geometry simple, assume the farm is a rectangle (1,044 feet by 4,174 feet, Figure 1). All fences are powered by a high capacity electric fence energizer. The perimeter is fenced with four strands of high tensile wire (4 HT) and all cross fences are two strands of high tensile wire (2 HT). If she does not peruse rotational grazing (Farm I), she will use the stream as the sole source of water and divide the farm into two 50-acre fields, with one field set aside for a spring hay crop. The whole farm is then grazed for the remainder of the year, and hay is fed for about 135[2] days.

If she peruses the rotational grazing options (Farm II), she will be eligible for 50 percent cost share[3] on some investments. She has contacted NRCS and once the perimeter of the farm is fenced they will cost share the following: cross fencing, a well, permanent waters, stream bank fencing, and a stream crossing. Farm II is set up to provide for rotational grazing and stockpiling fescue for winter grazing. The 100 acres is divided into six paddocks of approximately 17 acres with permanent water access in all paddocks. Other investments or requirements to be eligible for costs-share are:

- Stream fencing must extend 35 feet on each side of the stream, resulting in a net loss of approximately 1.4 acres of pasture land. Stream fencing must be at least 5-wire HT to maintain eligibility.
- A stream crossing must be installed.

[1] This topic was first discussed at a grazing workshop in Marshall, VA on 11/30/2006.
[2] Virginia Cooperative Extension Crop and Livestock Budgets.
http://www.ext.vt.edu/cgi-bin/WebObjects/Docs.woa/wa/getcat?cat=ir-fbmm-bu
[3] Eligibility for cost-share and the amount are highly dependent on location-specific programs and availability of funding. This is used as an example; contact your local NRCS or SWCD office for program information.

- A well is dug, cased, and connected to 3 permanent waters.
- With the exception of the 4-wire HT perimeter fence, all fence, water systems (well), and stream crossing are eligibility for cost-share at a 50 percent rate.

Figure 1 illustrates the two (I and II) alterative farm setups for the 100 acres. Table 1 lists the base assumptions used to develop the annualized costs and returns for Farms I and II. The comparison between Farms I and II is based on costs to get the farm up and running. Each farm produces calves for sale and retains heifers to maintain a 40 cow herd, thus generating the same level of income. The focus of this exercise is to highlight the difference in costs, investments, and expenses. Not all expenses/investments are considered, e.g. cattle working facilities, trucks, labor, etc., since these costs will be similar across farm types and are not included. The three major items for comparison are 1) capital investments in fence and water systems, 2) capital investments in machinery and equipment or rolling stock, and 3) pasture and hay costs. Capital investments in fence and water systems show a difference of $12,249 with Farm I investing

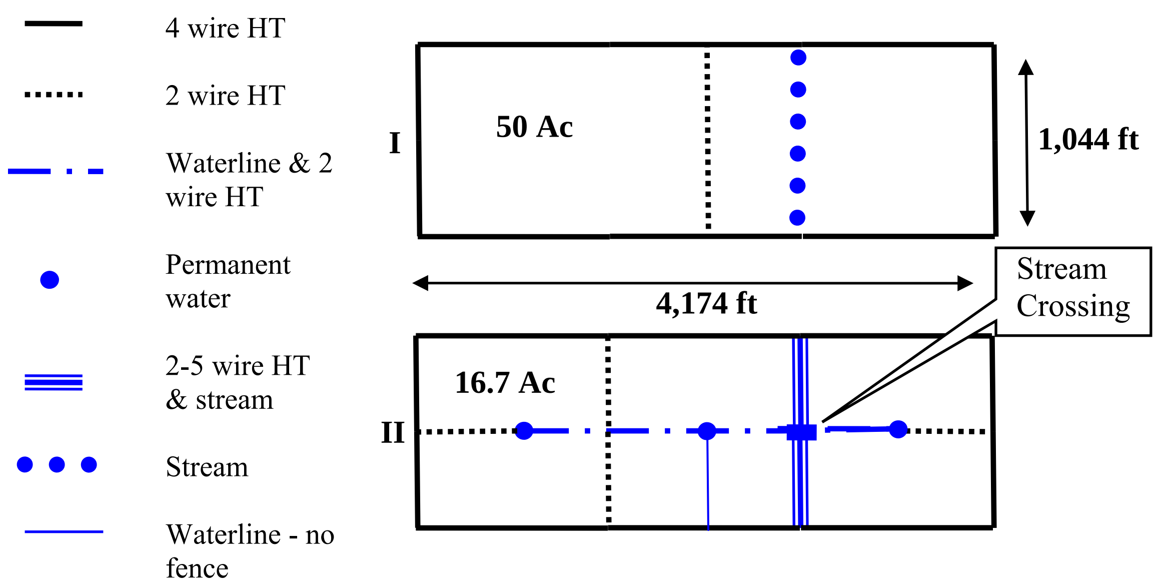


Figure 1: Farm Schematics

$8,659 and Farm II $20,908. This includes a 50% cost-share reducing Farm II's total investment by $11,625 or a without cost-share investment of $32,533. This additional investment is required to subdivide pastures and provide water to facilitate rotational grazing and to fence animals out of the stream. Harvesting surplus forages as hay has been a mainstay of many livestock farms in the spring and summer; however, the costs of machinery and equipment quickly add up when a full complement of hay making equipment is purchased. Note: The comparison uses new costs, not always realistic, yet new costs are much more reliable for comparison. The *machinery & equipment investments* section of Table 1 shows a $64,083 difference in total investment with Farm I requiring $96,883 to make hay and maintain the farm and Farm II only $32,800 to maintain the farm and feed purchased hay[4]. On an annualized basis, these costs show that Farm I has $7,468 more in machinery and equipment fixed costs. Total forage costs are described in the *forage costs* section. There is not a major difference ($47) in the total costs of providing forages and hay between the two farms; however, the items required to meet the year round forage supply are very different. Farm I relies on grazing during the summer and any deficit is met by farm produced hay; Farm II meets forage deficits with stockpiled fescue and purchased hay. The bottom line of this comparison is that Farm II annually spends $8,267 less than Farm I and, on a per cow basis, Farm II saves $207.

What Else?

What has been forgotten in this analysis? This question is the final issue to address. First, most forage agronomists and practicing rotational grazers would say that adopting rotational grazing and not making hay would lead to more total forage production, resulting in more total weight gain or a higher carrying capacity (more and larger calves) for Farm II. The end result would be a more efficient farm or higher total returns from the same set of resources.

Second, purchasing hay can be risky and the manager of Farm II must rely on the market to obtain winter hay and/or summer hay during times of drought. Purchasing hay can result in additional and/or new weeds taking up residence in your pastures and hay fields, thus, higher weed control costs. Looking at the breakeven price of hay (where the price of hay equals the net difference between the forage costs for Farm I and II and all other costs held constant) can increase to $133 per ton before the advantage for Farm II goes to zero. However, every year that hay costs less than $133 per ton, Farm II without equipment is better off than Farm I with equipment. Consider that in a drought year Farm I will incur the costs of making hay (there may be less harvest costs) and the additional hay to meet the deficit at much higher prices (or reduce cow numbers); in short, you are buying the hay twice. Relying solely on purchased hay may require that you have on farm storage to protect hay and reduce storage losses (may need added fixed costs).

Third, rotational grazing may require more time for grazing and grazing stockpiled fescue, i.e. moving fence and pasture walks and procuring a hay supply. However, considerable time is required to make hay, feed hay, and maintain equipment. Overall, it is close to a wash on total time between the two systems.

Fourth, research shows that stockpiled fescue often is of higher nutritional value than your average hay; thus, gains and utilization may be higher than with a traditional winter feeding system using round-baled hay.

Fifth, used equipment will further reduce total costs; however, Farm II can make efficient use of older equipment since it will be used only for routine pasture and fence maintenance and moving round bales.

---

[4] This example highlights the difference between 2 extremes. Prudent farmers do find many lower cost solutions to high costs of machinery required to make hay. For example, making hay on shares, split machinery ownership, where one farmer owns a baler and the other the mower conditioner and they cooperate to make hay reducing costs and improving labor efficiency, and there many other examples.

Sixth, getting the cattle out of the stream may make the cattle healthier and reduce vet and medicine costs and environmental costs to society will be less, i.e. less pollution in the stream, less erosion, and higher water quality. Overall, in my opinion, smaller farms (less than 150 brood cows) making efficient use of grazing while not owning hay equipment will reduce a farm's total costs and higher potential for profits.

Table 1: Investment and costs details for Farm I (makes hay) and Farm II (make no hay)

Items	**Farm I (hay)**	**Farm II (no hay)**
Acres	100	98
Number of cows	40	40
Number of field/paddocks	2	6
Average acreage	50	16.7
Capital investment in fence and water		
300 ft well & casing	$0	$6,600
3,305 ft of water lines to pastures $	$0	$7,171
3 Permanent water $	$0	$3,300
Round bale feeders $ (#)	$1,000	$2,000
5 strand HT fence – 2,870 ft - stream	$0	$1,900
4 strand HT fence 10,436ft $	$6,783	$6,783
2 strand HT fence $ (feet)	$376	$1,878
Stream crossing	$0	$2,400
Electric fence energizer $	$500	$500
Cost-share 50%	$0	-$11,625
Total capital investment	**$8,659**	**$20,908**
Machinery & equipment investments		
40-hp tractor and front-end loader	$24,000	$24,000
2-bale spears	$700	$700
Rotary mower	$2,500	$2,500
Utility wagon/trailers	$5,100	$5,100
60-hp tractor	$33,000	$0
Mower-cond 9'	$12,750	$0
Hay rake 9'	$4,400	$0
Round baler 800#	$13,933	$0
Subtotal Machinery & equipment investments	**$96,883**	**$32,800**
Forage costs		
Pasture costs $120/acre	$16,000	$15,728
Winter hay for 135 days - 94 tons	94	94
Stockpiled tons available - 50 tons	0	(50)
Additional hay needed	94	44
Hay purchased - $80 per ton	$0	$3,960
Nitrogen – stockpiling $0.90/lb @ 40 lbs/ac	$0	$1,200

Table 1: Investment and costs details for Farm I (makes hay) and Farm II (make no hay)

Items	Farm I (hay)	Farm II (no hay)
Roll polywire 600ft/roll	$0	$160
20 fiberglass posts (1 every 25')	$0	$50
Additional fertilizer for hay crop 50 ac $100/ac	$5,000	$0
Hay harvest costs $21.00/ton	$1,974	$0
Total forage costs	**$22,974**	**$21,098**
Total forage costs per cow	**$574**	**$527**
Difference	**$47**	
Prorated fixed costs capital investment	$755	$1,824
Prorated fixed costs machinery	$11,291	$3,823
Total Annual Expense	**$35,020**	**$26,744**
Difference	**$8,276**	
Per cow	$876	$669
Difference	**$207**	

Returns to land, management, family labor, and taxes

Carrying the example one step further to include estimated returns to land, management, family labor, and taxes sheds some light on the profitability side of the cattle business. Table 2 adds income from the sale of cattle and assuming that Farm II increases the number of cows by 10 percent to 44 head. Using the VCE livestock budgets (*Beef Cows Fall Calving - Hay Ration* and *Beef Cows Fall Calving - Stockpiled Fescue Pasture)*, other variable costs were calculated (see attached budgets). Summing up the costs and subtracting from the income (Table 2) from sales of calves and culls yields a negative situation for both Farms I and II. However, Farm II is losing $7,449 annually versus a $18,812 loss for Farm I. Potentially, a few improvements in efficiency or reductions in costs (N, P, and K fertilizers) for Farm II could yield a farm that might breakeven or help pay returns to land, management, and family labor.

Table 2: Returns to land, management, family labor, and taxes - Farm II 10% increase in cow numbers

Receipts - Beef Cows Fall Calving - Hay Ration	**Farm I (hay)**	**Farm II (no hay)**
Steers	$13,455	$14,203
Heifers	$6,864	$8,112
Cull Cows & Heifers	$3,450	$3,450
Cull Bull	$332	$332
Total receipts	**$24,101**	**$26,096**
Costs		
Total forage costs	$22,974	$21,098
Other Variable Costs (see budgets)	$7,892	$6,801
Prorated fixed costs capital investment	$755	$1,824
Prorated fixed costs machinery	$11,291	$3,823
Total Annual Expense	$42,912	$33,545
Returns to land, management, family labor, and taxes	**-$18,812**	**-$7,449**
Difference	**$11,363**	

Summary

"To Hay or Not to Hay?" Hey, it depends on lots of things; for example, your costs, management skills, price of forages, prices of N, P, and K, cost-share, and lots more. The final results depends on knowing your total costs of feeding cows and calves and managing the capital investments to reduce your total fixed costs. In my opinion, if you have less than 150 cows owning a full complement of hay equipments is not a wise investment.

Note: The spreadsheet use in the paper can be found at http://www.extension.agecon.vt.edu/farmbusinessmgt.html and look for the section titled *Hay Enterprise Decision Aids* or contact me directly.

References

Eberly, E., G. E. Groover, et al. 2007 Virginia Farm Business Management Crop Budgets and http://www.ext.vt.edu/cgi-bin/WebObjects/Docs.woa/wa/getcat?cat=ir-fbmm-bu.

Eberly, E., G. E. Groover, et al. 2008 Virginia Farm Business Management Livestock Budgets http://www.ext.vt.edu/cgi-bin/WebObjects/Docs.woa/wa/getcat?cat=ir-fbmm-bu .

See: www.ext.vt.edu/pubs/agecon/446-048/446-048.html#BeefCowCalfBudgets to download this budget in MS Excel® format.

Beef Cows Fall Calving - Hay Ration

ITEM	HEAD		CWT	UNIT	PRICE		QUANTITY	TOTAL	Your Farm
				40	COWS & BRED HEIFERS				
90	% CONCEPTION RATE					85	% WEANED CALVES PER COW EXPOSED		
40	COWS PER BULL					30	% of Heifers Weaned Kept as Replacements		
15	% ANNUAL CULLING RATE					1.0	% ANNUAL COW DEATH LOSS		
ITEM	HEAD		CWT	UNIT	PRICE		QUANTITY	TOTAL	Your Farm
1. GROSS RECEIPTS									
Steers	18	@	6.50	Cwt	$115.00		117.00	$13,455.00	________
Heifers	11	@	6.00	Cwt	$104.00		66.00	$6,864.00	________
Cull Cows & Heifers	6	@	11.50	Cwt	$50.00		69.00	$3,450.00	________
Cull Bull	0.30	@	17.00	Cwt	$65.00		5.10	$331.50	________
2. TOTAL GROSS RECEIPTS						$602.51	Per Cow	$24,100.50	________
3. VARIABLE COSTS									
	Feed Loss								
Corn Silage	5.0%			Ton	$25.00		0.00	$0.00	________
Alfalfa Hay, Bloom	5.0%			Ton	$150.00		0.00	$0.00	________
Mixed Hay, 2nd Cutting	5.0%			Ton	$110.00		0.00	$0.00	________
Grass Hay, Average	10.0%			Ton	$0.00		81.68	$0.00	________
Corn Grain	2.0%			Bushel	$5.00		689.11	$3,445.57	________
SBOM 48%	2.0%			Ton	$380.00		0.00	$0.00	________
Other Feed	5.0%			Ton	$0.00		0.00	$0.00	________
Grinding & Mixing				Cwt	$1.40		0.00	$0.00	________
Salt & Mineral	68.00	Lbs per Cow		Cwt	$22.00		27.20	$598.40	________
Vet & Medicine		$/Head		Head	$32.61		40	$1,304.51	________
Supplies				Head	$2.00		40	$80.00	________
Replacement Bull				Head	$2,500.00		0.3	$750.00	________
Stockpiled Pasture		Acres per Cow		Acre	$51.00		0	$0.00	________
Pasture	2.75	Acres per Cow		Acre	$0.00		110	$0.00	________
Haul Cull Cattle				Head	$5.20		6.3	$32.76	________
Market Cull Cattle		$/Head		Head	$15.00		6.3	$94.53	________
Haul Calves				Head	$3.75		29	$108.75	________
Market Calves		$/Head		Head	$17.51		29	$507.88	________
Building & Fence Repairs				Head	$0.00		40	$0.00	________
Utilities				Head	$3.29		40	$131.60	________
Other,(insurance etc.)				Head	$0.00		40	$0.00	________
Machinery (Non-Crop)				Head	$14.91		40	$596.40	________
Labor	8	Hours per Cow		Hours	$0.00		320	$0.00	________
Operating Interest	6	Months		Dollars	7.00%		$ 6,906	$241.71	________
4. TOTAL VARIABLE COSTS						$197.30	Per Cow	$7,892.11	________
5. ANNUAL DEBT PAYMENTS								$0.00	________
6. PROJECTED NET RETURN TO EQUITY, MANAGEMENT, & FAMILY LABOR						$405.21	Per Cow	$16,208.39	________

See: www.ext.vt.edu/pubs/agecon/446-048/446-048.html#BeefCowCalfBudgets to download this budget in MS Excel® format.

Beef Cows Fall Calving - Stockpiled Fescue Pasture

40 COWS & BRED HEIFERS

90	% CONCEPTION RATE	85	% WEANED CALVES PER COW EXPOSED
40	COWS PER BULL	30	% of Heifers Weaned Kept as Replacements
15	% ANNUAL CULLING RATE	1.0	% ANNUAL COW DEATH LOSS

ITEM	HEAD		CWT	UNIT	PRICE		QUANTITY	TOTAL	Your Farm
1. GROSS RECEIPTS									
Steers	18	@	6.50	Cwt	$115.00		117.00	$13,455.00	________
Heifers	11	@	6.00	Cwt	$104.00		66.00	$6,864.00	________
Cull Cows & Heifers	6	@	11.50	Cwt	$50.00		69.00	$3,450.00	________
Cull Bull	0.30	@	17.00	Cwt	$65.00		5.10	$331.50	________
2. TOTAL GROSS RECEIPTS						$602.51	Per Cow	$24,100.50	________
3. VARIABLE COSTS									
	Feed Loss								
Corn Silage	5.0%			Ton	$25.00		0.00	$0.00	________
Alfalfa Hay, Bloom	5.0%			Ton	$150.00		0.00	$0.00	________
Mixed Hay, 2nd Cutting	5.0%			Ton	$110.00		0.00	$0.00	________
Grass Hay, Average	10.0%			Ton	$75.00		0.00	$0.00	________
Corn Grain	2.0%			Bushel	$5.00		382.84	$1,914.21	________
SBOM 48%	2.0%			Ton	$380.00		0.00	$0.00	________
Other Feed	5.0%			Ton	$0.00		0.00	$0.00	________
Grinding & Mixing				Cwt	$1.40		0.00	$0.00	________
Salt & Mineral	68.00	Lbs per Cow		Cwt	$22.00		27.20	$598.40	________
Vet & Medicine		$/Head		Head	$32.61		40	$1,304.51	________
Supplies				Head	$2.00		40	$80.00	________
Replacement Bull				Head	$2,500.00		0.3	$750.00	________
Stockpiled Pasture	0.67	Acres per Cow		Acre	$0.00		26.8	$0.00	________
Pasture	2.75	Acres per Cow		Acre	$0.00		110	$0.00	________
Haul Cull Cattle				Head	$5.20		6.3	$32.76	________
Market Cull Cattle		$/Head		Head	$15.00		6.3	$94.53	________
Haul Calves				Head	$3.75		29	$108.75	________
Market Calves		$/Head		Head	$17.51		29	$507.88	________
Building & Fence Repairs				Head	$0.00		40	$0.00	________
Utilities				Head	$3.29		40	$131.60	________
Other,(insurance etc.)				Head	$0.00		40	$0.00	________
Machinery (Non-Crop)				Head	$14.91		40	$596.40	________
Labor	8	Hours per Cow		Hours	$0.00		320	$0.00	________
Operating Interest	6	Months		Dollars	7.00%		$ 5,375	$188.13	________
4. TOTAL VARIABLE COSTS						$157.68	Per Cow	$6,307.16	________
5. ANNUAL DEBT PAYMENTS								$0.00	________
6. PROJECTED NET RETURN TO EQUITY, MANAGEMENT, & FAMILY LABOR						$444.83	Per Cow	$17,793.34	________

What Does that Bale of Hay Really Cost?

Dr. Gordon Groover
Extension Economist, Farm Management
Department of Agricultural and Applied Economics
Virginia Tech
E-mail: groover@vt.edu

Introduction

Traditionally, when asked what something costs, e.g. a bushel of corn, we call the co-op or a feed dealer and ask. When purchasing corn, we know that the price for number 2 yellow corn is good for today and that transportation costs must be covered by the purchaser. If selling corn, the price that you would sell at is less than the market price by costs of transporting the grain to the dealer, the dealer's margin, handling costs, handling loss, and so on. These systems are well established and we know and understand some of these basic concepts. Yet when we ask what does a bale of hay cost, the certainty of understanding diminishes.

In the East, there are no well established and high volume hay markets, no well established grades and standards, and no recognized terminal markets for hay. In addition, hay is a bulky (round bales specifically) product that makes transportation cost by traditional methods higher than for grains. In contrast, in the Great Plains and West there are established markets for hay based on specific standards and hay packages that make transportation less costly, e.g. large square bales. Yet in the East, the cost of hay to either the buyer and/or seller is not easily determined by looking to a local and/or terminal market. Our Eastern markets also do not clearly communicate the market based costs of producing hay. The market price reflects the long-run efficient cost on making a ton of hay. Therefore, farmers cannot easily look on the internet and see both the local price and historical prices of hay and say, "I can grow hay for less than that" or the converse, "I cannot grow hay for that price." In both cases, the farmer is making a choice based on their knowledge of their own costs of producing a ton of hay. Thus, the key concept or objective of this paper is to illustrate how to determine your costs of producing hay.

Getting Started

To get stated on answering this question you could start with any of the items required to produce hay: machinery and equipment, species, land, storage/loss, or labor supply. All are important and must be addressed when determining the costs of hay production. Which we choose to discuss first makes little difference.

Defining a few words and explaining how they are used when making decisions will aid your understanding.

> **Fixed costs** (also known as sunk costs) are items that do not vary with level of use. The most common are 1) depreciation[5], interest, taxes, and insurance on

[5] Depreciation in this document will refer to a reduction in value or obsolescence of an asset over time (not tax depreciation).

equipment and machinery; and 2) depreciation, insurance, taxes, and maintenance on buildings. Fixed costs do not change with the level of use. For example, if hay equipment is used on an additional 30 acres, the interest, taxes, or insurance charges do not change. However, fixed cost measured on the basis of either per acre or per ton of hay harvested decreases as more hay is harvested. Simply, the more you use the hay equipment the less it costs per unit. Conversely, if you stop using the hay equipment you still have to pay the full fixed costs.

Variable costs (also known as out-of-pocket costs) increase with use: an increase in the tons of hay harvested will certainly result in more fuel consumed and higher repair costs. If a farmer stops making hay altogether, variable costs will drop to near zero, but fixed costs will remain essentially unchanged.

Long-run decisions are made based on all costs being covered; that is, the income from hay sales will exceed the fixed and variable costs of machinery and equipment, hay production, storage, labor, management, and return on investment. These costs are important when you start a new venture requiring additional investments.

Short-run decisions are made day-to-day and/or year-to-year to help improve the profitability or reduce the losses of an on-going venture. Short-run decisions consider only variable costs: as long as the income from hay sales are greater than the total variable costs to produce that hay, the farmer is better off continuing to produce hay. What happens when the income from hay sales no longer cover the variable costs to produce that ton of hay? Then the farm business has reached the "**shut down**" or the "**I quit**" point. This situation implies that continuing to produce hay will lead to insufficient funds to pay for fuel, labor, fertilize, and so on.

The question that you should be able to answer after reading or listening to this presentation is, "Have I reached the 'I quit' point for nitrogen (N) fertilized grass hay, given the current costs of fertilizer and fuel?" or "Do I know my 'I quit' points for my farm?"

What Does it Cost to Produce Grass-Clover Hay Crop?

Budgeting: To answer the question "What Does it Cost to Produce Grass-Clover Hay Crop?", some of the basics of budgeting must be explained. The purpose of a budget is to list the annual qualities and prices of inputs involved in the production of hay. The sum of the income items less total expenses leaves an estimate of net income or returns to land, risk, and management. Since the sales price is often the most variable, most budgets concentrate on the cost of inputs like fertilizer. The breakdown of major budget categories and explanations are listed in Table 1.

Table 1: Example Abbreviated Budget for 1 Acre
1. **Gross Receipts** = quality sold (produced) * price
Tons of hay * $/ton (3 tons * $70/ton)

2. **Pre-Harvest Variable Costs**	
	Units of inputs * $/unit (150 lbs of N * $0.60/lb)
3. **Harvest Variable Costs**	
	Fuel, Lubrication, and Repairs per acre * $/ac ($50/ac * 1 ac)
4.**Total Variable Costs** – sum lines 2-3	
	Sum of all costs
5. **Machinery Fixed Costs** (based on new equipment cost)	
	Ownership costs per ac – prorated to over the typical life of the equipment (depreciation taxes, insurance, interest on investment)
6. **Other Costs**	
	General Overhead Costs
7. **Total Costs** – sum lines 4, 5, & 6	
8. **Projected Net Returns** – line 1- line 7	
	Returns to land, risk, and management

Gross Receipts: Gross receipts are the sales price or value of a bale or ton of hay times the estimated production units. Hay sold into the equine industry vs. home-consumed hay will have to be marketed based on quality, so that hay from different fields may not have the same value and should be reflected as separate items or as an average price representation quality from poor to excellent (Table 2). The yield should indicate long-term average yields, not just the best of the last 10 years.

Table 2: Example Gross Receipts for Grass Clover Hay	**Grass-clover - 3 ton yield**		
Receipts	**Yield**	**Price**	**Total**
Gross receipts per ton round bales (lower quality)	2.0	$70.00	$140.00
Gross receipts per square bale (higher quality)	50	$4.00	$200.00
Total Gross Receipts			$340.00

Pre-harvest Variable Costs: The current budget estimates of pre-harvest variable costs for grass-clover hay is shown in Table 3. The level of complexity increases when you move to the pre-harvest costs. In the case of hay, the cost of establishing the crop is an expense just like year-to-year maintenance and needs to be prorated over the life of the crop. Calculating establishment costs requires a separate budget (please see the Virginia Cooperative Extension web site for hay establishment budgets http://www.ext.vt.edu/cgi-bin/WebObjects/Docs.woa/wa/getcat?cat=ir-fbmm-bu-cr). The total is prorated over seven years. The remaining items are a listing of the estimated units of inputs like fertilizer, lime, herbicides, and so on, priced at rates that are reflective of 2007. Most farmers use a line-of-credit to finance the needed cash flow in the spring before crops are sold in the summer and/or fall. The production interest charged on the line of credit is calculated on the total pre-harvest costs for six months at the going short term interest rate. The total of these expenses yields the total pre-harvest expenses per acre ($264), per ton, or per bale

> Side bar: Under the assumptions that the pre-harvest costs are $88/ton. Farmers should ask "Is this standing hay worth $88/ton?" If not, should the hay be harvested? This illustrates one of the "I quit" points. Are you better off grazing?

($88), depending on what units are used to measure production.

Table 3: Grass-Clover Hay Pre-harvest Variable Costs, Based on 3 ton yield from 2 cuts.				
Pre-Harvest Variable Costs	**Units**	**Per Acre**	**Price $**	**Total $**
Prorated establishment cost	7 yrs	1.00	38.00	38.00
Red clover	Lbs	3.00	2.00	6.00
Phosphate	Lbs	45.00	1.00	45.00
Potash	Lbs	150.00	0.90	135.00
Fertilizer application	Acre	1.00	7.25	7.25
Other costs	Acre	1.00	15.48	15.48
Production interest[6]	$	246.73	7%	17.27
Total Pre-Harvest Costs				**264.00**
Total Pre-Harvest Costs per Ton				**88.00**

Harvest Variable Costs: The first step in addressing the fixed costs is to select the harvest equipment. The estimated harvest costs can vary greatly based on the machinery and equipment selected, e.g. 800 lb. round baler, large square balers, small rectangular balers, and so on. Each of these systems varies in costs, efficiency, and labor required. This analysis will consider a typical round bale system. The costs of machinery must be annualized over the life of each piece of equipment. New hay harvest equipment, total investment, and useful life are listed in Table 4. Table 4 lists the equipment for a traditional round bale system. Round bale systems requires the smallest capital investment, as compared to rectangular bales, or large square bales, at $115,000 based on new costs.

Table 4: Round Baler						
Equipment	**#**	**Unit Costs $**	**Total Costs $**	**Salvage Value $**	**Net Value $**	**Life**
75HP tractor w/loader	1	$43,000	$43,000	$4,300	$38,700	12
55HP tractor	1	$25,000	$25,000	$2,500	$22,500	12
12 ft disc mower conditioner	1	$20,000	$20,000	$2,000	$18,000	10
17 ft tedder		$4,500	$4,500	$450	$4,050	10
18 ft wheeled rake		$4,500	$4,500	$450	$4,050	10
Round baler		$12,000	$12,000	$1,200	$10,800	10
9x20x8 hay wagons	2	$3,000	$6,000	$600	$5,400	10
Totals			**$115,000**	**$11,500**	**$103,500**	

Calculating annual fixed costs for the machinery complements requires allocating those costs over the life of the farm machinery. Allocation of fixed costs is accomplished by using the capital recovery method (I prefer this method; however, there are other methods). The capital recovery method sets up a payment schedule to fully recover the value of the machinery and

[6] Production interest is calculated on costs that are used prior to fall at the annual interest rate to reflect only 6 months of interest; the total costs are divided in half.

interest on the investment over the life of the equipment. Capital recovery is based on the assumption that when the machinery is worn-out or obsolete, enough money will be available to fully replace the machinery with equivalent but updated technology. Table 5 lists the fixed costs of tractors lasting 12 years[7] and other machinery lasting 10 years, an interest rate of 5 percent, and insurance at 1 percent of the total investment. Once this equipment arrives on the farm, the fixed costs must be covered each year, regardless of how much hay is made. Under these assumptions the annualized costs and fixed costs for round baling are $13,402.

Table 5: Fixed Costs Round Bale System		
Items	**Round Baler**	
Useful life ==>	**12 year**	**10 year**
Investment $	**68000**	**47000**
Salvage $	**6800**	**4700**
Amount to be recovered $	**61200**	**42300**
Interest rate (I) %	**0.05**	**0.05**
Number of periods (n)	**12**	**12**
Capital recovery =	**0.11283**	**0.11283**
Periodic recovery $	**6905**	**4773**
Insurance 1%	**680**	**470**
Interest on salvage $	**340**	**235**
Sub-Total $	**7925**	**5478**
Total Annual Costs $	**$13,402**	

See Appendix B for details.

Fixed Costs and Harvest Acreage

Figure 1 show the dramatic relationship between fixed costs and total acreage harvested. Used machinery may cut the total fixed costs as much as 40 percent; conversely, used machinery may increase annual repair costs. In addition, if the tractors are used in other activities on the farm (silage harvest, custom work, grain crops, etc.), the total fixed costs per hour will be less for the hay enterprise and all other enterprises. In Figure 1, total costs decline sharply as tons or acreage harvested increase. At the lowest acreage, 50 acres (150 tons) yields a total cost of $89.35/ton, and if the equipment was used over 350 acres (1,050 ton), total costs drop to $12.76/ton. Notice that after harvested acres exceed say, 225 acres, the rate of decline in fixed costs slows down considerably. Thus, with this machinery complement farmers should strive for harvesting more than 225 acres per year to achieve a reduction in fixed costs.

Finalizing the harvest costs are the variable costs associated with two harvests - mowing, raking, baling, and moving the hay to a storage site. Table 6 details the assumptions and costs for round baling an acre of grass-clover hay. The total annual cost of harvest is $68.49 per acre

[7]This is a somewhat arbitrary assumption. The life of a new tractor (2WD) is defined as 12,000 hours (American Society of Ag Engineers Standards). In this example both tractors are assumed to be used 1,000 hours annually. Consider if these tractors are used just 200 hours annually, then the expected life of each tractor would be 60 years. So the question for many farmers is “How many years will my tractor out live me?” All attempts at humor aside, matching hours of use and life of equipment is a measure of machinery and capital efficiency for a farm business.

and assuming a 3 ton yield, a cost per ton of $22.83. These variable costs apply the same to the first and to the last ton of hay harvested.

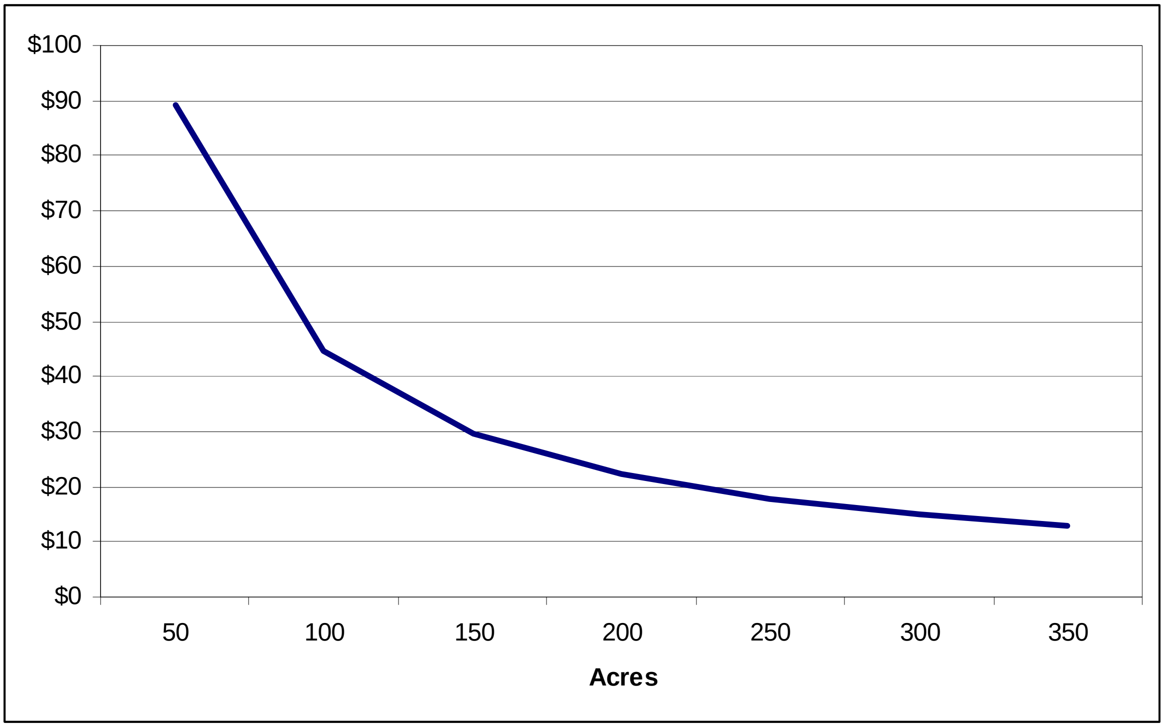


Figure 2: Grass-Clover Hay – Total Fixed Costs

Table 6: Grass-Clover Hay Harvest Variable Costs, Based on 3 Ton Yield from 2 Cuts

Harvest Variable Costs	**Units**	**Per Acre**	**Price $**	**Total $**
Fuel, Oil, Lube	Acre	1.00	$19.30	$19.30
Repairs	Acre	1.00	$11.78	$11.78
Harvest Labor	Hrs	2.68	$12.00	$32.16
Baler Twine	Ton	3.00	$1.75	$5.25
Total Harvest Costs				**$68.49**
Total Harvest Costs per ton				**$22.83**

Total Costs

Figure 2 sums up the important issues in understanding the cost of making a ton of hay. That is, the variable costs of hay fertilizer, lime, fuel, etc. remain unchanged as acreage increases and fixed costs (ownership) decline (see Appendix A for a summary of the data for orchardgrass and alfalfa). In Figure 2, total costs per ton of hay are $200 when only 50 acres (150 tons) are harvested, and in contrast for 350

Side bar: If total costs to produce a ton of grass-clover hay approaches $130/ton, then we all must ask "Is this enterprise covering all the costs and should this enterprise continue in the short-run/long-run? This illustrates another of the "I quit" points and we need to ask "Are you better off grazing that field?"

acres (1,050 tons) costs are reduced to $126 per ton. These numbers are a stark contrast to a few years ago when oil-based inputs (fuel and fertilizers) were drastically lower in costs. Under these assumptions, a breakeven price for grass clover hay approaches $130 per ton. And this does not include returns to STORAGE, LAND MANAGEMENT, and/or RISK.

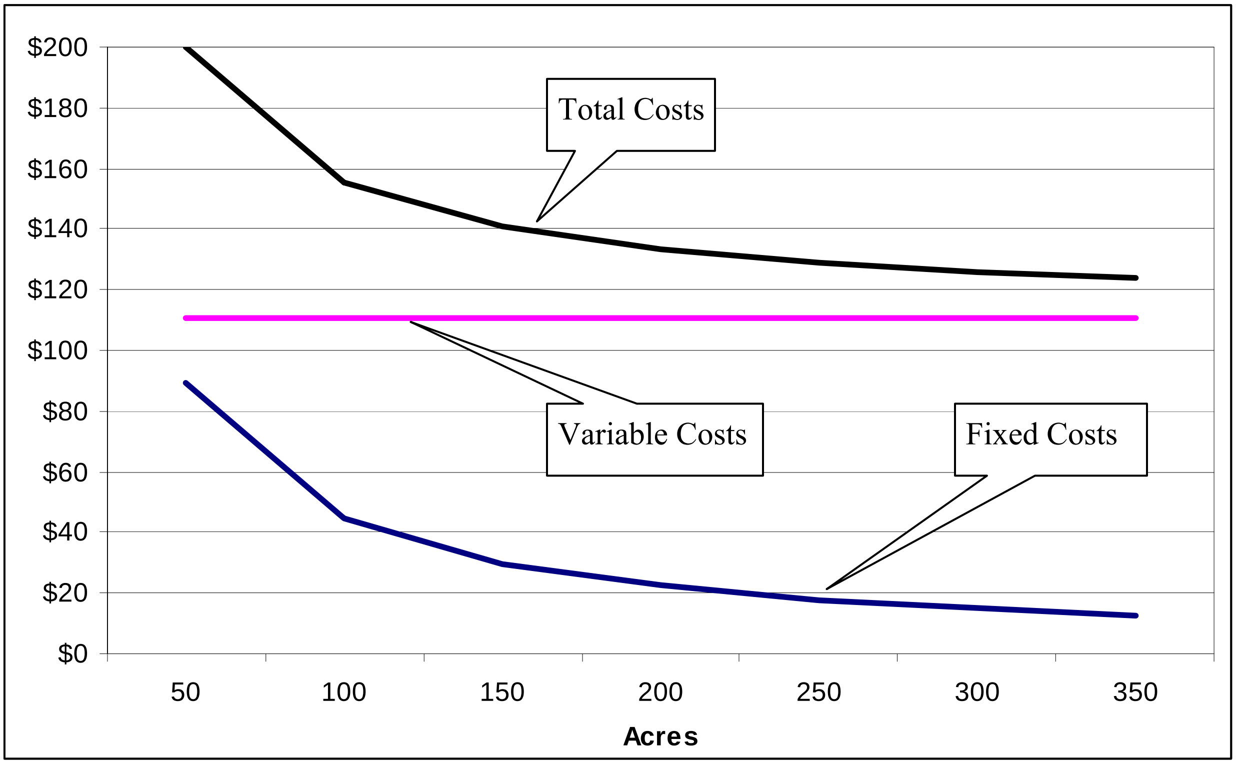


Figure 3: Grass-Clover Hay – Total Costs

Storage and Storage Loss

Once the hay is harvested, you have two decisions: 1) store outside or 2) store inside, or at least protect the hay from the elements. The answers to these questions are not straight forward. In a pervious study (Groover, 2003), I discussed the costs of different storage methods with the final conclusion that storage and reducing hay losses depends on the value of the hay being stored. Thus, if your hay supplies are limited or you purchase all your hay, then storage is a wise investment. For example, if you are buying hay for $150 per ton, then the math is simple: for every 1 percentage drop in storage loss, you get $1.50 back. So, if you reduce your loss from 30% round bales outside to 10% by storing in a pole barn, then you save $30 per ton annually. However, if your hay is worth only $70 per ton, then this same savings in loss would be worth only $14 per ton annually. What do we conclude from this? The short story is "We need to do the math on savings verses the costs of storage." Home grown (machinery costs and remember these are sunk costs) hay destined for the cow herd with few alternatives for sale may not justify investment in storage structures other than gravel areas to reduce ground contact. However, higher quality hay destined for animals requiring higher quality forages (dairy cows, stocker, and sheep) or hay to be sold to horse owners should consider an investment in a storage structure. The University of Kentucky has an excellent publication titled "Round Bale Hay Storage in Kentucky" that lists out alternative methods and loss comparisons.

Figure 3 shows the results of comparing the annualized costs of the three methods (hay shed, reusable tarp, and elevated stack). The graph shows the value of dry matter savings from the three storage methods over just ground storage as the value of hay increases from $15 to $155 per ton. Dry matter savings over ground storage are 26% for the hay shed, 23% for the reusable trap, and 13% for the elevated stack. The first thing to observe from Figure 3 is that the value of hay saved over ground only storage pays for the additional costs of shed, tarp, and stack storage with the exception of shed storage for hay valued at $45 per ton. Second, when hay values exceed $75 the preferred storage methods shift entirely to tarp and shed. Third, as the value of hay to your farm increases, the less advantage tarp storage has over a shed. The advantage for tarps could diminish if additional labor must be hired to stack, cover, and recover hay during the year. If the hay shed could be filled 1.5 times per year, e.g. store 150 tons instead of 100 tons, then the advantage at the $75 value would favor building a hay shed. A 2008 update on Figure 3, given that grass-cover hay variable costs are around $111/ton, the value of the hay saved from a shed or tarp should be considered. Caution: We all must realize that with the financial uncertainty we are experiencing anything could happen to input/output prices. In the last few years crude oil prices have gone from $30 to $160 back to $50 per barrel. So doing the math is very important. Note: Appendix B (Estimate of Annual Machine Cost) can easily be adapted to building to determine the annual fixed costs for comparison to hay savings from storage.

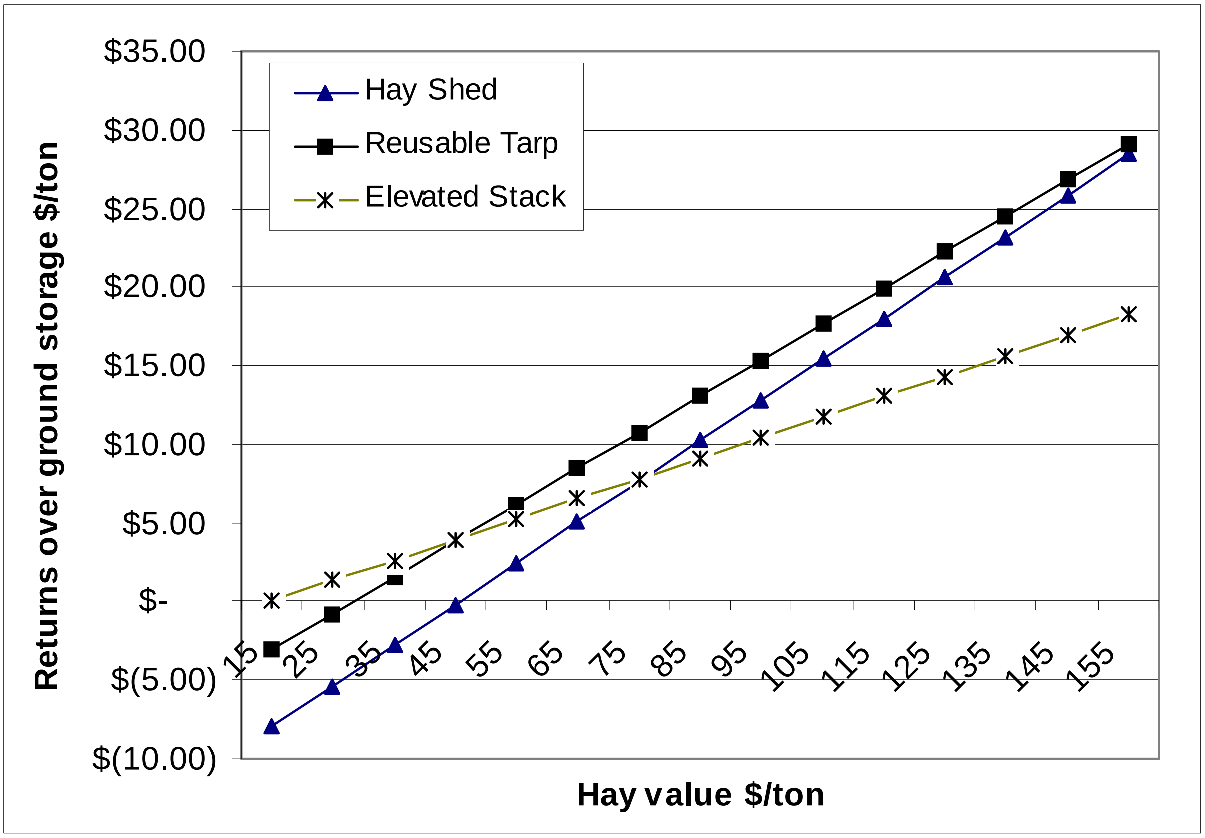


Figure 4: Comparison of Returns Over Storage Costs (Groover, 2003)

Land and Labor Costs

Labor can be important when considering a new enterprise or if you must hire labor to complete a task. Yet how to value labor costs always provide some challenges because many farmers have a mixture of family and hired labor (sometimes only family labor). This is further complicated since many farmers operate as a sole proprietor for tax purposes, and their labor and possibly a spouse's labor are a residual claim (what's left over after paying all cash expenses and debt payments) on the net returns from the farm business. This residual claim is often considered the family living draw and makes estimating a per hour value of labor very difficult. Furthermore, family labor (sometimes all labor) tends to be more like a fixed cost in that the total cost of labor does not change much within a year. But labor can be reallocated from a lower priority to a more important task; thus, any labor saved on one task can be made available to a higher priority task. Thus, the labor value to the farm is based on the opportunity costs of that labor in another activity on or off the farm. In all reality most farmers do not put a price tag on their own or their family members' labor. But they do set priorities on tasks or jobs based on opportunity costs. For example, baling hay before a summer thunder storm soaks the hay is a good example of a higher opportunity cost than say trimming the grass around the farm's sign. So the value of labor does not need to be included in the budget unless it is hired or family labor that can be used in a competing (more profitable) enterprise.

Land is important to a hay enterprise and carries similar considerations of opportunity costs as family labor. The question that arises is what other more profitable alternatives can use this land? If the land base and the enterprises are fixed, then there is no reason to consider the opportunity costs of the land outside of the tax and insurance that are annual land-based costs. However, if the land base is rented, rental payments must be included as a part of the variable cost of the hay enterprise. However, converting hay land to pasture does present a more complex decision involving the land base. For example, if all winter feeding was supplied via stockpiled fescues and off-farm purchase of hay, then the farm could increase the carrying capacity or stocking rate and potentially improve the overall profitability. This analysis is beyond the scope of the paper, yet the potential increased profitability would be gained from lower fixed costs of hay equipment and increased cattle sales but offset by greater investments in fence and water systems.

Now What?

First, know your costs-of-producing a ton of hay (fixed and variable), keep financial and production records, and analyze these records. Question why you are doing all these production practices; for example, ask why you make hay, what alternatives are there to making hay, and if you can improve your bottom line by investing in cattle and not machinery. Second, strive to size your machinery to your acreage to keep fixed costs as low as possible and still make a quality product. The bottom line requires that all costs, including handling, transportation, and management, must be covered for the hay business to remain profitable relative to purchasing hay. Third, collect enterprise budgets to see how it is done – we (Ag Economists) all follow the same basic process but there are differences that might work better for your farm. The key is to develop your own base and know your farm's costs and returns. Fourth, spend some time working out your own answers to the questions I have posed below.

Q: Given the high costs of all inputs, what should I do first?
A: First, a basic concept; hopefully, you have heard of diminishing marginal returns. This concept follows the basic yield response function, i.e. you get a bigger response to the first unit of an input than the last unit. Applying dollar values to the inputs and outputs allows us to compare the added value of the response to costs of the next input unit. When they are equal we stop adding inputs. For example, if you could spend $10 on another 10 lbs. of fertilizer and get $9.00 in hay or grazing to feed or sell, the obvious conclusion is - **don't do that**! This simple concept is not simple to apply in a field situation because farmers do not routinely have enough field data to support these fine tuned management decisions. But you do have soil maps, historical knowledge of yields of fields, and your observations over the years. Using these observations and soil tests allows you to roughly estimate the response to fertilizers. Thus, apply fertilizers to the fields that will respond the most and moving down the list from the most productive fields to the least. Keep in mind that the first unit of an input applied gives the biggest bang for the buck. This could result in some fields not receiving any fertilizers. Is this a problem? Maybe not if the left out fields are droughty and routinely low yielding, regardless of your best efforts. Also, consider in large fields locating the areas that are eroded or sallow levels of top soil and reducing fertilizer use on these areas. Note: New GPS technologies combined with variable rate fertilizer applications have addressed these concerns for row crop farmers.

Q: Okay, but what's that got to do with the price of fertilizer in Fredrick?
A: Here's another way to think about the first question. Individual farmers can do very little about the price of fertilizer. However, farmers can respond in a manner that makes efficient/profitable use of that fertilizer. We know that a forage crop grown on two different fields may respond very differently to fertilizer. Let's consider N. Assume we have two fields and N is $0.80/lb. (includes spreading costs). Thus, the question "Should we put N down and where should it be spread?" We also know that hay prices have been going up but we can get hay delivered to the farm for $120/ton or $0.06 per lb. (opportunity costs/value of our hay). Let's look at the break even yield you need to cover the added costs. We divide the price of N $0.80/lb. by the price of hay $0.06 per lb. and this yields the value of 13 lbs. of hay being equal to the costs of a $0.80/lb. of N. Or if we applied 50 lbs. of N per acre, then we'd need to have a yield increase of about one third of a ton of hay (667 lbs) per acre to breakeven on applying 50 lbs. of N at $0.80 per lb. So if you know the production history of these two fields, then ask yourself "Will 50 lbs. of N make me at least a one-third a ton of hay/forage?" So if you say no, then **don't do that**!

Q: If N is so expensive, what are the alternatives?
A: We all know about the synergistic relationship between legumes and grasses, and that with sufficient levels of legumes (Chris Teutsch tells me 35%-40%) N fertilization can be avoided. Lets assume that sufficient levels of legumes in pasture or hay field will allow for an average yield of 3 tons per acre. Given the rule of thumb that a ton of grass hay needs 40 lbs. of N, and we assume that N is $0.80/lb., then we have saved $96 (3 tons * 40 lbs./ton) * $0.80/lb.). Now consider using legumes to provide the N. For ease of math we'll apply 6 lbs. of seed (both red and ladino) at $3.00/lb. yields $18; add to that the $7.50 application costs per acre to provide the same benefit as 120 lbs of N. Under these assumptions, what's the breakeven price of N = ($18+$7.50) ÷ $96 = $0.27 per lb.? Thus, the price of N would have to drop to $0.27 per lb.

before you would switch back to N instead of using legumes. This assumes that, N, clover seed, and spreading costs stay the same. What's the added forage quality benefit of the legume in that pasture or bale of hay?

Q: With the relative change in fertilizer prices, what about alfalfa verses grass hay?
A: To answer, let's compare an orchard grass budget to alfalfa that takes into consideration yield difference and the life of each stand. Comparing three budgets based on the following assumption: $3.50/gallon for fuel, $0.80/lb. for N, $1.00 for phosphate, and $0.90/lb. for potash, 7 years of life for an orchard grass stand, 5 years for an alfalfa stand, 3-ton yield for orchard grass, and 5-ton yield for alfalfa (for the details please see our enterprise budgets at www.extension.agecon.vt.edu/enterprisebudgetsdetail.html). Table 1 reports the total costs per ton.

Table 1: Budgets (budgets referenced below have be change to reflect prices listed above)	Costs $/ton
N fertilized orchard grass hay www.ext.vt.edu/departments/agecon/spreadsheets/crops/2007/OrchardgrassRedCloverHay.pdf	$184
Alfalfa hay www.ext.vt.edu/departments/agecon/spreadsheets/crops/2007/ALFALFAHay.pdf	$153
Orchard grass and clovers hay www.ext.vt.edu/departments/agecon/spreadsheets/crops/2007/OrchardgrassRedCloverHay.pdf	$141

The total costs in Table 1 speak for themselves. The relative costs per ton for alfalfa and orchard grass-legumes are significantly less than annual applications of N to a cool-season grass. In addition there are other positives, mostly the added quality of the legumes and mixes. A potential downside may occur for hay growers marketing to the equine industry where some horse owners are reluctant to purchase grass-clover hay – may limit your market.

Summary

The first decision is to understand the hay market in your area and get good estimates on prices for low to excellent quality hay. This will help set the base or the long-run costs of producing a ton of hay – a benchmark for your farm business. Second, understand your total cost of making hay and develop individual budgets for each crop (orchardgrass, fescue, alfalfa, timothy, bermudagrass …). Third, develop a machinery budget (see Appendix B) to cover all costs of making hay. This budget should have costs broken down per ton and per acre based on typical yields. Fourth, combine the crop, machinery, and overhead to estimate total costs. Finally, compare estimated purchase prices in your region to your estimated total costs and ask, "Am I better off making my own hay?" Obviously, if the difference is positive you are better off making hay on your farm. If not, consider alternatives to owning hay equipment.

References

G. E., Gordon. "Hay Storage Alternatives." Farm Business Management Update, October/November 2003. http://www.ext.vt.edu/news/periodicals/fmu/2003-10/haystorage.html.

M. Collins, D. Ditsch, J.C. Henning, L.W. Turner, S. Isaacs, and G.D. Lacefield. Round Bale Hay Storage in Kentucky. 10/1997. http://www.ca.uky.edu/agc/pubs/agr/agr171/agr171.pdf

Appendix A: Estimated Costs for Orchardgrass and Alfalfa Hay - Round Baled

Orchardgrass Nitrogen Fertilized							
Acres harvested – 3 tons	50	100	150	200	250	300	350
Equivalent tons harvested	150	300	450	600	750	900	1050
Fixed costs per ton $	89.35	44.67	29.78	22.34	17.87	14.89	12.76
Pre-Harvest variable costs per ton $	135.94	135.94	135.94	135.94	135.94	135.94	135.94
Harvest variable costs per ton $	22.83	22.83	22.83	22.83	22.83	22.83	22.83
Sub-total variable costs per ton $	158.77	158.77	158.77	158.77	158.77	158.77	158.77
Total costs per ton $	248.12	203.44	188.55	181.10	176.64	173.66	171.53

Orchardgrass and Clover							
Acres harvested – 3 tons	50	100	150	200	250	300	350
Equivalent tons harvested	150	300	450	600	750	900	1050
Fixed costs per ton $	89.35	44.67	29.78	22.34	17.87	14.89	12.76
Pre-Harvest variable costs per ton $	88.00	88.00	88.00	88.00	88.00	88.00	88.00
Harvest variable costs per ton $	22.83	22.83	22.83	22.83	22.83	22.83	22.83
Sub-total variable costs per ton $	110.83	110.83	110.83	110.83	110.83	110.83	110.83
Total costs per ton $	200.18	155.50	140.61	133.17	128.70	125.72	123.59

Alfalfa						
Acres harvested – 5 tons	10	25	50	100	150	200
Equivalent tons harvested	50	125	250	500	750	1000
Fixed costs per ton $	268.05	107.22	53.61	26.80	17.87	13.40
Pre-Harvest variable costs per ton $	100.17	100.17	100.17	100.17	100.17	100.17
Harvest variable costs per ton $	26.97	26.97	26.97	26.97	26.97	26.97
Sub-total variable costs per ton $	127.14	127.14	127.14	127.14	127.14	127.14
Total costs per ton $	395.19	234.36	180.75	153.95	145.01	140.54

Appendix B: Estimate of Annual Machine Cost

____
(Machine name)

Line		Amount
1.	Purchase cost	$_______
2.	Salvage value	$_______
3.	Cost to be recovered (line 1 minus line 2)	$_______
4.	Estimated years of life	_______
5.	Units of estimated annual use (hours, acres, miles, etc.)	_______

Fixed or Ownership Costs:

6.	Cost recovery and (____%) interest factor (from table on back)	_______
7.	Cost recovery and interest (line 3 x line 6)	$______
8.	Interest on salvage value (line 2 x interest rate ____%)	$______
9.	Insurance, taxes, housing (line 1 x 1%)	$______
10.	License	$______
11.	Total Fixed Cost (add lines 7 thru 10)	$______
12.	Fixed cost per unit (line 11 + line 5)	$______

Variable or Operating Costs:

13.*	Fuel (____ gal. / ____ x ____ ____ x ____ price/gal.) unit no. units	$______
14.	Oil, grease, anti-freeze -15% of total fuel costs	$______
15.	Repairs (including service labor), tires, etc. (VCE crop budgets)	$______
16.	Total Variable Cost (add lines 13 thru 15)	$______
17.	Variable Cost per Unit (line 16 + line 5)	$______
18.	TOTAL ANNUAL MACHINE COST (line 11 + line 16)	$______
19.	TOTAL COST PER UNIT (line 18 + line 5)	$______

* Fuel consumption per hour can be estimated by multiplying the maximum PTO Hp by one of the factors below:
  Gasoline engines - 0.060 x maximum PTO horsepower
  Diesel engines - 0.044 x maximum PTO horsepower

Capital Recovery (CR) Table

Years - n	0.04	0.05	0.06	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15	0.16
	Annual interest rate i												
1	1.04000	1.05000	1.06000	1.07000	1.08000	1.09000	1.10000	1.11000	1.12000	1.13000	1.14000	1.15000	1.16000
2	0.53020	0.53780	0.54544	0.55309	0.56077	0.56847	0.57619	0.58393	0.59170	0.59948	0.60729	0.61512	0.62296
3	0.36035	0.36721	0.37411	0.38105	0.38803	0.39505	0.40211	0.40921	0.41635	0.42352	0.43073	0.43798	0.44526
4	0.27549	0.28201	0.28859	0.29523	0.30192	0.30867	0.31547	0.32233	0.32923	0.33619	0.34320	0.35027	0.35738
5	0.22463	0.23097	0.23740	0.24389	0.25046	0.25709	0.26380	0.27057	0.27741	0.28431	0.29128	0.29832	0.30541
6	0.19076	0.19702	0.20336	0.20980	0.21632	0.22292	0.22961	0.23638	0.24323	0.25015	0.25716	0.26424	0.27139
7	0.16661	0.17282	0.17914	0.18555	0.19207	0.19869	0.20541	0.21222	0.21912	0.22611	0.23319	0.24036	0.24761
8	0.14853	0.15472	0.16104	0.16747	0.17401	0.18067	0.18744	0.19432	0.20130	0.20839	0.21557	0.22285	0.23022
9	0.13449	0.14069	0.14702	0.15349	0.16008	0.16680	0.17364	0.18060	0.18768	0.19487	0.20217	0.20957	0.21708
10	0.12329	0.12950	0.13587	0.14238	0.14903	0.15582	0.16275	0.16980	0.17698	0.18429	0.19171	0.19925	0.20690
11	0.11415	0.12039	0.12679	0.13336	0.14008	0.14695	0.15396	0.16112	0.16842	0.17584	0.18339	0.19107	0.19886
12	0.10655	0.11283	0.11928	0.12590	0.13270	0.13965	0.14676	0.15403	0.16144	0.16899	0.17667	0.18448	0.19241
13	0.10014	0.10646	0.11296	0.11965	0.12652	0.13357	0.14078	0.14815	0.15568	0.16335	0.17116	0.17911	0.18718
14	0.09467	0.10102	0.10758	0.11434	0.12130	0.12843	0.13575	0.14323	0.15087	0.15867	0.16661	0.17469	0.18290
15	0.08994	0.09634	0.10296	0.10979	0.11683	0.12406	0.13147	0.13907	0.14682	0.15474	0.16281	0.17102	0.17936
16	0.08582	0.09227	0.09895	0.10586	0.11298	0.12030	0.12782	0.13552	0.14339	0.15143	0.15962	0.16795	0.17641
17	0.08220	0.08870	0.09544	0.10243	0.10963	0.11705	0.12466	0.13247	0.14046	0.14861	0.15692	0.16537	0.17395
18	0.07899	0.08555	0.09236	0.09941	0.10670	0.11421	0.12193	0.12984	0.13794	0.14620	0.15462	0.16319	0.17188
19	0.07614	0.08275	0.08962	0.09675	0.10413	0.11173	0.11955	0.12756	0.13576	0.14413	0.15266	0.16134	0.17014
20	0.07358	0.08024	0.08718	0.09439	0.10185	0.10955	0.11746	0.12558	0.13388	0.14235	0.15099	0.15976	0.16867
21	0.07128	0.07800	0.08500	0.09229	0.09983	0.10762	0.11562	0.12384	0.13224	0.14081	0.14954	0.15842	0.16742
22	0.06920	0.07597	0.08305	0.09041	0.09803	0.10590	0.11401	0.12231	0.13081	0.13948	0.14830	0.15727	0.16635
23	0.06731	0.07414	0.08128	0.08871	0.09642	0.10438	0.11257	0.12097	0.12956	0.13832	0.14723	0.15628	0.16545
24	0.06559	0.07247	0.07968	0.08719	0.09498	0.10302	0.11130	0.11979	0.12846	0.13731	0.14630	0.15543	0.16467
25	0.06401	0.07095	0.07823	0.08581	0.09368	0.10181	0.11017	0.11874	0.12750	0.13643	0.14550	0.15470	0.16401
26	0.06257	0.06956	0.07690	0.08456	0.09251	0.10072	0.10916	0.11781	0.12665	0.13565	0.14480	0.15407	0.16345
27	0.06124	0.06829	0.07570	0.08343	0.09145	0.09973	0.10826	0.11699	0.12590	0.13498	0.14419	0.15353	0.16296
28	0.06001	0.06712	0.07459	0.08239	0.09049	0.09885	0.10745	0.11626	0.12524	0.13439	0.14366	0.15306	0.16255
29	0.05888	0.06605	0.07358	0.08145	0.08962	0.09806	0.10673	0.11561	0.12466	0.13387	0.14320	0.15265	0.16219
30	0.05783	0.06505	0.07265	0.08059	0.08883	0.09734	0.10608	0.11502	0.12414	0.13341	0.14280	0.15230	0.16189

$$CR \quad \frac{i}{1-(1+i)^{\wedge}-n}$$

Rotational versus Continuous Grazing: Who wins?

Dr. Ben Tracy
Grassland Ecosystem Management Specialist
Virginia Tech
Email: bftracy@vt.edu

A main theme for the 2009 VFGC meetings is optimizing the efficiency of forage resources. Rotational grazing, or stocking, has long been promoted as one way increase forage use efficiency. Rotational grazing is a system constructed to spread out grazing pressure in space and time. Livestock are grazed at high stocking densities but moved frequently to new pasture. Moving livestock among pastures allows a producer to track pasture growth. It also allows grasses to rest and recover following grazing. Continuous grazing implies no, or perhaps minimal, movement of livestock among pastures. Many advocate that more producers should use rotational systems because they generate greater animal and plant productivity compared with continuous systems.

This issue of rotational grazing, and it purported benefit to productivity, was at the heart of a review paper published in the journal Rangeland Ecology and Management this past January. The paper generated some attention, and I think it merits some discussion here given the upcoming winter meetings that will be held around Virginia.

The authors collected data from research studies that compared continuous and rotational systems. These studies were done on rangeland - mostly in the United States and South Africa. A key word in that sentence is "rangeland". Rangeland differs from grassland we have in Virginia. It consists of mostly native species (our species are introduced from other countries) and is generally confined to arid and semi-arid regions. Out of 23 rangeland studies, 83 percent found no difference in forage production between rotational and continuous systems. Only 13 percent of the studies reported greater forage production in rotational systems. For animal weight gain, 50 percent of studies (of 38 total studies reviewed) also reported no difference between systems. Surprisingly, 42 percent of studies reported greater animal performance in continuously grazed systems.

During the growing season, rangeland climates tend to be hot and much drier than ours. As a result, grasses spend most of the time dormant. Most growth occurs over 60 days or so. In contrast, our pastures usually grow for more than 150 days during the growing season. In a hot, dry climate with sporadic rainfall, rotating cattle among pastures does little to help productivity most of the time. For rotational grazing to work effectively, grasses need to be actively growing most of the time. This situation rarely occurs on rangeland. I think these climatic effects mostly explain why rangeland studies find rotational and continuous systems to be similar.

Does this hold true in Virginia? Well, there are not many studies. The most relevant were done by Dr. Roy Blaser at the Middleburg Research Station some years ago. Unlike rangeland studies, he found that animal performance was about 34% greater using rotational grazing compared with continuous. Studies were done using several orchardgrass-legume mixtures. Interestingly, when orchardgrass was grown alone, with no nitrogen (N) fertilization, animal production was very similar between systems. This result suggests that optimal responses from rotational grazing also may be dependent on N fertility.

To sum it up, I think we should expect rotational grazing to work better in regions of high, consistent rainfall - like much of the eastern US. With adequate rainfall, rest periods, and redistribution of grazing pressure has greater potential to improve forage growth and animal performance. Remember though, a successful grazing system is fundamentally dependent on good stocking rate management. A poorly managed rotational system is no better, and maybe even worse, than a well-managed continuous system. Matching stocking rate with seasonal forage availability is the key.

Ben Tracy is a grassland and ecosystem management specialist in the Crop and Soil Environmental Sciences Department at Virginia Tech and currently serves as an education advisor to the Virginia Forage and Grassland Council.

Twinning and Double Ovulation in Dairy Cattle: Inheritance and Sub fertility Problems

Dr. Robert M. Dyer, VMD, PhD
Associate Professor Animal and Food Science
University of Delaware
Email: rdyer@udel.edu

Introduction

The selection of one follicle for ovulation in monovular species like the dairy cow is a process wherein a single follicle in a wave of many growing follicles develops the capacity to ovulate. Emergence of that follicle or follicles determines ovulation and therefore twinning rates. Twinning could be considered to be an error in ovulatory follicle generation. Accordingly, twinning incidence in beef is <1.0% (a negatively selected trait) whereas in dairy cattle, (less selection pressure) twinning frequency runs around 4-5%. Interestingly, selection against twinning in dairy cattle negatively impacts selection for higher milk yield because of a poorly defined positive relationship between twinning and milk yields.

The twinning rate in dairy cattle appears to have increased even though the basic underlying causes have not been assessed. In dairy cattle, there is an effect of age on twinning in that first calf heifers twin less than 1.0% of the time whereas aged cattle twin >10% of the time. The largest rise in twinning frequency occurs between the first and second parity. Most twinning events in dairy cattle are dizygote rather than monozygote in nature meaning the majority of twins occur from multiple ovulations. Monozygotic twins appear to be a relatively rare event (accounting for only 3.9% of all twinning) meaning there is a low frequency of embryonic split at the 2 cell stage to generate identical twins (Silva Del Rio et al., 2004). There is evidence to show twinning has some underlying genetic as well as environmental events associated with and possibly causal in twinning.

Genetics and Heritability of Twinning in Cattle

Twinning has a low heritability ranging between 0.01-0.09. Recent studies showed heritability was lowest (0.01) in first lactation heifers but increased (0.03) in 5th parity cattle. Heritability of ovulation rate distributed over a number estrus cycles is much higher at between 0.34-0.38 while the correlation between double ovulations and twinning is very high and close to 1.0. Accordingly, selection for twinning based upon double ovulation rate considerably impacts twinning rates.

The data is very clear genetic events controlling heritability in cattle likely stem from multiple genetic loci (genes) with small effects rather than a single gene with a large effect on twinning. Most likely this multi-trait form of heritability impacts many hormonal and nervous system events directly and indirectly regulating the axis driving both reproductive and nutrient metabolism and partitioning functions. Of course, any of these predisposing genetic events could be heavily modified by environmental components such as production, ration, nutrition, and housing events.

Genetic Candidates Associated with Twinning Heritability

Several genes (gene loci) appear to affect twinning rates and have been mapped to a variety of bovine chromosomes. Some data indicated up to nine different genetic markers were associated with effects on twinning rate. These were mapped to chromosomes 1, 5, 6,7,8,14,15 and 23 (Weller, J.L et al., 2008). The most prominent loci appearing to be involved in reproductive fecundity and ovulation rate map to chromosomes 5,7, 10, 19 and 23 (Cruickshank et al., 2004). Interestingly one of the most important genes mapped close to the insulin growth factor 1 (**IGF-**1) loci in chromosome 5. IGF-1 is known to play an enormous role in follicle growth, steroidogenisis and LH responsiveness that drives follicle growth and ovulation. IGF-1 also increases embryonic growth rates in utero and thereby can reduce losses from early embryonic death. Increased IGF-1 amounts in serum as well as follicular fluids have been associated with twinning and multiple ovulations.

Gene loci coding growth hormone (GH) must also be evaluated as this hormone regulates hepatic and follicular production of IGF-1. Growth hormone has been implicated in modulating follicular growth and development, follicular steroidogenisis although the effect may not be direct but more through modulating hepatic, and ovarian IGF-1 secretion. Thus, genes important in heritance of twinning also control functions involved in follicle recruitment, selection, and ovulation as well as fertilization and embryonic survival.

Mutations in sheep mapping to genes located on the 6th and X chromosomes increased ovulation rates by impacting hormones directly involved in stimulating follicle growth and development in preparation for ovulation. Mutations in these loci diminished steroidogenisis (B estradiol and estrone synthesis) and inhibin production thereby delaying the decrease in follicle stimulating hormone **(FSH)** secretion that must occur to decrease the number of follicles presented for ovulation. As a result, many more follicles matured at the time of ovulation, leading to multiple ovulations and enhanced twinning rates in these individuals. In spite of the strong evidence implicating chromosome 5 loci in heritance of twinning, no evidence currently exists showing loci implicated in heritance of twinning are linked to genetic loci controlling milk yields and production. Thus, any genetic explanation for the association of twinning with higher lactation in dairy cattle remains unknown. The negative genetic correlation between female fertility and twinning across parities could imply twinning is highly likely to be a manifestation of sub-fertility or abnormal reproductive function in dairy cattle.

Folliculogenesis and Dominant Follicle Ovulation in Cattle

Follicle growth occurs in waves on the cow's ovary. Normally there are 2-3 waves of follicle growth appearing in each 21 day estrous cycle. Usually the first wave emerges after ovulation at the time of estrus. The second wave emerges about day 10 of the estrus cycle (midcycle). Each wave is supported by a rise in follicle stimulating hormone (FSH) secretion that drives follicle growth. At some point after emergence of the wave, there is an abrupt change in the rate of follicle growth between most follicles in the wave and one outstanding follicle that suddenly acquires a large growth advantage over all other follicles. The abrupt change in growth that distinguishes the largest, fastest growing follicle from the rest of the follicles in the wave is often (but not inevitably) assigned to the largest follicle in the wave at sometime around 3-6 days after wave emergence. This sudden burst in growth rate bestowed upon one follicle generates a follicle whose size and function quickly supersedes all other follicles in the wave. The change in size is termed follicle deviation and that follicle is known as the dominant follicle while all remaining slower growing follicles are known as the subordinate follicles. The destiny of all subordinate follicles is quickly dominated by the rapidly growing dominant follicle.

A constant finding at the time of follicle deviation and growth spurt is a profound and important nadir in FSH amounts. Before the nadir, growth rates in all follicles in the newly emerged wave are the same. After the nadir in FSH, the growth rate in the deviated follicle is much greater than growth rates in the remaining follicles in the wave. The dominant follicle apparently develops a selective sensitivity to growth stimulants such as FSH that fails to develop n the subordinate follicles. As a result, the dominant follicle acquires a selective growth advantage over the sub-dominant follicles.

All follicles in the wave have equal capacity to become the deviated follicle with dominant growth rates far exceeding the subordinate follicles in the wave. The decrease in FSH associated with emergence of a dominant follicle disallows all other non-dominant (sub-dominant) follicles in the wave from also becoming a dominant follicle and forces the death of all other follicles. Two important hormones (estrogen and inhibin) produced by the dominant follicle lowers FSH amounts available to all other follicles in the wave. In so doing, the dominant follicle creates a deteriorating hormonal environment for all subordinate follicle growth. Thus, dominant follicular production of estrogen and inhibin at the time of dominant follicle deviation is critical for reduced FSH levels at the time of deviation.

What makes the dominant follicle dominant over all others? The answer to this question is not clear. Follicle size as well as time of growth spurt in the dominant follicle may be unimportant. Apparently, the dominant follicle develops a very selective advantage in growth probably generated by a very large increase in sensitivity to follicle growth hormones like LH and FSH. Events bestowing dominance on the deviated follicle are not entirely established but likely relate to increased expression of FSH and LH receptors that trigger further responsiveness to LH and FSH growth promotion and estrogen synthesis. In addition, dominant follicles show increased IGF-1 activity partly due to FSH stimulation. IGF-1 helps drive follicle cell growth steroidogenisis (estrogen synthesis) in the dominant follicle. The decrease in FSH triggered by the high estrogen production from the dominant, rapidly growing dominant follicle then closes the growth opportunity for all other follicles (subordinate follicles) that fail to develop increased sensitivity to LH and FSH stimulation. The lack of sensitivity in light of a deteriorating amounts of LH an FSH results in death for all sub-dominant follicles in the wave. At the time of dominant follicle growth and deviation, the drop in FSH amounts results in FSH amounts that are insufficient to support growth spurts in any other follicles in the wave. The dominant follicle, by virtue of its dominance directs the death of all other follicles in the wave thereby leaving the wave with one remaining, rapidly growing dominant follicle that can ovulate.

Regulation of Double Ovulations and Twinning in Dairy Cattle

Numerous factors have been associated with but not necessarily shown to be causative in double ovulations and twinning. These include use of antibiotics, hormones, heavy lactation, decreased energy and DMI intake, days open and ovarian cysts. It has been proposed milk production and parity play an important role in twinning. Earlier it was stated twinning tends to be low in first parity animals (1%) but increases markedly in second and third parity animals (6-7%). Moreover, twinning rates usually (but not inevitably) tend to be higher in cattle producing high levels of milk, fat and protein and particularly in cattle with high peak milk yields.

Double ovulation rates in mature dairy cattle are as high as 44% in lactating dairy Holstein cows compared to 1.7% in breeding age heifers (Sartori et al, 2002). Ovulation rates in cattle milking 40.5 kg/day milk and on an OvSync program were 7% in cows milking below the mean and 20% in cows above the mean production. Thus, ovulation rate is closely linked to milk yields at the time of ovulation.

Mechanisms Producing Multiple Ovulations in Cattle

Multiple ovulations almost always are generated from the same follicle wave as opposed to two different waves of follicle growth in cattle. Multiple ovulations in dairy cattle most often occur because of events impacting the relationship of dominant follicle growth with deviated follicle growth in the subordinate follicles of the same folliclular wave. Indeed, when the dominance process is altered, two or more follicles in the same wave become dominant resulting in co-dominant follicle development and multiple ovulations. Several possibilities could create co-dominant follicle development in a follicle wave.

For unclear reasons, two or more follicles in the wave acquire a large increase in sensitivity to follicular growth stimulants FSH and LH. Thus, two follicles in the wave become dominant and grow to ovulation resulting in a wave with multiple ovulations. One could speculate about the causes of this type of problem. Since folliculogenesis occurs over a 65-100 day period in cattle, anything that impacts follicle growth during this window could potentially result in waves producing two or more co-dominant follicles. The most obvious problem could be inadequate DMI so severe at the time of peak milk production that follicular injury results. At the time of severe energy nadirs, IGF-1 levels could be sufficiently low as to impair follicle growth during negative energy balance. IGF-1 from the follicle and the liver is an important factor driving dominant follicle development. IGF-1 stimulates follicle growth, steroidogenisis, and increasing follicle sensitivity to growth stimulants such as LH and FSH. Alternatively, obese cattle with fatty infiltrates of the liver during deep nadirs in negative energy balance have been shown to have lower amounts of circulating IGF-1. Hepatic cells filled with triglycerides in fatty livers simply fail to synthesize and secrete IGF-1 following growth hormone stimulation. Lower amounts of IGF-1 during fatty liver disease could slow follicle growth leading to co-dominant follicle formation during folliculogenesis. Alternatively, positive energy balance, high levels of growth hormone secretion and elevated IGF-1 amounts in follicles and serum were associated with increased ovulation rates in cattle.

Recent evidence suggests multiple ovulations and twinning may arise from acquired problems with follicular development itself. Follicular growth stimulants like FSH and LH have been shown to fail to adequately decrease at the time of dominant follicle spurts in growth just before ovulation (Wiltbank et al., 2000). As a result, all the subordinate follicle growth is not blocked as readily as when LH and FSH levels properly drop to block multiple ovulation. Indeed, Lopez et al. (2005) showed heifers with co-dominant follicle development and therefore increased risk of twinning had higher LH and FSH levels around the time when follicle sizes reached the time for deviate growth spurts to establish the dominant ovulatory follicle. In contrast, heifers with single dominant follicles had much lower amounts of LH and FSH at the times before or at emergence of the dominant follicle. What could cause this problem? The answer is not clear, but it would appear the ability of the dominant follicle to lower production of LH and FSH is dysfunctional. Some data indicate inhibin, a hormone produced by the dominant follicle is lower in those cows with co-dominant follicle development and twinning. Inhibin normally functions to lower FHS secretion and thereby limit follicle growth to the single dominant follicle. Accordingly, lower inhibin production allows for higher FSH levels that drive more follicles to become dominant, ovulate, and produce twins.

Diminished production or increase excretion of the steroids progesterone and/or estrogen would also produce co-dominant follicle growth. Sangsritavong et al. (2002) showed livers of heavily lactating cattle conjugated and cleared estrogens and progesterone from the blood nearly twice as fast as livers from cattle under moderate lactational stress. Blood flow through the livers of heavily lactating cattle was increased by as much as 60% over blood flow in livers of cattle under low lactation stress. Presumably higher rates of hepatic blood flow follow higher DMI intake in cattle under high lactational stress. Blood content of estrogen as well as progesterone was therefore lower in cattle under heavy lactation stress. Indeed, cattle under high lactational stress showing multiple ovulations had lower progesterone amounts in serum than cattle with single ovulations under lower lactational stress (Lopez et al., 2005). Sangsritavong et al. (2002) have proposed the higher rates of steroid elimination from the blood would allow higher amounts of FSH and LH to exist at the time of establishing follicle deviation, dominance, and sub-dominance. Higher FSH and LH levels therefore would promote development of follicle co-dominance rather than single follicle dominance. Co-dominance would result in multiple ovulations and increased risk of twinning.

In one report, follicle co-dominance and multiple ovulations occurred in 47% of cows with follicle waves developing in the presence of very low amounts of progesterone (Musssard et al., 2007). Usually, a very low frequency of follicular co-dominance and twinning develops when follicle waves develop in the presence of higher amounts of progesterone (Musssard et al., 2003). In another report, an amazing 75 and 60% of all ovulations in cows and heifer respectively showed co-dominance and multiple ovulations in the face of low amounts of progesterone (Matsu et al., 2004). The practical implications of these findings is that follicle wave development and ovulatory follicle formation in the context of low amounts of progesterone would most likely occur in cows recovering from periods of anestrous or anovulation or heavily lactating cows with high rates of progesterone clearance from the blood. These animals could therefore be considered at higher risk for multiple ovulations and twinning.

In summary, current evidence suggests increased hepatic excretion of progesterone couples with lower amounts of inhibin production by a dominant follicle allows for increase growth stimulation of more than one follicle in a wave. The increased stimulation may be associated with higher than normal amounts of the follicle growth stimulants LH and FSH at the time of follicle development.

Anestrus, Anovulation, Early Embryonic Death (EED) and Twinning: Producer Considerations

Higher milk yields at the time of estrus are considered a risk factor for double ovulations and twinning. Producers should be aware, however, that higher milk yields are not necessarily causative but more associated with multiple ovulations in dairy cattle. In one study, multiple ovulations occurred more frequently in cattle groups with average production of 104 lb milk/day compared to cows with 85 lbs milk per day (Lopez et al., 2005). Cows producing 85-90 lbs milk per day experienced 3 times as many double ovulations (20.2% vs. 6.9%) as cows producing less than 85 lbs milk per day. Reports indicate the prevalence of multiple ovulations ranges between 15-39% in normally cycling, high producing cows bred after estrus detection. Similar frequencies of double ovulation have been reported in heavily lactating cattle on OvSync programs of timed artificial insemination.

Moreover, multiple ovulations may occur at a frequency as high as 45-50% of ovulations in the first ovulation following recovery from anestrus and anovulation. Anestrus and anovulation at 40-50 DIM is a problem that plagues 20% of modern dairy cattle. Follicular co-dominance and double ovulations tend to occur around the first 60-100 DIM as cows begin to recover body condition scores and resume cycling. Even though follicle co-dominance and multiple ovulations are often associated with very heavy lactational stress in the 14 day window surrounding the time of actual ovulation, producers should be aware that lactational stress and/or loss in body condition may not be inevitably different in cattle at the time they experience multiple verses single ovulatory events. These cattle may have already recovered from excessive loss in body condition and resumed ovulatory and estrus functions in the context of high lactational loads. The problems may have developed prior to the onset of estrus, early in lactation (20-40 DIM), and propelled the cow into a state of anovulation and anestrus at the time of the first post partum ovulation. Producers should recognize conditions of severe negative energy balance, heavy lactational stress, and excess loss of body condition can result in higher frequencies of anovulatory cows in the first 100 DIM post partum. Higher frequencies of anovulatory cows leads to a higher frequency of recovery from anovulatory states and therefore a higher frequency of multiple ovulations and twinning. Indeed, multiple ovulations rates as high as 50% occur in the first ovulation following recovery from anestrus and anovulatory conditions. Moreover, multiple ovulation rates remain high (15-39% of ovulating cows) in the second and subsequent ovulations following recovery from anestrus in heavily lactating cattle (80-100 lb milk/day)(Santos et al., 2000, Sartori et al., 2004, Lopez et al., 2005).

Higher metabolic and energy partitioning demands from heavy lactation have been proposed to lower circulating levels of several key hormones (most likely low progesterone, estrogen, and inhibin) controlling follicle maturation to ovulation. Lower amounts of these hormones promote double ovulations and twinning through deregulated ovarian follicular activity. Many of these conditions occur in heavily lactating cattle experiencing significant body condition loss, anestrus, and anovulation.

The previous discussion strongly implies negative energy balance is coupled to problems with multiple ovulations in dairy cattle: There appears to be a pronounced carry over effect of deep nadirs in negative energy balance on multiple ovulations and twinning. Cows maintaining higher body conditions during the transition period suffer fewer incidences of anovulation and the consequential twinning from multiple ovulations. A likely explanation for the double ovulations in the recovering anovulatory cows is a low progesterone level caused by anovulatory problems (no corpus luteal body formation) that apparently persists through as many as three estrous cycles into the recovery. Low progesterone levels allow for higher than normal levels of follicle growth stimulants (LH and FSH) to persist at the time of dominant follicle selection. Higher levels of LH and FSH promote co-dominant follicle selection, multiple ovulations, and twinning. Thus, producers experiencing anestrus problems 50-100 DIM, prolonged days open coupled with actual or historical evidence of higher than expected frequency of twinning should be alerted to target severe negative energy problems and excessive loss in body condition during the first 60-70 DIM for transition cows.

Increased prevalence of early embryonic death (EED) has been associated with anovulation, anestrus, multiple ovulations, and twinning in herds. Once anestrus or anovulatory cows recover and become pregnant they appear to be at a somewhat greater risk of experiencing EED (Galvao et al., 2004). Cattle with a combination of these problems experience prolonged days open, lower pregnancy rates, lower heat detection rates, lower conception rates, and irregular and prolonged (> 44 days) inter-estrus intervals. EED generally occurs up to 50 days post insemination. Data indicate the frequency of EED is quite variable (ranging between 7-80%) in cattle bred at the first estrus after recovering from anovulation/anestrous problems. Never the less, losses over several studies indicated 26% of cows recovering from anovulation or anestrus experienced EED. In contrast, only 16% of cows bred in the absence of pre-existing anovulatory problems experience EED (Santos et al., 2004). The EED is likely related to the same slow and low rise in progesterone levels that dysregulate FSH and LH levels that would otherwise prevent co-dominant follicle formation, multiple ovulations, and twinning. In those animals that do become pregnant after recovery from anovulation and anestrus, low levels of progesterone in the previous cycle before pregnancy appear to predispose these animals to premature loss of corpus luteal function and EED 30-40 days into the pregnancy (Galvao K.N. et al., 2004 and Santos et al., 2004). An EED problem should be suspected if producers find many open cows at some point after the 30-35 day of pregnancy diagnosis. Records showing too many inter-estrus intervals greater than 42 days also indicate an EED problem. Veterinarians often receive the blame for these pregnancy losses but a much more productive approach to the problem might entail an evaluation of energy balance, body condition scores, frequencies of anestrus in transition cows, and the historical frequency of twinning in the herd.

Conclusions and Summary

Double ovulations and follicular co-dominance are associated with heritance and environmental factors. Increased risk of twinning has been associated with greater lactation number, higher milk yield, heat stress, excess loss of body condition, recovery from anovulation/ anestrus problems, and early embryonic death. Twinning in dairy cattle is a highly undesirable event because it increases risks of diminished milk yields, reduced conception rates, and increased rates of involuntary culling or death. Episodic increases in twinning frequency should increase producer suspicions about deeper than desirable nadirs in negative energy balance associated with excessive loss in body condition during the first 30-60 DIM.

References

Bicalho, R.C., S.H. Cheong, K.N. Galvao, L.D. Warnick and C.L. Guard. 2007. Effect of twin birth calvings on milk production, reproductive performance, and survival of lactating cattle. JAVMA 231, 1390-1397.

Cruickshank, J., M.R. Dentine, P.J. Berger and B.W. Kirkpatrick. 2004. Evidence for quantitative trait loci affecting twinning rate in North American Holstein cattle. Animal Geneitcs. 35: 206-212.

Galvão, K. N., J. E. P. Santos, S. O. Juchem, R. L. A. Cerri, A. C. Coscioni and M. Villaseñor. 2004. Effect of addition of a progesterone intravaginal insert to a timed insemination protocol using estradiol cypionate on ovulation rate, pregnancy rate, and late embryonic loss in lactating dairy cows. J. Anim. Sci. 82:3508-3517.

Lopez, H, D.Z. Caraviello, L.D. Satter, P.M. Fricke and M.C. Wiltbank. 2005. Relationship between levelof milk production and multiple ovulations in lactating dairy cows. J. Dairy Sci. 88, 2783-2793.

Lopez, H, R Sartori and M.C. Wiltbank. 2005. Reproductive hormones and follicular growth during development of one or multiple dominant follicles in cattle. Biol. Repro. 72: 788-795.

Mussard, M.L., C.R. Burke, C.L. Grasser, E.J. Behlke, K.A. Coliflower, D.E. Grum, and M.L. Day. 2003. Ovulatory response luteal function and fertility in cattle induced to ovulate dominant fiollicles of early or late maturity. Biol. Reprod. 68, (supplement 1), 332.

Mussard, M.L., C.R. Burke, E.J. Behlke, C.L. Grasser and M.L. Day. 2007. Influence of premature induction of a luteinizing hormone surge with gonadotropin-releasing hormone on ovulation, luteal fiunction and fertility in cattle. J.Animl.Sci. 85, 937-943.

Sangsritavong, S., D.K. Combs, R. Sartori, L. Armentano and M. C. Wiltbank. 2002. High feed intake increases liver blood flow and metabolism of progesterone and 17β estradiol in dairy cows. J. Dairy Sci. 85:2831-2842.

Santos, J.E.P., W.W. Thatcher, R.C. Chebel, R.L.A. Cerri and K.N. Galvo. 2004. The effect of embryonic death rates in cattle on the efficacy of estrus synchronization programs. Animal. Reprod. Sci. 82: 513-535.

Sartori, R., JG.J.M. Rosa and M.C. Wiltbank. 2002. Ovarian structures and circulating steroids in heifers and lactating cows in summer and lactating cows and dry cows in winter. J. Dairy Sci. 85: 2813-2822.

Weller, J.L, M. Golik, E. Seroussi. M. Ron and E. Ezra. 2008. Detection of quantitative trait loci affecting twinning rates in Israeli Holsteins by the daughter design. J. Dairy Sci. 91: 2469-2474.

Wiltbank, M.C., P.M. Fricke, S. Sangsritavong, R. Sartori and O.J. Ginther. 2000. Mechanisms that prevent and produce double ovulations in dairy cattle. J. Dairy Sci. 83, 2998-3007.

2008 Delaware Soybean Variety Trial Results

Bob Uniatowski
Associate Scientist
University of Delaware
Email: bobuni@udel.edu

The 2008 Delaware Soybean Variety Trial Results can be found at the following web address: http://ag.udel.edu/extension/information/varietytrials/index.html

If You Missed the 2008 Mid-Atlantic Dairy Grazing Conference

Dr. Chris Teutsch from the Va Tech Southern Piedmont AREC has many of the talks from the conference available on the web as Camtasia videos you can watch and listen to right from your computer. In addition, proceedings and other materials from the "2008 Mid-Atlantic Dairy Grazing Conference" are available on the website. The address is http://arecs.vaes.vt.edu/arec.cfm?webname=blackstone&section=links&subsection=11764.

Professional Crop Producers Conference

The 2009 Professional Crop Producers Conference will be held on February 17 & 18 at the Penn State Conference Center and Hotel in State College. This conference is hosted by the Pennsylvania No-till Alliance, Corn Growers, Soybean Growers and Forage and Grassland Council and has something for all crop producers.

The conference will have producer, consultants and scientist coming from across Pennsylvania and North America to speak with Pennsylvania producers. The conference will also have Round Table Discussions which involves producers and speakers getting together and discussing some aspect of crop production. These discussion sessions will be about one hour in length and cover the "down and dirty", "nuts and bolts" discussion among producers about how they have incorporated a crop production practice into their farming operation.

The conference should be very exciting and informative. If you can only attend one conference this year, this is the one! No other conference in Pennsylvania in 2009 will offer such a national group of producers to expose you to new crop production concepts. Make plans now to attend by going to www.conferences.cas.psu.edu.

Back to Reality!
Profitable Approaches for Managing Forage-Based Operations in the 21st Century

Clemson University is excited to host this conference February 12-13th, 2009 focusing on forage-based meat and milk production. Rapidly rising input costs are squeezing conventional, commodity-oriented margins; however, there are still opportunities for profitable production. Conference speakers are experienced, farm-oriented producers and researchers.

Total registration is $500 which will include detailed handouts and multiple breaks and meals. Hold your space at this conference with a $100 deposit by December 13, 2009. Space is limited. Click here for registration form and details.

Speakers include:

Dr. Annibal Pordomingo who manages an active forage-fed beef research program in Argentina.

Mr. Bill Hodge who is a grazier located near Atlanta GA who has over 30 years experience in all aspects of forage-based beef production and marketing.

Dr. Richard Watson a native New Zealander and former Forage Specialist for Mississippi State University.

Mr. Kit Pharo , a Colorado cattle rancher who has focused on cow efficiency and profitability for the past 25 years.

Dr. Susan Duckett of Clemson University who has been involved with researching management factors that effect marbling and fatty acid composition of beef.

Mr. Steve Ellis who is associated with a farmer cooperative who recently purchased and operate an abbatoir for processing poultry, sheep, goats, swine and beef cattle.

Dr. John Andrae is a forage specialist at Clemson University, who has extensive experience with forage production and grazing systems in the deep South.

For more information on this program contact John Andrae at jandrae@clemson.edu or at 864-656-3504.

Notices and Upcoming Events

January 5-9, 2009
Delaware Ag Week, Harrington, DE. Contact Cory Whaley at 302-856-7303 or Email: whaley@udel.edu. Visit the DE Ag Week website for complete program information at: http://www.rec.udel.edu/AgWeek/home.htm

Delaware—Maryland Hay and Pasture Day, Evening program for part-time hay and pasture producers, Equine Pasture Management Program, and Agronomy/Soybean Day, Equine Nutrient Management Program

January 6-9, 2009
Keystone Farm Show, York Fairgrounds, York, Pennsylvania. For more information visit: http://www.biztradeshows.com/trade-events/keystone-farm-show.html

January 12-15, 2009 (four locations)
Optimizing Livestock and Forages Efficiencies in Times of Change, Reva, Mt. Crawford, Lynchburg, and Wytheville, VA. Contact Margaret Kenny, makenney@vt.edu or 434-292-5331 http://arecs.vaes.vt.edu/arec.cfm?webname=blackstone

February 2, 2009
Kent County Crop Masters—Crop Knowledge Review, Dover, DE. For more information contact Gordon Johnson at 302-730-4000 or by email gcjohn@udel.edu

February 4, 2009
First Annual VANTAGE Conference "Taking Your Farming to the Next Level, Harrisonburg, VA. For more information see page 55 or contact Brian Jones, Extension Agent, Augusta County Office: 540-245-5750 or Rockingham County Office: 540-564-3080 or via email: brjones8@vt.edu

February 10, 2009
Kent County Crop Masters—Nutritional Management Research Updates and Ask the Expert Roundtable, Dover, DE. For more information contact Gordon Johnson at 302-730-4000 or by email gcjohn@udel.edu

February 11-12, 2009
Virginia Beef Industry Annual Convention and Trade Show, Roanoke, VA. For information call (540) 992-1009 or visit http://www.vacattlemen.org/

February 12-13, 2009
Back to Reality! Profitable Approaches for Managing Forage-based Operations in the 21st Century, Clemson University, Clemson, SC. For more information on this program contact John Andrae at jandrae@clemson.edu or at 864-656-3504.

February 16, 2009
Kent County Crop Masters—Advanced Forage Production, Dover, DE. For more information contact Gordon Johnson at 302-730-4000 or by email gcjohn@udel.edu

February 17-18, 2009
Professional Crop Producers Conference, State College, PA. For more information visit: www.conferences.cas.psu.edu or register today at http://conferences.cas.psu.edu/ or call 877-778-2937.

February 18, 2009
2009 Delmarva Dairy Days, Hartly Fire Hall, Hartly, DE. For more information contact Dr. Limin Kung, Jr. at 302-831-2822 or Email: LKSILAGE@udel.edu

February 27, 2009
Organic Crop Workshop, Wilson, NC, Wilson County Extension Office.
Dr. Julie Grossman (NCSU, Organic Soil Fertility Specialist) will present information about organic soil fertility and cover crop use and management. An organic farmer panel will answer questions about the challenges and benefits of large-scale organic crop production and marketing. For more information, please contact Molly Hamilton at 828-273-1041 or by email molly_hamilton@ncsu.edu

March 2, 2009
Kent County Crop Masters—Meet the Pest, Dover, DE. For more information contact Gordon Johnson at 302-730-4000 or by email gcjohn@udel.edu

March 2-4, 2009 (three locations)
Horse Pastures: From the Ground Up, Middleburg, Charlottesville, and Abingdon, VA. Contact 540-687-3521 Ext. 27 or by email cpoor@vt.edu

March 6-7, 2009
Joint Maryland Cattlemen's Convention/Central Maryland Hay and Pasture Conference, Hagerstown, MD at the Sheraton Four Points. For more information, please contact Scott Barao

at 410-795-5309 or sbarao@marylandcattle.org or Dr. Les Vough, 301-405-1322 or vough@umd.edu.

March 6-7, 2009
Appalachian Grazing Conference, Morgantown, WV. For more information contact Becky Casteel at (304) 293-6131 x4231 or Becky.Casteel@mail.wvu.edu or visit http://www.wvca.us/grazing_conference/

March 10, 2009
Kent County Crop Masters—Taking Advantage of the Information age, Evaluating Agricultural Information Sources, Dover, DE. For more information contact Gordon Johnson at 302-730-4000 or by email gcjohn@udel.edu

March 16, 2009
Kent County Crop Masters—Agricultural Chemicals—Tools to Use Wisely, Dover, DE. For more information contact Gordon Johnson at 302-730-4000 or by email gcjohn@udel.edu

April 17-19, 2009
Virginia Beef Expo, Rockingham, VA. For more information call (540) 992-1009 or visit http://www.vacattlemen.org/

June 21-23, 2009
American Forage and Grassland Council Annual Conference with Michigan Forage Council, Grand Rapids, MI. Contact Michael Bandy at 800-944-2342 or email info@afgc.org or visit http://www.afgc.org/mc/community/eventdetails.do?eventId=149462&orgId=afgc

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/grains/Articles/articles.htm or
http://www.grains.cses.vt.edu/

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

VANTAGE
The Virginia No-Tillage Alliance
Farming from a different perspective

First Annual VANTAGE Conference

"Take Your Farming to the Next Level"

February 4th, 2009
Rockingham County Fairgrounds
4808 S. Valley Pike
Harrisonburg, Virginia 22801

Please consider attending the first annual **Virginia No-Tillage Alliance (VANTAGE)** Conference. The theme of this year's conference is "Take Your Farming to the Next Level", through increased understanding of soil biology and soil fertility in no-till systems. The conference will feature **Dr. Jill Clapperton**, internationally respected lecturer and expert in understanding how farmers can maximize the **long-term biological fertility** of their soil. This conference will also feature a panel of **dairy and crop farmers** from Pennsylvania who have made the transition to continuous no-till production systems. They will be on hand to share their experiences for **dealing with those tough problems** in continuous no-till such as corn-on-corn, residue management, herbicide and weed control issues, slugs, and many more. Finally, our program will feature two of Virginia's top corn producers, **David Hula and David Black**. They will talk with us about how they grow award winning corn crops every year with long-term continuous no-till. Don't miss out on this opportunity to hear these speakers and get your questions answered!

To Register Contact:

Brian Jones, Extension Agent
Augusta County Office:
540-245-5750
Rockingham County Office:
540-564-3080
brjones8@vt.edu

What is VANTAGE?

The Virginia No-Tillage Alliance (VANTAGE) is a group of farmers, agribusinesses and local agricultural government organizations that are using no-till systems in their operations or are advising others about these systems.

Sponsored In Part By:

The Shenandoah Valley VANTAGE Chapter
Virginia Cooperative Extension
USDA-NRCS

Mission Statement:

"The Virginia No-Tillage Alliance exists to maximize farm productivity and profitability by promoting the successful implementation of no-till practices through shared ideas, technology, conservation and education."

AGENDA

8:30 to 9:00......Registration and Refreshments

9:00 to 9:30.....Welcome and Purpose of the VANTAGE Program (Brian Jones)

9:30 to 10:30....Make the Soil Work for You: Biological Fertility in No-Till Systems (Dr. Jill Clapperton)

10:30 to 11:30…Overcoming the Real-World Challenges of Continuous No-Till (Pennsylvania Dairy and Crop Farmers)

11:30 to 1:00....FREE Lunch and Visit with Vendors

1:00 to 1:30.....Live Rainfall Simulator Demonstration (Chris Lawrence, NRCS)

1:30 to 2:30.....Cover Crops and No-Till: Money in the Bank! (Dr. Jill Clapperton)

2:30 to 3:30.....How to Grow the Best Corn in the Country Without Tilling (Virginia Crop Farmers David Hula and David Black)

3:30…………..Closing and Future Plans (Brian Jones)