



# Mid-Atlantic Regional Agronomist Quarterly Newsletter

March 2012

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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](http://www.scenicbuckscounty.com) to view more photographs.

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## Response of Full Season Soybean to Nitrogen Fertilizer

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Has your fertilizer dealer been suggesting to you that your soybean crop needs a little nitrogen fertilizer in order to maximize yield? Have you questioned the wisdom of this suggestion because you know that soybean is a legume that via its symbiotic relationship with *Bradyrhizobium japonicum*, a nitrogen-fixing bacteria, obtains from 50-75% of its nitrogen requirements from the air. Additional nitrogen needed to maximize production is supplied from 1) soil residual nitrogen and 2) nitrogen supplied via mineralization of organic matter during the growing season. University of Maryland Extension currently recommends that no additional nitrogen fertilizer be supplied to soybean. But, this recommendation recently has been questioned by some Maryland fertilizer dealers who are suggesting to their customers that some starter N fertilizer (25-50 lb N/acre) is required for soybean to attain maximum yield. With funding support from the Maryland Soybean Board, a study to investigate the response of full season soybean to nitrogen fertilizer was conducted during 2011.

The study was conducted at four University of Maryland Research and Education Center (REC) farms: 1) Lower Eastern Shore REC – Poplar Hill; 2) Wye REC; 3) Central Maryland REC - Beltsville; and 4) Central Maryland REC - Upper Marlboro. Two Asgrow soybean varieties (3539RR2 and 4630RR2) were planted between the dates of 6 and 21 May in 30-inch rows, a spacing that would accommodate in-season nitrogen applications. Nitrogen treatments were rates of 25 and 50 lb N/acre supplied as UAN that was directed to the ground by drop nozzles at time of application. Three application time treatments were tested: 1) at planting; 2) at R1 (appearance of first flower); and 3) at R3 (appearance of first pod). And, a treatment of no fertilizer nitrogen was used as the control. Root samples for the purpose of assessing soybean nodulation were collected between growth stages R1 and R2 from the control treatment and the two at planting nitrogen treatments at all locations except the Wye. The number of nodules on the roots of 5 plants/plot was counted.

Different numbers of nodules were observed at the three locations. Approximately eleven nodules per plant were present for the soybeans collected at Poplar Hill and Beltsville while the plants from Upper Marlboro averaged 42 nodules/plant. The two varieties did not differ for nodule number at Poplar Hill and Beltsville while at Upper Marlboro Asgrow 4630RR2 had nearly 48 nodules/plant compared to 36 for Asgrow 3539RR2. The primary reason for assessing nodules was to determine if the addition of nitrogen fertilizer to the system changed the soybean plant's ability to nodulate. At both Poplar Hill and Beltsville, the addition of either 25 or 50 lb N/acre had no influence on nodule formation. However, at Upper Marlboro significantly more nodules (30%) were present for the two nitrogen fertilizer treatments compared to the control.

Soybean yield differed across the locations; 34.5 bu/acre at Poplar Hill and Beltsville; 55 bu/acre at Upper Marlboro; and nearly 73 bu/acre at Wye. However, there was no significant

nitrogen response observed at any of the locations. The nitrogen treatments averaged 49.4 bu/acre across the four locations and were neither different from each other nor different compared to the control (no nitrogen) which averaged 48.7 bu/acre. The only difference of note was between varieties with Asgrow 4630RR2 producing 4 and 9 bu/acre better than Asgrow 3539RR2 at Wye and Beltsville, respectively.

Seed protein, oil content and seed size were quality factors measured. And, nitrogen fertilizer application had no effect on any of these variables.

This study will be repeated at a number of Maryland locations during 2012. However, at this time, I do not see a different result and thus see no reason to alter University of Maryland Extension's current recommendation that nitrogen fertilizer application to soybean is not necessary to optimize yield. In order to ensure that your soybean will be able to manufacture an adequate supply of nitrogen, University of Maryland Extension does recommend that a seed inoculant be used at planting whenever soybean has not been part of a field's crop rotation during the past 2-3 years.

## **What's The Risk? Development of the 2012 Small Grain Crop and Potential for Spring Freeze Injury**

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The warm winter many of us in the region have experienced in 2011-12 has resulted in wheat and barley that is developmentally two (or more) weeks ahead of what we normally expect this time of year. This has many growers wondering about the risk for spring freeze injury to our developing crop. As is evidenced by Figure 1, wheat that is mostly dormant in mid-winter is quite tolerant of cold temperatures. However, once growth resumes in spring, plants become less winter hardy. At jointing, (Zadoks growth stage 30) wheat is generally tolerant of temperatures in the range of 20°F for an exposure time of two hours. And that's an important fact to be considered for the data in both Figure 1 and Table 1. To experience the expected or predicted level of injury from these temperatures requires exposure of TWO HOURS. Just dipping to that point at dawn or just before will not cause this level of injury (Table 1).

The actual severity of freeze damage in a particular field or part of a field is difficult to predict because of difference in topography, elevation, and exposure. The extent of damage also is impacted by plant growth stage, moisture content within and on plants, humidity, and wind.

Common freeze injury symptoms include:

- Emerging leaf in whorl turns yellow or is brown
- Stems are flaccid, rough and collapse
- Areas below or above nodes begin to show a brown discoloration

- Head located in boot becomes milky in color, water-soaked or begins to turn tan-brown
- Exposed head turns light tan to bleach
- Developing kernels begin shriveling, turn brown

Figure 1. The relationship between wheat growth stage and sensitivity to freeze. From: Spring Freeze Injury to Kansas Wheat (<http://www.ksre.ksu.edu/library/crpsl2/c646.pdf>)

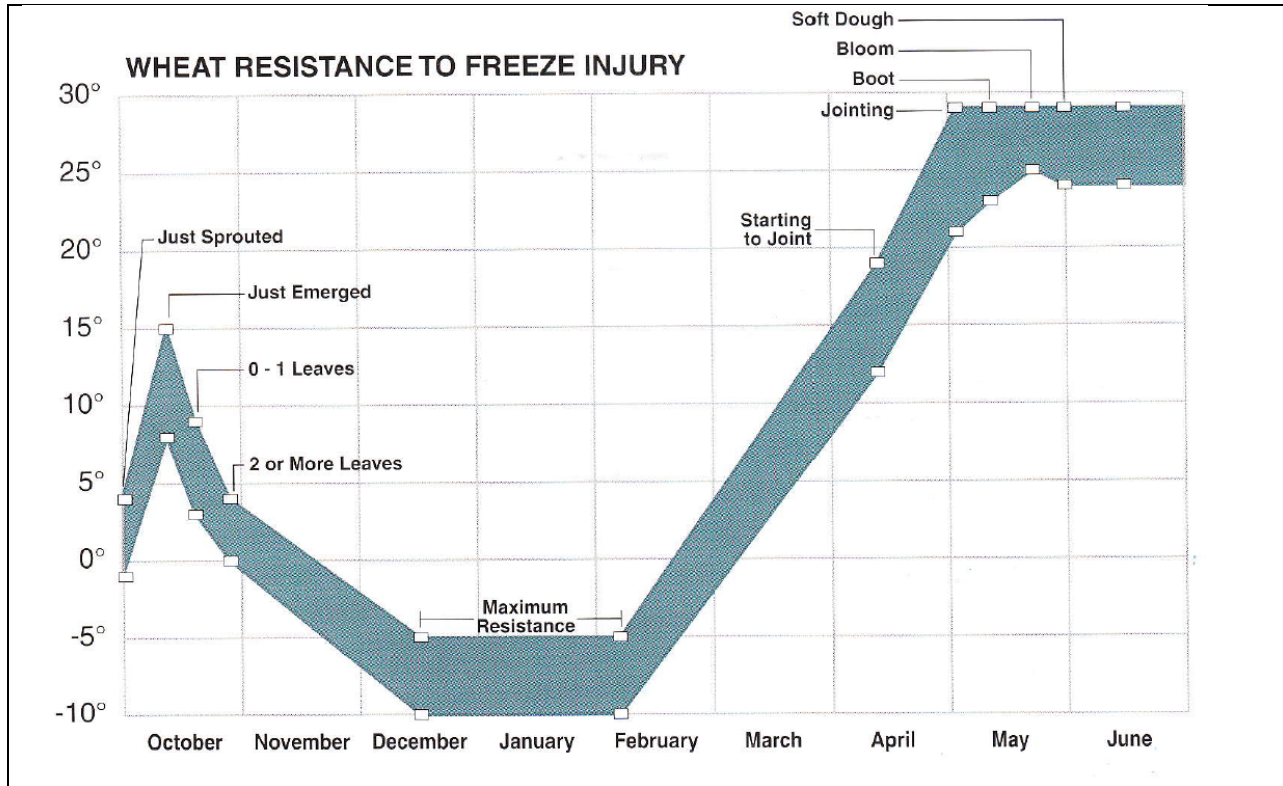


Table 1. Temperatures that cause freeze injury to wheat at spring growth stages and symptoms and yield effect of spring freeze injury.

Growth stage	Approximate injurious temperature (two hours)	Primary symptoms	Yield effect
Tillering	12 F (-11 C)	Leaf chlorosis; burning of leaf tips; silage odor; blue cast to fields	Slight to moderate
Jointing	24 F (-4 C)	Death of growing point; leaf yellowing or burning; lesions, splitting, or bending of lower stem; odor	Moderate to severe
Boot	28 F (-2 C)	Floret sterility; spike trapped in boot; damage to lower stem; leaf discoloration; odor	Moderate to severe
Heading	30 F (-1 C)	Floret sterility; white awns or white spikes; damage to lower stem; leaf discoloration	Severe
Flowering	30 F (-1 C)	Floret sterility; white awns or white spikes; damage to lower stem; leaf discoloration	Severe
Milk	28 F (-2 C)	White awns or white spikes; damage to lower stems; leaf discoloration; shrunken, roughened, or discolored kernels	Moderate to severe
Dough	28 F (-2 C)	Shriveled, discolored kernels; poor germination	Slight to moderate

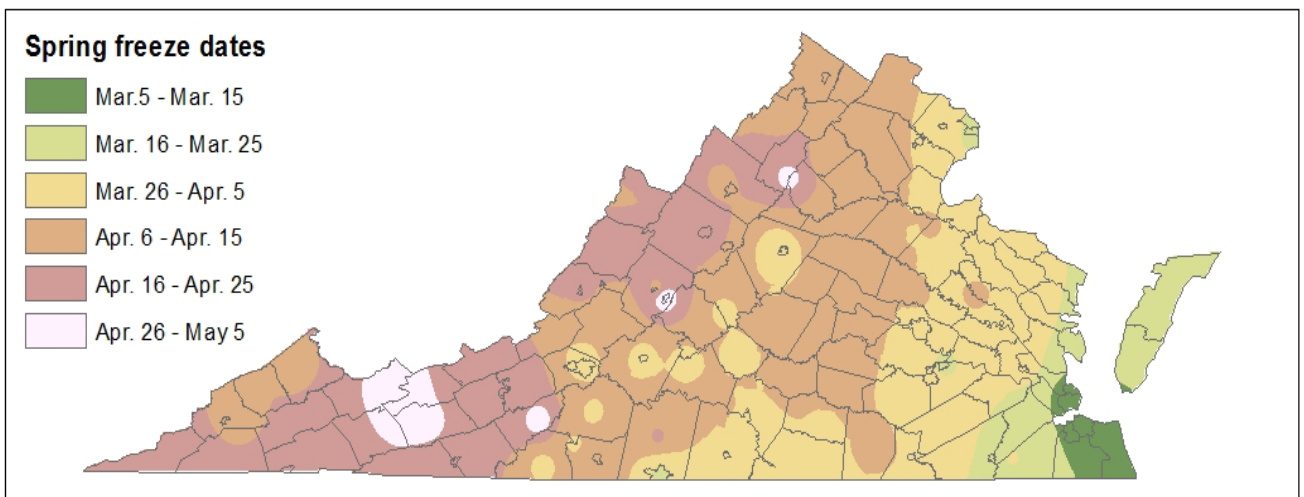
When estimating the extent of injury, it takes several days for the symptoms to manifest. In fact, it's best to wait 4-5 days until plants resume active growth before searching for injury symptoms. Of course, the type of damage that can be observed varies with time as well. For example, leaf tip scorching from cold weather (left) appears shortly after exposure while damage to the developing head (right) may take 5 days to accurately identify.



While it is impossible to say whether or not we will experience freeze damage in this year's small grain crop, we can look to historic temperature data for some insight. Figure 2 illustrates the 50% hard spring freeze date for various locations in Virginia, based on 30 years of historical temperatures collected from weather stations at these sites. The 50% hard freeze date should be interpreted to mean that this temperature (28°F) occurs on this date or before ½ of the time. Or said another way, ½ of the time we will not reach a low temperature of 28°F or lower after the date indicated.

Figure 2. Historic 50% hard freeze (28°F) date range for various locations in Virginia. Data from the University of Virginia Climatology Office.

<http://climate.virginia.edu/YourVAGrowingSeason.htm>





## Potential of Interseeding Cover Crops in Corn

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Cover crops can play many important roles in cropping systems that are well recognized: preventing soil erosion, enhancing soil carbon, reducing drought stress, suppressing weeds, minimizing nutrient runoff and providing supplemental forage. Despite these advantages, the establishment of cover crops is often limited by the late fall harvest of the corn or other crops in central and northern Pennsylvania, which leaves little growing season for a functional cover crop to become established. The cost of cover crop seeding can also be an issue with the expense of an added trip across the field and seed costs keeping some crop producers from using the practice.

One approach used in Europe and the Pacific Northwest is to interseed cover crops in standing corn at the V4 to V8 stage. This is actually a practice that was common 60 years ago and involved broadcasting ryegrass into corn at the last cultivation. Interseeding cover crops in no-till corn and soybean fields can be challenging. Broadcasting the seed late in the season is one option, but our results have been inconsistent. Cultivating early in the season and broadcasting seed has been another option, but is difficult in no-till, high residue fields. Both of these approaches involve a separate trip across the field, increasing the cost of cover crop establishment.

To address this issue we have developed a machine to interseed a cover crop of corn in no-till fields that can apply N fertilizer and a postemergent directed herbicide at the same time. This

approach has several advantages: multiple trips across the field can be combined, reducing the cost of cover crop seeding, good seed to soil contact achieved with the potential of reducing cover crop seeding rates, and the N and herbicide applications can be directed to maximize efficiency. The system is particularly well adapted where the season is too short to establish cover crops following harvest, where grazing a cover crop in the corn field is desired, or where the corn stover may be removed and a fall cover crop with good growth is desirable.



**Figure 1. Interseeding no-till corn while sidedressing and applying a postemergent herbicide with the new interseeder and applicator developed at Penn State.**

This machine utilizes strip or zone tillage technology between 30 inch corn rows to prepare a 16 inch wide seedbed between each row, broadcasts the cover crop seed across this area, and then incorporates the seed and packs the soil with a packing wheel assembly. At the same time, a postemergent herbicide is applied to the field for weed control and a liquid nitrogen fertilizer application is strategically directed 4 inch off the side of the corn row to maximize effectiveness beyond that associated just with the delayed timing. This method and timing of combining the three operations (Spraying, fertilizing and seeding a cover crop) and performing them in

a no-till field can reduce the cost and energy associated with multiple trips while facilitating these environmentally sound practices.

We have conducted two seasons of evaluation of the interseeder, with reasonably good success. In 2010, we established two trials on the Penn State research farm in corn following corn or soybeans, interseeding ryegrass, red clover, ryegrass/red clover or white clover. Establishment was good in both trials and all provided a good cover crop following grain harvest, where generally no cover crops are established in central Pennsylvania. We did not measure any impact on corn yields. In the following spring, we found that this system resulted in cover crops with unplanted bands along the old rows that allowed for corn planting in zones with little interference from the cover crop.

We followed up with the same trials in 2011 and seven on-farm demonstrations of the technology, in part with support from Capital Region RC & D and Kings Agriseeds. A severe mid-season drought occurred near the research farm and we did not achieve good establishment in those trials, but in the other seven demonstrations we achieved fair to excellent success. On some farms we documented that the ryegrass and a ryegrass/ crimson clover mixture produced up to a ton of forage in the fall, sequestering 50-60 pounds/acre of nitrogen and providing significant fall forage for livestock or wildlife.



**Figure 2. Planting into the inter-row zones in 2011 between cover crops established in corn harvested for grain the previous fall in Centre County.**

We plan to continue to evaluate the interseeding concept more broadly in 2012 and are excited about learning more about its potential in our region. For more information on the interseeders and our demonstrations check out our cover crops website: <http://extension.psu.edu/cover-crops>

## **An Integrated Approach to Weed Control in Pastures**

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Webster defines a weed as “a plant that is not valued where it is growing.” This broad definition could include almost any plant including common forage and crop species. In practical terms, weeds in pastures might be defined as any plant species that livestock do not readily consume. Although it is commonly assumed that weeds are low in nutritive value and unpalatable, work at Virginia Tech shows that this is not always the case (Table 1). In some instances, weeds are more digestible and can contain higher levels of crude than commonly used forage species (Abaye et al., 2009). In these cases, weeds can actually be an important part of grassland ecosystems. However, weeds that are not readily consumed can reduce pasture production and utilization. Weeds can actively compete with desirable forage species for space, light, water, and nutrients and in some cases reduce grazing in the vicinity of the weed.

### ***An Integrated Approach to Weed Control in Pastures***

In many cases, producers and agricultural professional’s base weed control programs for pastures solely on herbicides. While very effective herbicides are available for many weed species commonly found in pastures ([http://pubs.ext.vt.edu/456/456-016/Section\\_5\\_Weeds-4.pdf](http://pubs.ext.vt.edu/456/456-016/Section_5_Weeds-4.pdf)), programs based solely on herbicide use have little chance of effectively and persistently controlling problem weeds. In contrast, successful weed control programs will be based on an integrated approach that includes cultural practices that encourage a healthy and vigorous sod, such as choosing well adapted forage species, setting a sustainable stocking rate, proper grazing management, timely clipping, and fertilization and liming, along with the judicious use of herbicides when needed.

Table 1. In vitro dry matter digestibility, acid detergent fiber, and crude protein concentrations of alfalfa and various weed species. Adapted from *The Nutritive Value of Common Pasture Weeds and Their Relation to Livestock Nutrient Requirements*, VCE Pub. 418-150.

Plant Species	IVDMD <sup>a</sup>	ADF <sup>a</sup>	CP <sup>a</sup>
	-----%-----		
Alfalfa <sup>c</sup>	72	24	27
Redroot pigweed <sup>c</sup>	73	21	25
Common lambsquarters	68	22	25
Common ragweed	73	25	25
Pennsylvania smartweed	51	22	24
Yellow foxtail	69	30	20
Giant foxtail	62	33	18
Barnyardgrass	70	33	18

<sup>a</sup>In vitro dry matter digestibility, IVDMD, acid detergent fiber, ADF, and crude protein, CP.

<sup>b</sup>Adapted from Marten, G. C. and R. N. Andersen. 1975. Forage nutritive value and palatability of 12 common annual weeds. *Crop Science* 15:821-827.

<sup>c</sup>Alfalfa was seeded on May 14, 1971.

<sup>d</sup>Weed nursery was seeded naturally in late summer and autumn of 1970.

*Selecting well adapted forage species.* The first step in establishing a vigorous and healthy sod that will prevent weeds from germinating and becoming established is choosing well adapted forage species. Forages selected for grazing systems in Virginia should be adapted to the region and soils where they are being grown, tolerant of environmental stresses such as high temperatures and drought, persistent under close and frequent grazing, and have a seasonal distribution that matches animal requirements. Characteristics of forages commonly used in the mid-Atlantic region can be found in Table 2.

*Setting a sustainable stocking rate.* Setting the proper stocking rate, defined as animals per acre per year, is a primary determinant in grazing system success. A stocking rate set too high will result in the degradation of the entire grassland ecosystem. A stocking rate that is set too low will result in wasted forage and decreased profitability. In addition, stocking rate also impacts the amount of conserved forage that will be needed. A stocking rate set too high will result in less grazing and more hay feeding. The optimal stocking rate depends on many factors such as forage species, soil type, soil fertility level, and grazing management. In general, supplying each cow-calf unit with 2 to 3 acres of grazable pasture is a good place to begin. In most cases it is better to start with a lighter stocking rate that can be gradually increased as soil fertility increases and grazing management improves.

Table 2. Characteristics of forage species commonly used in Virginia's pastures. Adapted from *Southern Forages, Fourth Edition*.

Species	Life Cycle <sup>1</sup>	Productive Season	Seedling Vigor <sup>2</sup>	Tolerance to <sup>3</sup>			
				Acid Soil	Poor Drainage	Drought	Grazing
KY Bluegrass	PN	Spring & Fall	P	F	F	P	E
Orchardgrass	PN	Spring & Fall	G	F	F	F	G
Tall Fescue (EI) <sup>4</sup>	PN	Spring & Fall	G	G	G	G	E
Tall Fescue (EF) <sup>5</sup>	PN	Spring & Fall	F/G	G	G	F	G
Tall Fescue (NT) <sup>6</sup>	PN	Spring & Fall	G	G	G	G	E
Timothy	PN	Spring & Fall	G	F	F	F	F
Red Clover	PN	Spring & Fall	E	F	F	F	G
White Clover	PN	Spring & Fall	F	F	G	P	E
Bermudagrass	PN	Summer	F	E	P	E	E
Annual Ryegrass	AN	Late Fall & Spring	E	G	E	F	E
Rye	AN	Late Fall & Spring	E	E	F	F	G
Wheat	AN	Late Fall & Spring	E	P	P	F	G
Oats	AN	Late Fall & Spring	E	F	F	F	G
Pearl Millet	AN	Summer	E	E	P	E	F
Crabgrass	AN	Summer	G	G	P	G	F/G
Teff	AN	Summer	E	G	G	E	P

<sup>1</sup>PN=Perennial, AN=Annual

<sup>2/3</sup>E=Excellent, G=Good, F=Fair, P=Poor

<sup>4</sup>EI, infected with the toxic endophyte

<sup>5</sup>EF, not infected with an endophyte

<sup>6</sup>NT, infected with the non-toxic endophyte

*Grazing management.* Controlled grazing or rotational stocking is a management practice that allows producers to determine how closely pastures are grazed and how long they are rested between grazing events. Leaving residual leaf area and resting pastures between grazing events allows pastures to re-grow quicker and produce up to a third more forage in a given grazing season. Some forage species are better adapted to close and frequent grazing than other (Table 2). Grazing height and suggested rest periods for commonly used forages are shown in Table 3.

Table 3. Optimal heights for starting and stopping grazing and suggested rest periods.

Forage Species	Start Grazing	Stop Grazing	Rest Period <sup>a</sup>
	-----inches-----		days
Alfalfa	10-16	2-4	30-40
Bermudagrass	4-8	1-2	7-15
Tall Fescue	4-8	2-3	15-30
Ky. Bluegrass	8-10	1-3	7-15
Orchardgrass	8-12	3-6	15-30
Switchgrass	18-22	8-12	30-45
Pearl Millet	20-24	8-12	10-20

<sup>a</sup>Length of rest periods can vary greatly depending on environmental conditions and time of the year. When forage plants are actively growing, rest periods will be shorter. In contrast, when growing conditions are poor, rest periods will be longer.

*Clipping pastures.* Mowing pastures can help to control some weeds species, but the cost can be significant. It is estimate that clipping can cost between \$15 and 20/acre. If timed correctly, clipping can reduce weed seed production. However, if performed after weeds have produced viable seed, it can actually worsen weed problems by spreading seeds. Clipping is also less effective on plants with large underground root systems and plants that have low growth habits.

*Herbicide use.* There are a number of very effective herbicides that can be used to control difficult pasture weeds. A good example of a difficult to control weed is horsenettle or sand brier (Fig. 1). This weed is commonly found in pastures throughout the mid-Atlantic region and possesses an extensive underground root and rhizome system that enables it to spread vegetatively. In the case of horsenettle, herbicides may provide the only viable means of control. It is important to remember that commonly used pasture herbicides also injure or kill clover and other legumes. Since legumes are an important source of nitrogen in grassland ecosystems, increase forage quality and animal performance, and dilute the toxins contained in endophyte infected tall fescue, the use of broadleaf herbicides should be carefully considered. In some cases herbicides can be spot applied to smaller areas within pastures or applied with a wicking or wiping device to taller growing weeds and not clover.



Figure 1. Horsenettle.

Figure 2. Wiping tall growing weeds using a rotating weed wiper.



## ***Soil Fertility and Weed Control in Pastures***

Soil fertility is a key component of an integrated weed control program for grassland ecosystems. Maintaining soil nutrients and pH at proper levels promotes the growth and maintenance of a healthy and vigorous sod that excludes weeds. The remainder of this paper outlines cost-effective strategies that can help cattle producers better manage nutrient flows in grazing systems, with the ultimate objective minimizing the use of commercial fertilizers and pesticides while optimizing pasture production.

### ***Trends in Fertilizer Cost***

The cost of nitrogen (N), phosphorus (P), and potassium (K) fertilizer has more than doubled for the period of 2002 to 2011 (ERS, 2011) (Fig. 3). The cost N, P, and K remained fairly low until the mid-2000s when prices started to climb to historic highs. In late fall 2011, urea, triple superphosphate, and potassium chloride are retailing for \$675, 660, and 685/ton, respectively (D. Brankley, personal communication, 2011). This represents an increase of more than 237% for N, 184% for P and 315% for K since 2000. In order to effectively manage soil fertility costs in ruminant livestock operations, it is imperative that cattlemen strengthen and effectively manage nutrient cycles on their farms.

### **Forage Fertilization Principles**

*Soil testing provides a starting point to work from.* We can not look at a soil and tell how much lime and fertilizer is needed. Applying fertilizer and lime without a soil test is simply guessing and could lead to an over or under application of nutrients. An over application of fertilizer is bad for your wallet and the environment. An under application of nutrients could lead to lower production and poor stand persistence. Regular soil testing needs to be a part of your grazing system. In most cases pastures should be soil tested every two to three years to help you track your progress.

*Apply lime according to soil test results.* Soil acidity is a major factor limiting pasture growth in Virginia. Acidic conditions reduce nutrient availability, limit root growth, and decrease nitrogen fixation of legumes. Lime applications reduce both soil acidity and the availability of toxic metals such as aluminum and manganese that limit plant growth. Lime also supplies calcium as well as Mg if a dolomitic source is used. When needed, applying lime to pastures provides the most return for dollar spent.

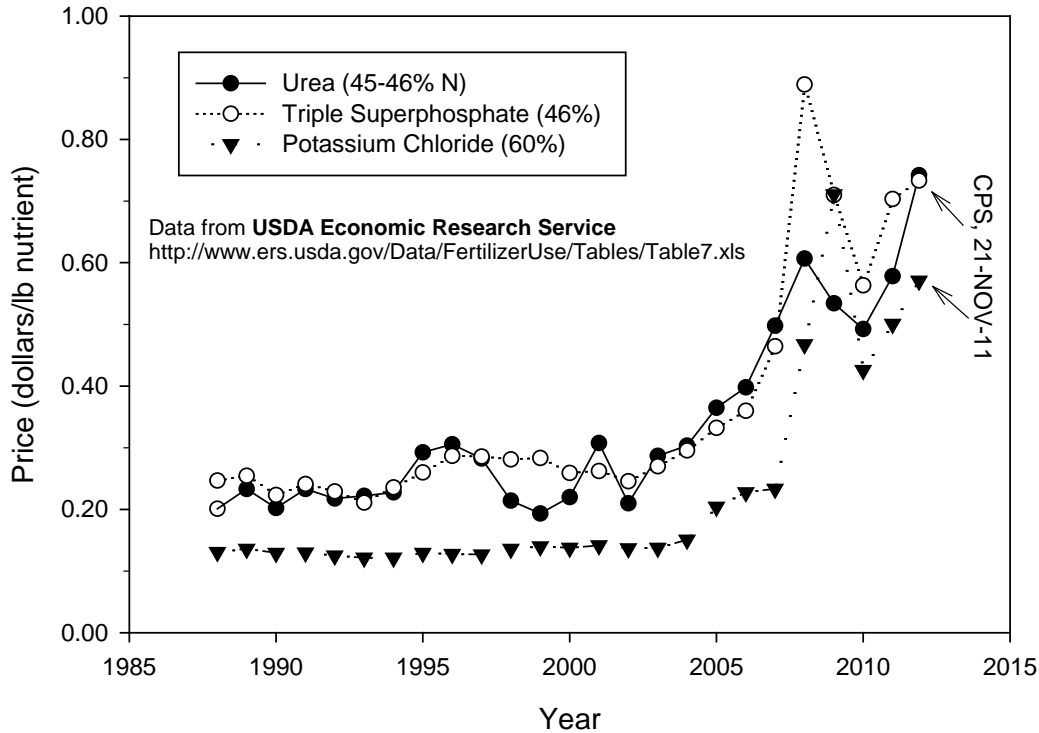


Figure 3. Price trends for urea, triple superphosphate, and potassium chloride fertilizers (ERS, 2008).

*Legumes fix nitrogen in the air to a plant available form.* The importance of legumes in grasslands has long been recognized. They bring N into grassland ecosystems via symbiotic nitrogen fixation, improve forage quality and animal performance, and dilute the toxic effects of the endophyte found in tall fescue. It is estimated that commonly used pasture legumes will fix between 50 and 250 lb nitrogen per acre per year (Table 4). This nitrogen is valued between \$25 and 250 per acre per year.

Table 4. The amount and value fixed by commonly used pasture legumes.

Legume	N Fixed		Value of Fixed N (\$/A/year)		
	lb/A/yr	N cost=\$0.50/lb	N cost=\$0.75/lb	N cost=\$1.00/lb	
Alfalfa	150-250	75-125	115-190	150-250	
Red Clover	75-200	35-100	55-150	75-200	
Ladino Clover	75-150	35-75	55-115	75-150	
Annual Lespedeza	50-150	25-75	35-115	50-150	

Adapted from *Southern Forages, Fourth Edition*.

*Legumes share nitrogen with grass indirectly.* Nitrogen is transferred to grass grown in association with legumes through the ingestion of legumes and subsequent deposition of dung and urine by grazing animals, death and decomposition of above and below ground plant parts including roots, shoots, and nodules, and to a lesser extent direct legume to grass transfer. The sharing of nitrogen is limited during the first growing season after establishment.



*Grazing animals remove only small quantities of nutrients.* Over 90% of the nutrients consumed by livestock are recycled in the form of dung and urine. Nutrients are removed from grazing systems as animal product and amounts will vary with livestock class (Table 5). One cow-calf pair will remove approximately 7 lb phosphate and >1 lb potash per year. If we are stocked at 3 acres per cow-calf unit then our nutrient removal would be >3 lb phosphate and >1 lb potash per acre per year.

Table 5. Nutrient imports (+) and exports (-) for different livestock classes and hay (Adapted from the Missouri Grazing Manual).

Livestock Class	Nitrogen	Phosphorus	Potassium
	lb N	lb P <sub>2</sub> O <sub>5</sub>	lb K <sub>2</sub> O
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 where 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 Forage Systems Research Center found that increasing the number of subdivisions from 3 to 24 for a given pasture area increased the number of manure piles in the main grazing area by 2 to 4 times (Fig. 4). From this research it was determined 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.

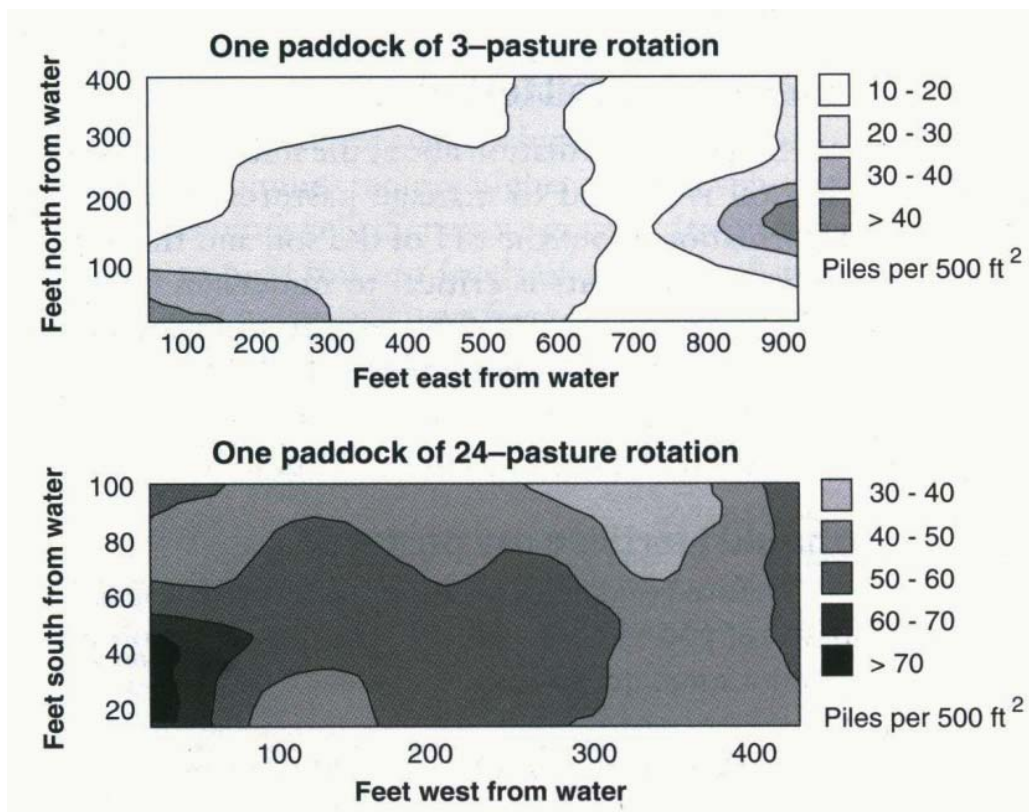


Figure 4. Distribution of manure piles as impacted by the number of subdivisions for a given pastures area (Adapted from the Missouri Grazing Manual, 1999).

*Hay and silage remove large quantities of nutrients.* In contrast to grazing, making hay or silage removes large quantities of nutrients. These nutrients must be replaced to maintain soil fertility, and stand health and productivity. Each ton of hay that is removed from a field takes with it approximately 15 lb of phosphate and 50 lb potash. In a good year a tall fescue-clover mix may yield 4 tons per acre and remove 60 lb phosphate and 200 lb of potash (Table 6).

Table 6. Approximate nutrient removal in pounds per acre for several commonly grown hay types at specified yield levels.

Nutrient	Species and Estimated Yield (tons/acre)			
	Alfalfa @ 5	Tall Fescue @ 3.5	Orchardgrass @ 3	Sorghum-Sudan @ 4
	pounds of given nutrient removed per acre			
Nitrogen (N)	280	135	150	160
Phosphate (P <sub>2</sub> O <sub>5</sub> )	75	65	50	60
Potash (K <sub>2</sub> O)	300	185	185	288
Calcium (Ca)	155	30	30	35
Magnesium (Mg)	22	12	15	20
Sulfur (S)	25	14	13	14

Data from Ball et al., 2007, Brown, 1996, Robinson, 1996, and NRCS Animal Waste Management, NEH-651, 1999.

*Forage must be utilized for fertilization to be profitable.* Applying fertilizer to pastures is only profitable if the forage is utilized. Rotation interval can greatly impact forage utilization. For example in a large continuously grazed pasture less than 30% of the forage may be consumed compared with over 60% for a rotationally stocked pasture. In most cases, increasing stocking density will increase forage utilization.

### ***Low Cost Strategies for Building and Maintaining Soil Fertility***

*Rotationally stock your pastures.* 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. In addition, rotational stocking results in a more uniform distribution of nutrients over the pasture area.

*Actively manage for legumes in your pastures.* Legumes are a key component of profitable grazing systems and should make up approximately 25 to 30% of the sward. Pastures should be limed and fertilized according to soil samples. This will create an environment that will enhance legume growth. Once fertility has been adjusted, pastures should be overseeded with improved legumes in late winter. In the face of high nitrogen prices, overseeding smaller quantities of legumes on annual or biannual basis may be a good idea. A good general legume mixture for overseeding pastures in most of Virginia is 4-6 lb red clover, 1-2 lb of ladino or grazing type white clover, and 10 lb of annual lespedeza per acre. At current seed prices this mixture would cost around \$20 to 30 per acre.

*Buy and feed hay.* Each ton of hay contains N, P, and K along with organic matter (Table 3). At today's fertilizer prices these nutrients are worth more than \$75 per ton of hay. Buying hay and feeding it on your worst paddocks can be a very cost effective way to build fertility in your grazing system. In order for this strategy to work, feeding areas should be moved around the paddock to more uniformly distribute nutrients.

*Feed hay produced within your grazing system to redistribute nutrients.* 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. Overtime nutrients can be transferred from areas of high concentration to areas of low concentration.

*Use organic fertilizer sources.* In most cases organic fertilizer sources are applied for their N value, but they also contain significant amounts of P and in some cases K and even lime. It is often assumed that these materials provide an economical source of N, however in many cases this nitrogen is fairly expensive. For example if broiler litter cost \$35 per ton spread and each ton contains 40 lb of plant available N (PAN), then one lb of N that can be used by the plant costs \$0.88. This is similar to commercial fertilizer. However, if the other nutrients are needed, then the cost of the organic fertilizer sources become much lower. In Virginia, three of the most commonly used organic N sources are broiler litter, biosolids, and pelleted biosolids. A brief description of each can be found below:

- *Broiler litter* is commonly used on hay and pastureland in poultry producing areas of Virginia. The nutrients contained in broiler litter depends on the source, but will usually be in the range of 35 lb PAN, 60 lb P<sub>2</sub>O<sub>5</sub>, and 30 lb K<sub>2</sub>O per ton broiler litter. Cost share programs may be available to transport broiler litter out of poultry producing areas. Contact you local extension office to find out more about these programs.
- *Biosolids* are currently applied to agricultural land at no cost to the farmer. This makes them the most economical organic fertilizer source. Biosolids contain significant levels of N and P, but are very low in K. In some cases biosolids are stabilized with lime and these sources are especially beneficial for pastures with a low pH. The land application of biosolids in Virginia is regulated by the Department of Environmental Quality and requires a permit.
- *Pelleted biosolids* is a form of biosolids that has been dried and pelleted. They are considered a Class A Biosolid product and no permit is required for land application. This product is handled and spread like a granular fertilizer. Approximately 60% of the total N is available the first growing season and one ton of this product will contain approximately 60 lb PAN. Like conventional biosolids, this pelleted product is high in P and low in K.

*Use alternative legumes that are better adapted to low soil fertility.* Overall, our approach to soil fertility has been to modify the soil to meet the needs of the desired forage species. However, in some cases this may not be feasible, especially in the cases of very poor soils, high fertilizer prices, and rented land. An alternative approach would be to match the forage species to the soil. This approach is not new. Before the advent of readily available sources of fertilizer and lime, we grew forages that were better adapted to lower fertility conditions. These forages were not as productive and were quickly replaced with improved grasses and legumes as cheap fertilizer and lime became widely available. Two forage legumes that you may want to consider for low fertility areas are annual lespedeza (*Kummerowia striata* and stipulacea) and sericea lespedeza (*Lepedeza cuneata*). A brief description of each can be found below:

- *Annual lespedeza* is a drought tolerant summer annual legume that is very well adapted to acidic soils that are low in fertility. Since it is a true annual, it needs to be planted each year or allowed to reseed itself (not always dependable). It provides relatively good quality summer forage and yields in the range of 1.5 to 2 ton/acre.
- *Sericea lespedeza* is a drought tolerant warm-season perennial legume that is very well adapted to acidic soils that are low in fertility. This legume is widely used in the reclamation of drastically disturbed lands such as road banks and mined areas. It has poor seedling vigor which can make establishment difficult, but once established it can aggressively compete with most other forages, especially under low fertility conditions. Improved varieties have lower tannins, finer stems, and improved grazing tolerance. This plant is sometimes referred to as “poor man’s alfalfa” and can be expected to yield between 2.5 and 4 tons/acre.

### ***Weed Control in Grazing Systems: Putting the Pieces Together***

To successfully manage weeds in pastures an integrated approach is needed. This approach will involve managing the soil, plant, and animal in a manner that promotes a healthy and

vigorous sod that excludes weeds. In some cases, the judicious use of herbicides may be needed to manage difficult to control weeds. A key component of this integrated approach is building and maintaining soil fertility in grassland ecosystems. 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. In today's world where everything is instantaneous, it is important to remember that building stronger nutrient cycles in pastures takes time. To bring about measurable change in a grazing system it usually takes three to five grazing seasons. So set your goals, make your changes, and remember good things come to those who are patient.

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# **Evaluating the Effectiveness of Vertical Tillage in Managing Slug Populations in No-till Corn Systems—First Year, 2011**

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## ***Introduction***

This study was conducted to identify and document the conditions associated with vertical tillage that help reduce slug populations and/or the damage caused by slugs in no-till corn systems. In addition, we wanted to document the impact of vertical tillage on overall soil health and identify potential water quality benefits of using vertical tillage in no-till corn systems. This is a start toward developing a process to document the impact of vertical tillage.

Management of slugs in no-till corn systems continues to present major challenges to producers and threatens the viability of no-till production systems. Since no-till has been identified as important for maintaining the quality of the watersheds in the region, the identification of strategies that maintain a viable agriculture as well as healthy environment are needed. Vertical tillage was identified by producers and NRCS at the local level as one way to potentially address both of these needs. This demonstration has begun the collection of information to document the effectiveness of vertical tillage as a slug management tool and assess its impact on soil health.

## ***Summary of Procedures***

Demonstration plots were established by three growers in a total of four fields comparing no-till and vertical till. Each of the demonstration plots were arranged in paired plots of vertical-tilled and no-tilled strips. Six paired strips were established at location one and three paired strips at locations 2, 3 and 4. An AerWay strip was also established at location 2. Prior to performing the tillage treatments, each demonstration plot was sampled using shingle traps to

establish a baseline for slug densities. Once the tillage treatments were established, treatment effects on soil health were observed including soil compaction, percent cover, bulk density and infiltration rate. Immediately after planting, shingle traps were placed in each of the demonstration plots to monitor slug densities. Once the plants emerged, stand counts were taken and the plants were evaluated for slug feeding damage. Harvest data was collected in two of the four locations.

### *Pre-Tillage Slug Densities*

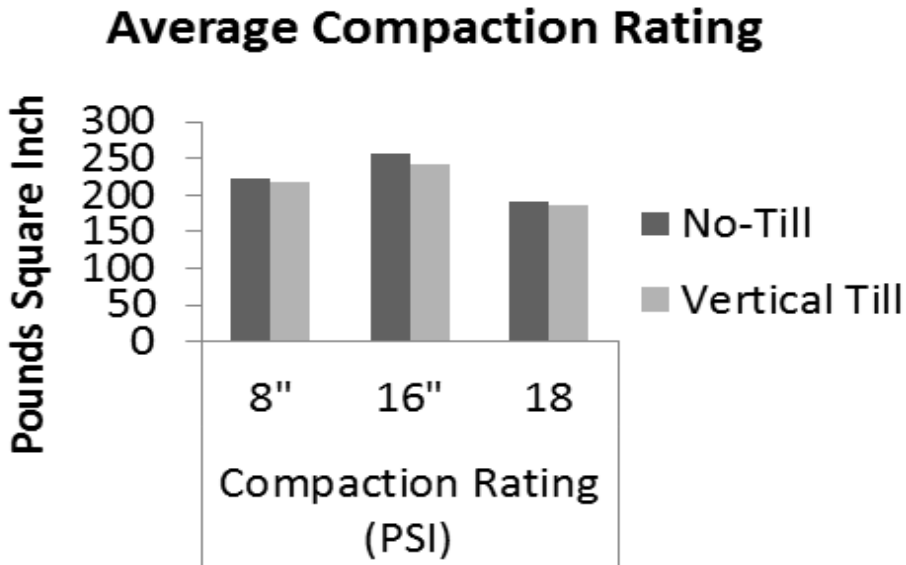
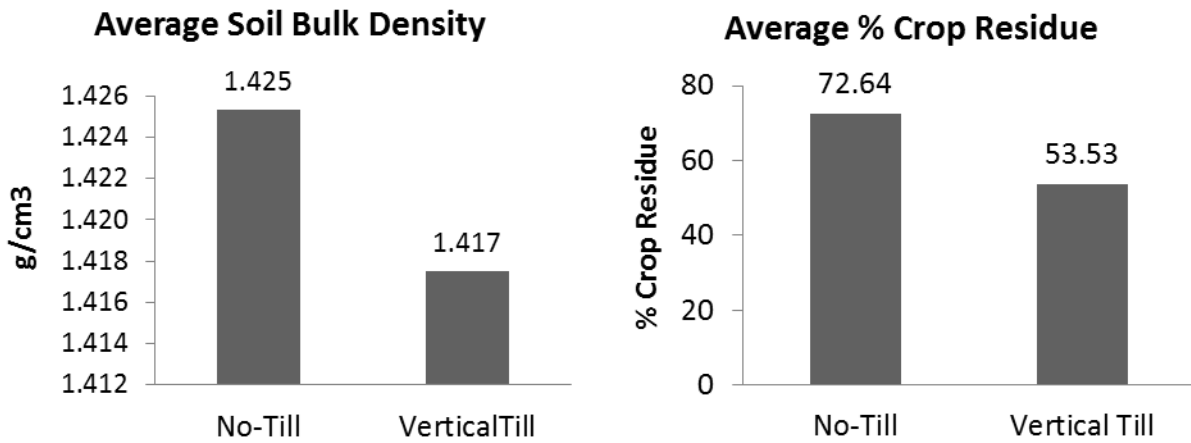
In mid-March, five shingle traps of 1ft<sup>2</sup> size were randomly placed in each field to establish a baseline for slug population densities. The traps were checked on a weekly basis for adult and juvenile slugs until mid-April. The total number of eggs observed under the shingle traps was also recorded (Table 1).

### *Shingle Trap Survey Results*

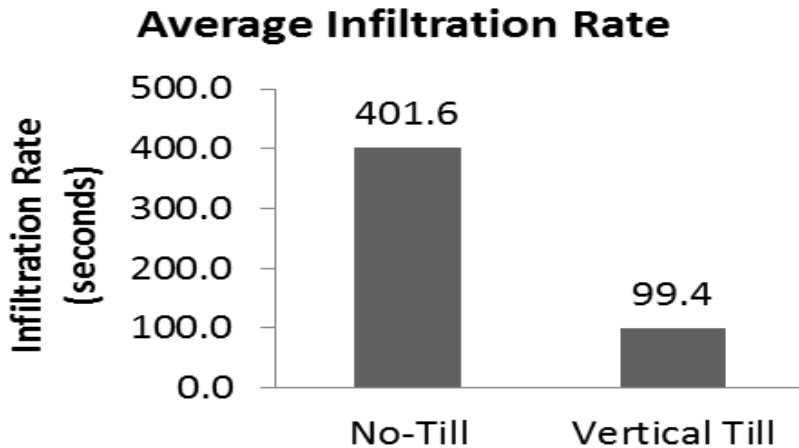
Table 1. Total number of slugs/eggs per 5 shingle traps.					
Sample Date	Marsh		Grey Garden		Eggs
	Adult	Juvenile	Adult	Juvenile	
<b>Location 1</b>					
21-Mar	0	0	1	0	3
29-Mar	1	0	2	0	3
4-Apr	1	0	2	0	3
11-Apr	0	0	2	0	0
20-Apr	0	0	0	0	14
<b>Location 2</b>					
21-Mar	1	0	3	0	6
29-Mar	0	0	2	0	2
4-Apr	2	0	0	0	5
<b>Location 3</b>					
21-Mar	0	1	0	0	12
29-Mar	2	0	2	0	2
4-Apr	1	0	2	0	28
11-Apr	0	0	7	7	11
20-Apr	0	2	0	6	7
<b>Location 4</b>					
21-Mar	0	0	0	0	0
29-Mar	1	0	0	0	5
4-Apr	1	0	2	0	11
11-Apr	0	0	0	7	11
20-Apr	0	2	0	6	7

**Pre-Planting Soil Health Measurements**

Soil compaction was measured using a penetrometer. Readings were taken in three random locations in each paired strip. Readings were recorded at 6", 12" and 18" in pounds per square inch (psi). The percent of crop residue was estimated in three random locations in each paired strip using the line transect methods. Water infiltration rates were estimated in two random locations in each strip by removing vegetation and crop residue from the soil surface and driving a cylinder 6" in diameter into the soil approximately 4" deep. The soil surface within the cylinder was gently firmed and 1000 ml of distilled water was poured into the ring. The amount of time required for the water to infiltrate into the soil was recorded in seconds. Soil bulk density was also measured in each of the demonstration plots using the cylindrical core method and reported as grams/centimeter<sup>3</sup>.







***Discussion of Soil Health Measurements***

The average compaction rating represented in pounds square inch (psi) at each of the three depths, 6”, 12”, and 18” indicates that the no-tilled plots were slightly more compacted compared to the vertical tilled plots. However, subsoil compaction was found to be severe in each of the demonstration plots regardless of the tillage treatment.

Vertical tillage reduced the percent of crop residue on average by 19 percent. However, the range of reduction was from six percent to twenty nine percent and the average cover even on the vertical tillage plots was greater than 50 percent.

Vertical tillage also had a significant impact on infiltration rates compared to no-tilling. The average rate of infiltration for the no-till demonstration plots was 402 seconds and the average rate of infiltration for the turbo-tilled plots was 99 seconds. Bulk density is a factor of the mineral composition of the soil and the degree of compaction. A compacted soil has fewer pores and therefore, a higher bulk density. On average, the vertical tilled plots had a slightly lower bulk density at 1.417g/cm<sup>3</sup> compared to the no-tilled plots at 1.425 g/cm<sup>3</sup>.

The agronomic and soil health benefits observed in the vertical till treatments compared to the no-till treatments including an increase in water infiltration rate and a slight reduction in bulk density are based on one year’s worth of data. These practices need to be evaluated over multiple years and multiple locations to determine the long term effects of these treatments on soil health and to identify any draw backs that may develop from continued use of vertical tillage.

***Post-Planting Data***

Once the demonstration plots had been planted, three shingle traps were placed in each paired strip to determine slug population densities and tillage treatment effects (Table 2). Stand counts were taken by counting the total number of corn plants in 17’5” of linear row in five random locations per plot. The percent of damage plants was determined by counting the number of plants out of ten consecutive plants exhibiting leaf feeding damage in five random locations per plot. A corn plant injury rating was assigned for each plant based on a scale from

0-4 and averaged for each location. *Corn Plant Injury Rating Scale*: 0 = no damage, 1 = only 1 leaf showing damage (less than 25% defoliation), 2 = all leaves showing moderate damage (25-30% defoliation), 3 = all leaves consumed except one remaining intact (greater than 75% defoliation), 4 = seedling completely cut off at the ground level.

### *Discussion of Post Planting Data*

The tillage treatments did not appear to have any significant affect on stand counts in any of the demonstration plots (Table 2). There does appear to be a trend suggesting that there is a

Table 2. Comparison of slug numbers per shingle, injury ratings, and percent damaged plants for multiple sampling dates at four locations in Delaware in 2011.					
Sample Date	Tillage	Stand 1/1000/Acre	Injury Rating	% Damaged Plants	#Slugs/Shingle
Location 1					
May 6	NT	28.33	--	0.93	0.23
	VT	28.00	--	0.80	0.03
May 16	NT	--	0.70	1.57	0.20
	VT	--	0.57	1.77	0.03
May 24	NT	--	0.33	0.70	1.80
	VT	--	0.27	0.60	1.23
Location 2					
May 18	NT	25.53	0.53	1.07	0.89
	VT	25.00	0.33	0.47	0.89
	Aerway	24.8	0.8	0.8	--
June 3	NT	--	0.77	1.8	0.56
	VT	--	0.3	0.53	0
	Aerway	--	0.40	0.60	--
Location 3					
May 9	NT	26.20	1.50	6.73	1.78
	VT	24.65	1.43	4.47	0.22
May 16	NT	27.53	1.33	4.07	1.22
	VT	28.27	0.67	1.73	0.22
May 24	NT	--	0.73	3.40	0.00
	VT	--	1.10	4.67	0.00
June 3	NT	--	0.07	0.07	0.00
	VT	--	0.07	0.27	0.00
Location 4					
May 9	NT	--	--	--	1.33
	VT	--	--	--	0.44
May 16	NT	26.53	1.93	7.60	0.78
	VT	26.93	1.67	6.33	0.00
May 24	NT	--	1.54	7.17	0.39
	VT	--	1.37	6.07	0.22
June 3	NT	--	0.67	2.42	0.39
	VT	--	0.47	1.13	0.00

slight increase in the percentage of damaged plants and the severity of damage in the no-tilled plots compared to the vertical tilled plots. A slight increase in the number of slugs per shingle trap in the no-tilled plots compared to the vertical tilled plots was also noted. This suggests that vertical tillage may be an effective cultural control strategy when managing slugs in corn. More information is needed to document when benefits are likely to occur.

The agronomic and soil health benefits seen in the vertical till treatments compared to the no-tilling treatments including an increase in water infiltration rate and a slight reduction in bulk density are based only on one year's worth of data. These practices need to be evaluated over multiple years to determine the long term effects of these treatments on soil health and to identify any draw backs that may develop from continued use such as a compaction layer just beneath the soil surface.

### ***Beneficial Insect Sampling***

Beneficial arthropods can play an important role in preventing crop pest populations from reaching levels high enough to cause significant economic damage. However, little is known about the beneficial arthropod complex found within crop fields that prey on slugs. In an attempt to identifying the abundance of these beneficial arthropods within crop fields and to determine the effects minimum tillage practices may have on them, a pitfall trapping survey was conducted in locations 2, 3, and 4.

Of the demonstration plots surveyed, three trapping locations were established in each treatment. Traps were constructed of 18 oz plastic beverage cups buried within the soil profile so that the lip of the cup was even with the soil surface. A roof, approximately 1 ft<sup>2</sup>, was placed over the traps at an elevation of 1-2 inches above the soil surface to prevent contamination from rain water. Pitfall traps were placed in the survey fields in mid-April and checked weekly until early-June. The arthropods collected were then combined for each treatment, identified, and tallied for each sampling date (Table 3).

Table 3. The average number of arthropods per tillage treatment.				
Date	Tillage ID	Araneae	Carabidae	Opilione
<b>Location 2</b>				
24-May	NT	5.00	1.67	3.00
	VT	1.67	2.67	3.67
3-Jun	NT	9.67	10.33	4.00
	VT	7.33	5.00	3.33
<b>Location 3</b>				
3-June	NT	5.67	22.00	0.00
	VT	4.67	25.33	0.00
<b>Location 4</b>				
3-June	NT	3.67	2.00	0.00
	VT	12.33	3.00	0.00

Based on the limited number of sample dates, it does not appear that the tillage treatments had any significant effect on the beneficial arthropod populations in any of the demonstration plots (Table 3). Additional research, including a more extensive sampling period is needed to determine the potential long term effects of tillage on beneficial arthropods.

Table 4. Yield data for no-till and vertical till treatments at two locations averaged over treatment strips.		
<b>Location #</b>	<b>No-Till</b>	<b>Vertical Till</b>
1	102.77	104.05
3	97.13	94.32

Yield data were very limited and were not analyzed statistically (Table 4). Observed differences were very minor.

Current plans call for fewer locations in 2012 but with more intensive soil health evaluations.

# **Production and Culling Effects of Mastitis: Cost Considerations in Clinical Mastitis**

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## ***Introduction***

Mastitis is one of the most costly production problems in the modern dairy industry. Producers are obligated therefore to make cost effective, economic decisions that are often based upon intuition and an incomplete set of facts on mastitis costs. These decisions effect culling pressure, treatment course and preventive measures designed to deal with mastitis problems.

Knowledge of the effect and costs of clinical as well as subclinical intra mammary infection on immediate as well as long term milk yields is a pivotal component in the decision process. On average, clinical cases of mastitis have been estimated to cost producers approximately 800-1000 pounds (lbs) of production per lactation. Similarly, production losses for subclinical intramammary infection have been estimated at approximately 1-1.5 lbs milk per 2 fold increase in somatic cell count greater than 50,000 cells/ml (Seegers et al., 2003). The exact cost varies slightly with lactation number, stage of lactation and relative genetic merit for milk yield. Economic costs vary with milk price, replacement costs and genetic merit.

## ***Estimated Costs of Modeled for Clinical Mastitis***

A model designed to estimate costs of clinical mastitis showed costs amounted to \$71 per cow and year. Losses from reduced yields in the lactation in which the clinical bout of mastitis occurred were \$33 and losses in the next successive lactation were \$15 per cow across the herd.

Losses from mortality across were \$5 per cow and year and losses due to treatment costs were \$18 per and year. Average cost per clinical case was estimated at \$179 and consisted of \$115 from milk lost, \$14 due to mortality loss, and \$50 due to treatment costs (Bar et al., 2007, Bar et al., 2009).

Costs of clinical mastitis were estimated to be highest in cows of high genetic merit for milk production and lowest for cows with lower than average production. In the model, higher milk prices predictably increased the cost of clinical mastitis due to increased losses from lowered milk yield. Thus, higher prices for milk resulted in higher culling pressures against cows with clinical mastitis.

Lower heifer replacement costs had little effect on the cost of a clinical case of mastitis but increased culling pressures against clinical mastitis. As a result, lower replacement costs reduced the incidence of clinical mastitis which in the final analysis improved profitability across the herd.

Higher pregnancy rate tended to lower culling pressures on cows with clinical mastitis because pregnancy will favor treatment. Pregnancy could therefore be expected to increase the incidence of clinical mastitis in the herd. However, the effect of pregnancy on culling against cows with clinical mastitis was dependent upon level of milk production by the cow, DIM when clinical mastitis developed and the appearance of clinical mastitis in a previous lactation. Producers should be aware; any event that increased culling pressure against clinical mastitis drove down the incidence of clinical mastitis across the herd.

### ***Clinical Mastitis Characteristics***

The distribution of organisms causing clinical mastitis within a herd will of course depend upon management practices. Never the less, the distribution has been reported as follows: *Escherichia coli* is the most common isolate (3% in first parity, 5.8% of isolates in second parity) followed by streptococcus species (2.8% in first parity, 5.2% in second parity) followed by *Staphylococcus* (1.3% in first parity and 2.8% in second parity) and *Klebsiella* (0.8% in first parity and 3.8% in second parity).

The incidence of clinical mastitis increases with parity and age with nearly a doubling of incidence between 1<sup>st</sup> and 2<sup>nd</sup> lactation animals across all types of bacterial agents. Although clinical mastitis cases appear early post partum, most cases of clinical mastitis are recorded in the mid-lactation at or around peak lactation. The tendency is for clinical mastitis to occur earlier in lactation of first lactation cows and later in second lactation animals (Bar et al, 2008, 2007,

### ***Production Losses Associated with Clinical Mastitis***

In general, losses due to clinical mastitis cases are 2.2 – 5.5 lbs milk per day in the first 2 weeks after diagnosis and with a total loss estimated at 240-1,240 lbs per lactation. Losses in first lactation animals are 11-15 lbs per day in the first 2 weeks post diagnosis and 1,500 lbs over the entire lactation. In older lactation animals, milk yields are reduced 13-19 lbs per day during the first 2 weeks post diagnosis and then 1,200 lbs over the entire lactation.

For most mastitis pathogens, milk yields do not drop much prior to the time of diagnosis with the exception of *Staphylococcus aureus* and other *Staphylococcus* sp. intramammary infections. *Streptococcus* spp. trigger losses in milk yields that begin at the time of diagnosis and may reach 5 lbs milk per day during the first week post diagnosis. Afterwards, milk yields return to those of uninfected herd mates throughout the rest of the lactation. Accordingly, intramammary infection with *Streptococcus* spp. has little sustained effect on production much beyond the first week after diagnosis.

Intramammary infection with *Staphylococcus aureus* triggers reductions in milk yields 2 weeks prior to diagnosis that climb to 18 lbs per day for 2 weeks post diagnosis. Reduced milk yields extend past 8-10 weeks after diagnosis where daily losses remain as high as 4 lb per day. *Staphylococcus aureus* intramammary infection, therefore, is a serious detriment to the productivity of first parity animals.

Intramammary infection with the minor *Staphylococcus* spp. pathogens results in variable and less severe losses in yield that begin 2 weeks prior to diagnosis and extend past 10 weeks after diagnosis. Reductions in yield are variable but can peak at 7 lbs per day in the first week and then persist at 6.0 lbs per day for 10 weeks after diagnosis.

Intramammary infection with reduction in milk yields do not occur prior to intramammary infection with *Escherichia coli* but after diagnosis yield precipitously drop to as low as 15 lbs per day within a week after diagnosis. Reductions in yield of 5 lbs per day may extend past 10 weeks post diagnosis and remain throughout the lactation.

Intramammary infections with *Klebsiella* spp. are often clinically quite severe and therefore generate profound losses in milk yields post diagnosis. Like intramammary infection with *Escherichia coli*, *Klebsiella* spp. trigger reductions in milk yield only at the time of diagnosis. Milk yields are reduced 15 lb per day within the first week of diagnosis and are sustained for 10 weeks and beyond in the first lactation.

Intramammary infections producing clinical mastitis in 2<sup>nd</sup> lactation animals caused similar types of losses to those seen in first lactation animals. Moreover, higher producing cows in lactation 2 appeared to be more susceptible to intramammary infection than their lower producing herd mates. Intramammary infection appeared most commonly around the time of peak lactation. Infection with *Streptococcus* spp. experienced 3 lb per day reduction in milk yield 1 week prior to diagnosis that increased to 11 lb per day a week after diagnosis. Loss in milk yields persisted through and remained close to 4 lb per day 10 weeks after diagnosis.

Intramammary infection with the major mastitis organism *Staphylococcus aureus* resulted in milk yield reductions paralleling those associated with *Streptococcus* spp. Intramammary infection in the 1<sup>st</sup> lactation animals tended to appear early in lactation probably because heifers are commonly infected prior to parturition and then experience a higher incidence of intramammary infection in the early post partum period. Reduction in productivity appeared 1 week prior to diagnosis and peaked at 12 lb per day 1 week post diagnosis. Losses in milk yield persisted through the 10 week period of observation after diagnosis remaining at 3.4 lb per day.

Intramammary infection with the minor mastitis pathogens, *Staphylococcus non-aureus* generally occurred in the heavier lactating animals in lactation 2. Infections produced a small loss in milk yield compared to the major mastitis pathogens. The loss in production however, ratcheted production yields in this group of heavy lactating animals down only enough to render their production yields equal to their less productive herd mates. Production losses therefore did not cause these animals to stand out from their herd mates in overall daily yields.

*Escherichia coli* intramammary infection also occurred more often in the heavier lactating animals in peak lactation for 2<sup>nd</sup> lactation animals. No loss in production occurred prior to diagnosis. Milk yields precipitously declined to 29 lbs per day during the first week after diagnosis, and were sustained at 16 lb per day less milk over the following weeks. Even as late as 10 weeks post diagnosis, milk yields remained reduced by 3 lbs per day.

Intramammary infection with *Klebsiella* spp. also appeared at peak lactation for 2<sup>nd</sup> lactation animals. No loss in milk yields occurred prior to diagnosis but thereafter milk yields dropped 22 lb per day over the first 7 days post diagnosis. Losses gradually diminished over the following 10 week post diagnosis but remained reduced 6 lbs per day as late as 10 weeks post diagnosis.

*Arcanobacterium pyogenes* infection in 2<sup>nd</sup> lactation animals caused serious reductions in milk yields that were never recovered. Losses began within 3 weeks prior to diagnosis, rose to 25 lbs per day at the time of diagnosis and peaked at 31 lbs per day within a week post diagnosis. Losses were sustained throughout 10 weeks after diagnosis and remained at 13 lbs per day 10 weeks after diagnosis.

In general cows developing clinical mastitis tend to be in the group of heavier lactating animals. This is true for both 1<sup>st</sup> and 2<sup>nd</sup> lactation animals. As a result, the impact of intramammary infection can be profound. Contagious organisms such as *Staphylococcus aureus* or the *Streptococcus* spp. most likely reduce milk yields prior to clinical signs of mastitis and diagnosis as they establish a subclinical intramammary infection. Earlier detection of these animals therefore would reduce production losses while lowering the transmission risk associated with these organisms. Reductions in milk yield tend to be greater with intramammary infections with coliforms, *Staphylococcus aureus* and *Arcanobacterium pyogenes*. *Arcanobacterium pyogenes*, though rarer than the others produces devastating and unrecoverable losses in milk yields. This organism creates widespread intramammary tissue destruction, abscessation and chronic, infections that resist therapy.

The incidence of recurrent episodes of clinical mastitis in a single lactation is twice as high for 2<sup>nd</sup> and greater lactation cows compared to 1<sup>st</sup> lactation animals (Bar et al., 2007, Schukken et al., 2009). Interestingly, the pathogens most commonly associated with recurrent clinical cases of mastitis were the environmental organisms, *Escherichia coli*, *Streptococcus* spp. and *Klebsiella* spp. and not the contagious bacteria like *Staphylococcus aureus*. The same organism occurred 40-50 percent of the time in repeated episodes of clinical mastitis.

Losses in milk yields also tend to be greater with recurrent bouts of coliform disease compared to the gram positive, staphylococcal and streptococcal diseases (Schukken et al., 2009). Clinical episodes of recurrent mastitis occurred in the heavier producing animals across all lactations. Milk yield immediately dropped 8-10 lbs per day immediately after the first and second episode of clinical mastitis and then remained below production yields of non-mastitis herd mates for at least 8 weeks thereafter. Thus, the superior yields exhibited by these cows were eliminated and never recovered after clinical intramammary infections. Compared to the clinically normal herd mates, cumulative loss in yield for 1<sup>st</sup> lactation animals was 277 lbs and 250 lbs milk following the first and second bout of clinical mastitis. Worse, when compared to *predicted* milk yields in these particular animals had they not developed clinical episodes of mastitis, the estimated loss was 360 and 435 lbs milk. Thus, with each succeeding episode of clinical mastitis, loss in milk yields lasts 5-8 weeks and cows never achieve production levels that could have been realized under disease free conditions.

Production losses in 2<sup>nd</sup> and later lactation animals were 340 lbs over 8 weeks after the first bout of clinical mastitis. In succeeding bouts, losses were 310 and 260 lbs milk after the second



and third episode of clinical disease. Estimated total unrealized production in these higher producing animals was 556, 523 and 475 lbs milk had they not experienced a first, second or third bout of clinical mastitis. Others (Schukken et al., 2009) found no reduction in the amounts of production losses with succeeding bouts of mastitis. Apparently, when reduced losses with each succeeding bout of clinical disease occur in a single lactation, they may be associated with increased ability of the animal to control the intramammary infection. Improvement may relate to elevated levels of immunity that more efficiently control intramammary disease. Lastly, Bar et al., (2007), estimated cows experiencing clinical mastitis in a previous lactation sustained lowered yields of 2.6 lbs milk per day over the next lactation. Thus, clinical bouts of intramammary disease generate production problems that are sustained far beyond the immediate episode of intramammary disease.

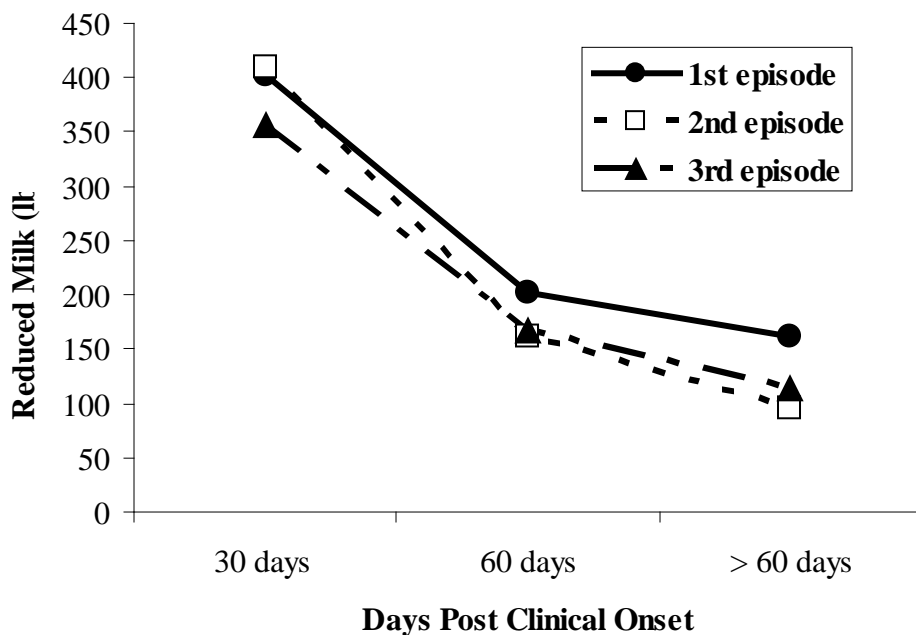


Figure 1. Estimated reduction in milk yield in clinical mastitis by days after initial diagnosis. (Modified from Schukken et al. 2009, Bar et al., 2007, 2009). Note losses decrease with time post diagnosis and losses (though large) tend to be lower with successive bouts of clinical mastitis in the same lactation.

Since clinical episodes of intramammary disease occur concurrently with the end of the voluntary wait period in lactation, the effect on conception and pregnancy rates is an issue. Delayed onset of estrus, lowered conception rates, increased services per conception, irregular cyclicity and early embryonic death have all been associated with intramammary disease (Santos et al., 2004, Wilson et al., 2008, Hertl et al., 2010).

More recent epidemiologic studies showed clinical mastitis eroded conception rates when the episode occurred 2 weeks prior to through 5 weeks after insemination. Lowered conception was most pronounced with gram negative (coliform) infections closest to the time of insemination. Generally, intramammary infections within 2 weeks prior to insemination reduced conception

rates by 30% while clinical episodes within 1 week of insemination were associated with a 50% reduction in conception rates.

Clinical episodes of mastitis from gram positive organisms (*Staphylococcus* and *Streptococcus* spp.) within 1,2 or 3 weeks after insemination reduced conception rates by 50%, 40 and 40% respectively. Gram negative (coliform) disease occurring within 1, 2 and 3 weeks of insemination reduced conception rates by 80%, 40 and 40% respectively.

Even cases of clinical disease 4 to 5 weeks after insemination were associated with 50% reductions in conception rates. Thus gram negative intramammary disease is associated with profound erosion of conception rates both before and for weeks after insemination. Moreover, the erosion of conceptions rates by clinical bouts of mastitis after insemination indicates how intramammary disease can induce early embryonic death and fetal reabsorption in the earliest stages of gestation. Altogether, producers can expect an erosion of reproductive efficiency when the prevalence of clinical mastitis increases during early to mid-lactation.

### ***Effect of Mastitis on Culling***

Mastitis is a high risk factor for involuntary culling. Risks of voluntary culling from the herd have been estimated by Bar et al. (2008a) to steadily rise for the 1<sup>st</sup> through 8<sup>th</sup> lactation (Bar et al., 2008a). Mastitis occurrence before calving or at peak lactation increase the risk a cow is culled from the herd (Beaudeau et al., 1995, Rajala.- Schultz et al., 1999). All types of mastitis organisms reduced the productive life of cows by increasing the risk of culling.

Cows experiencing clinical mastitis early in lactation are 5-6 times more likely to be culled than those without mastitis in early lactation (Grohn et al., 2005). Cows experiencing clinical mastitis later in lactation are at less risk but still remain 2 – 3 times more likely to be culled from the herd than cows without mastitis. Cows with clinical mastitis very late in lactation tend to be at extremely low risk for culling probably because of the value of the late pregnancy. Altogether, clinical mastitis decreases the probability a cow will survive through a complete lactation.

The type of pathogen involved in the intramammary infection also affects a cows risk for culling during the lactation. Intramammary infections with *Streptococcus* spp. early in lactation are 2 times more likely to be culled than cows without a clinical infection. Clinical intramammary infections later in lactation approximately double the chance of culling. Clinical mastitis very early in lactation due to the major pathogen, *Staphylococcus aureus*, placed a cow at low risk of culling compared to her non-mastitis herd mate. However, thereafter her risk of culling rose much more rapidly than the culling risk from clinical mastitis due to *Streptococcus* spp.. By mid to late lactation, clinical cases of *Staphylococcus aureus* mastitis placed a cow at 5-6 fold greater risk of culling than her non-mastitis herd mate. The apparent reason for the difference is the greater loss in milk production attending *Staphylococcus aureus* clinical mastitis compared to *Streptococcus* spp. mastitis.

Clinical cases of intramammary infection with *Staphylococcus* spp. (minor mastitis pathogens) tend to have a 5 fold greater chance of culling that remains fairly constant across the

entire lactation compared to their non-mastitis herd mate. This is a bit surprising given the relatively low production costs of this form of clinical mastitis. Clinical cases of coliform mastitis that occur very early in lactation place a cow at very high risk for culling. Later in lactation, her risk falls nearly 4 fold. Under most conditions of coliform mastitis, culling occurs soon after the diagnosis because of very large reductions in milk yield with the onset of coliform mastitis. The culling risk tends to fall off with these animals the more the DIM between the onset of clinical mastitis and the decision to cull. The likely explanation is these cows tend to recover production fairly well after the onset of acute, clinical intramammary infection.

Recurrent multiple cases of clinical mastitis during a single lactation tremendously impact culling decisions and herd life expectancy in dairy cows. The higher producing cows in any lactation show the greater prevalence of single and recurrent episodes of clinical mastitis. Second and greater lactation animals however, appear to experience a higher prevalence of single as well as recurrent clinical cases of mastitis compared to first lactation animals (Hertl et al., 2011).

Since mortality is a culling issue, recurrent episodes of clinical mastitis is an important contributing element to this form of involuntary culling. Mortality associated with clinical mastitis in first or second and greater lactation animals appeared to be greatest during early lactation. First lactation animals were found to be 3.9, 8.2 and 17.1 times more likely to die following a clinical case of intramammary infection. Gram negative (coliform) infection raised the risk of death 2.2-2.3 fold following the first and second episode of clinical mastitis in 2<sup>nd</sup> and greater lactation animals, respectively. Otherwise, the risk of involuntary culling associated with clinical mastitis increased 2-3 fold following the first, second or third episode of clinical mastitis in first lactation animals.

A similar type of production loss has been noted with each succeeding bout of clinical mastitis. The sustained erosion of productivity may finally trigger producer decisions to cull cows with recurrent clinical intramammary infection (Schukken et al., 2009). Culling risk also increased following each bout of clinical mastitis in second and greater lactation animals although the risk was higher for mastitis with coliform compared to *Staphylococcus* and *Streptococcus* spp.

The higher risk of culling following gram negative infections likely stems from the greater reduction in production as well as the greater likelihood of severe systemic disease following gram negative intramammary infections. Not surprisingly, risk of culling following one or more bouts of clinical mastitis was affected by profitability, pregnancy status, replacement costs and other concurrent disease problems during the same lactation in second and later lactation but not first lactation animals. Culling cost also depend upon producers desire to (1) treat most or all cases of clinical mastitis or (2) cull cows developing one or more recurrent case of mastitis in the same lactation.

## ***Conclusions***

Clinical mastitis remains a difficult and stubborn problem in most commercial dairy herds. Costs of clinical mastitis are accrued through tremendous losses in milk yield that are

sustained throughout the lactation in which the clinical episode occurred and into succeeding lactations. Repeated episodes of mastitis are a common problem that compound losses associated with single bouts of intramammary infection. Intramammary infection is a production problem across all levels of production and all lactations but is particularly prevalent in the higher producing animals in a herd. Production losses as high as 1,000 lbs milk can extend across the entire lactation and then be sustained into succeeding lactations. Losses due to clinical mastitis also arise from increased need for involuntary culling, an associated higher mortality rate in clinical mastitis and finally the erosion of reproductive efficiency.

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## **Growin' good corn: Rocket science or common sense?**

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### ***Background***

For 70 years, beginning in 1866, national corn grain yields in the U.S. were essentially flat (Fig. 1) and averaged only 26 bpa (bushels per acre) during that entire 70-year time period. The absence of noticeable yield improvement throughout all those years is remarkable given that farmers of the day were essentially also plant breeders practicing a recognized form of plant breeding (mass selection) as they saved the best ears from each year's crop for planting the next.

As the nation began to emerge from the Great Depression and Dust Bowl years of the 1930's, U.S. corn growers began to replace their traditional open-pollinated corn varieties with the new technology of double-cross hybrid seed corn. Within a few years, a significant shift in national corn grain yield was evident. During the period 1937 – 1955, average corn yields changed from no annual yield improvement to an annual rate of gain equal to roughly three quarters of a bu per ac per year (Fig. 1). Such a shift in the rate of improvement in corn grain yield represented a quantum leap shift in productive capacity.

A second quantum leap in the annual rate of yield gain in corn occurred in the mid-1950's with the greater adoption of single-cross hybrids and other new improved production technologies including mechanization, herbicides, and inorganic fertilizers (especially nitrogen). Beginning around 1956, the rate of annual yield gain dramatically changed from about three

quarters of a bu per ac per year to nearly 2 bu per ac per year and has remained at that rate in the succeeding 55 years (Fig. 1).

The exponential population growth on this planet mandates that we increase the rate of yield improvement in corn and other major food crops around the world. If the average annual rate of yield improvement remains constant at just under 2 bu per ac per year, then achieving a national average corn yield of 300 bpa would not be expected to occur until about 2086; a far cry from the often quoted promise that biotechnology will result in a national U.S. corn grain yield average of 300 bpa by the year 2030.

To reach that lofty goal by 2030, another quantum leap shift in the rate of annual yield gain would have to occur beginning NEXT YEAR that would take us to an annual increase of about 7.5 bu/ac/yr for the next 19 years. Such a quantum leap shift in yield improvement would be unprecedented in the history of corn production. Contrary to the hype and hoopla over transgenic corn traits by the farm press and seed corn industry in recent years, there is little evidence that a third quantum leap shift in corn productivity has yet begun (Fig. 1).

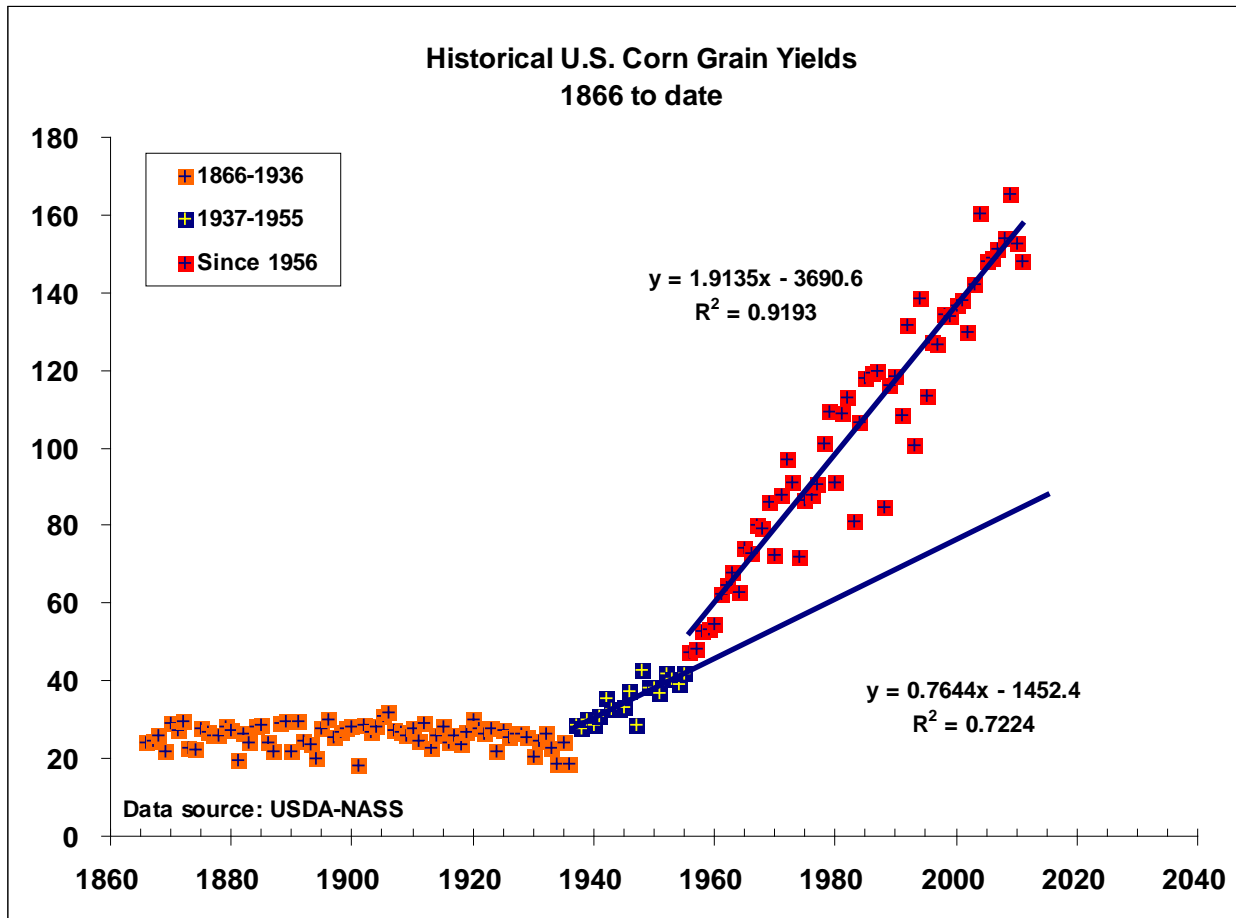


Figure 1. National average corn grain yield since 1866. Data source: USDA-NASS (2011).

Another disconcerting fact is that relative to trend yields, the annual relative rate of yield gain has been steadily decreasing for the past 50+ years (Fig. 2). Shortly after the second quantum

leap shift occurred in the mid-1950's, the relative rate of yield improvement was about 3.5% per year. Since then the absolute rate of yield gain per year has remained unchanged at 2 bu per ac per year. However, since today's average grain yield is significantly higher than those in the 1950's, the relative rate of annual yield gain today is only about 1.2% per year.

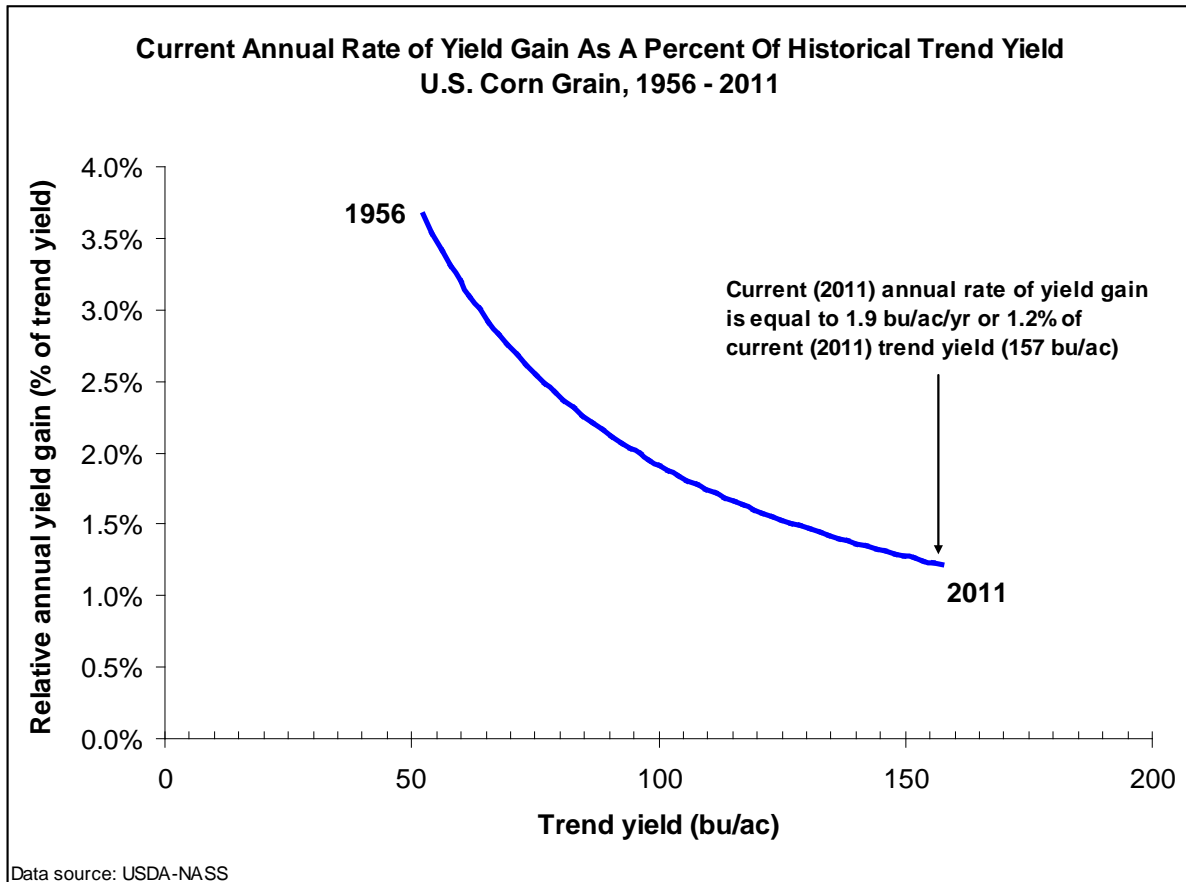


Figure 2. Fig. 2. Relative annual rate of yield gain for U.S. corn since 1956 based on current annual rate of 1.9 bu/ac/yr. Data source: USDA-NASS (2011).

***300 Bushels per acre is achievable today!***

Even though the goal of achieving a national AVERAGE corn yield of 300 bpa by 2030 is likely out of reach unless a miraculous improvement in technology occurs soon, it is true that individual growers have demonstrated in national corn yield contests that they can produce 300 bpa with today's technologies and genetics (NCGA, 2010).

Furthermore, the physiological yield components necessary to produce a 300+ bu crop are not terribly out of reach today. Potential ear size is easily 1000 kernels with today's hybrids. That would be equal to an ear with 18 kernel rows and 56 kernels per row. If (admittedly a big IF) that ear size could be maintained at a harvest population of only 30,000 plants per acre and IF kernel weight could be maintained at about 85,000 kernels per 56 lb. bushel (a modest kernel weight), those yield components would multiply to equal a yield potential of 356 bpa!

### ***The secret to producing 300+ bushel corn***

Given that the yield potential of that bag of seed corn is already 300+ bpa, then what is preventing all of us from routinely producing those high yields on our farms? The answer to that question is simple..... Once that seed is planted, that crop is subjected to a season-long array of yield influencing factors, most of which are stresses that reduce yield potential.

So, the secret to improving yields on your farm is simply to sharpen your focus on identifying the yield-influencing factors specific to the fields you farm. Once you have successfully done that, then you are better equipped to identify the appropriate agronomic management strategies to alleviate those factors holding back your yield and, perhaps, enhance those factors that promote high yields.

Pretty simple, eh?

### ***Rocket science or common sense?***

The trouble with the way many folks go about the business of improving yields on their farms is that they always look for the “silver bullets” or the “one-size-fits-all” answer to their problems.

They read farm magazine articles that highlight what one guy has done in Timbuktu that supposedly resulted a 20 bpa jump in his corn yields and figure that they ought to try the same thing on their farm in southwest Indiana. They listen to the testimonials of someone in the next county over that used Bob’s High Yield Snake Oil & Emolument on his crop and rush over to their local crop input retailer to buy some of the stuff to try on their farm. They take notes on the best management strategies presented at a crops conference by some guy from Purdue University who has never been on their farm and make plans to adopt those BMPs for next year’s crop.

The problem or challenge, you see, is that you need to invest your own time and effort to identify the important yield-limiting factors that are specific to your own fields. As I stated earlier, once you have successfully identified the yield-limiting factors specific to your production fields, then you are better equipped to identify the appropriate agronomic management strategies to alleviate those factors holding back your yield and, perhaps, enhance those factors that promote high yields.

It ain’t rocket science. It is hard work and common sense, coupled with a sound knowledge of agronomic principles.

### ***Yield influencing factors (YIFs)***

The process of identifying the YIFs that are important to your specific fields is not an easy one. First of all, these YIFs can be either negative or positive in their effects on yield. Pay attention to both.



These YIFs may occur every year in a given field..... or they may not.

These YIFs often interact with other YIFs to influence yield. Think about the compounded effects of heat + drought + soil compaction.

These YIFs often affect different crops differently. For example, most of us do not worry about gray leaf spot disease in soybeans. Frankly, as a corn guy, I don't worry about soybeans anyway, but that's another story.

These YIFs often interact with soil type / texture / drainage conditions.

These YIFs almost always interact with weather conditions.

Ultimately, the effects of YIFs on corn yield are equal to their effects on the four components that constitute grain yield. The timing of the occurrence of YIFs relative to crop growth stage greatly determines their effect on these yield components because they develop at different times throughout the season (Fig. 1).

- Plants per acre (population or “stand”)
- Ears per plant (degree of barrenness)
- Kernels per ear (potential vs. actual)
  - Kernel rows per ear
  - Kernels per row
- Weight per kernel

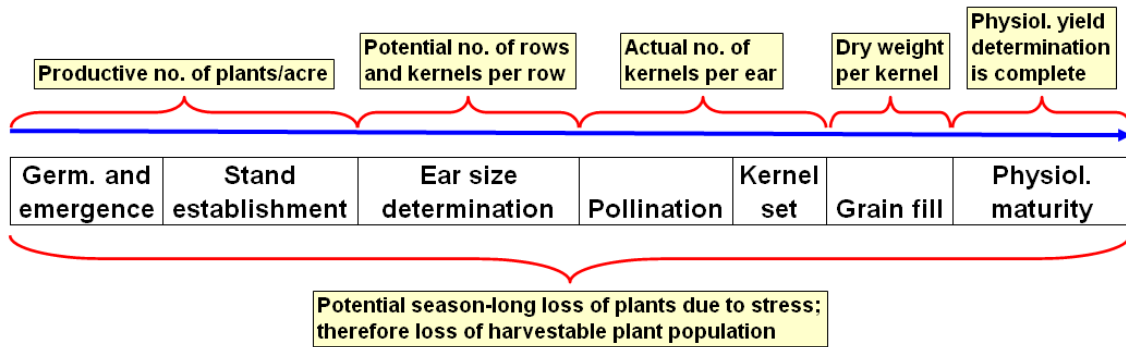


Fig. 3. Phenological timeline of the development of yield components in corn. (Source: Nielsen's imagination)

Once you sit down to list the possible YIFs that may influence corn yields on your farm, you will easily reach the conclusion that there must be a gazillion YIFs to consider. Where do you begin?

If you have farmed a particular field for a while, your own experience in that field is invaluable to identifying the YIFs specific to that field. You can probably come up with a short list of obvious YIFs based on that alone.

In future cropping seasons, strive to keep thorough notes on what happens with the crop during the entire growing season. Don't just plant it and come back at harvest. Visit your fields regularly. Sure, you can hire a crop scout to walk your fields for you, but there is a lot to be said for you walking your fields yourself.

Take advantage of the agronomic skills and knowledge of both the private and public sectors. Work closely with the sales or technical agronomists from your crop input retailers. Consider hiring the services of an independent crop consultant.

Don't forget the Extension resources available at your own land-grant university. You say you don't know the name of your state's Extension corn or soybean agronomist? Shame on you! You can find them in the following Web directories. These specialists can also put you in contact with other, more specific, content matter specialists at your land-grant university.

<http://www.kingcorn.org/experts/CornSpec.html>

<http://www.kingcorn.org/experts/soyspec.html>

Stay up to date during the growing season by reading Extension newsletters from around the Midwest. You can find most of them linked at my Chat 'n Chew Café Web site: <http://www.kingcorn.org/cafe>. Yes, I know this is shameless promotion of my own Web activity, but what can I say?

Spend time perusing two good university Web sites that focus on corn production issues.

Mine at Purdue: <http://www.kingcorn.org/news/archive.html>

Roger Elmore's at Iowa State Univ: <http://www.agronext.iastate.edu/corn>

Did your wife buy you a Smartphone or tablet for your birthday with 3G cellular connectivity? Install a GIS app on it and use the thing to map problem areas in the field for future reference. I have used an app called GISRoam with my Apple iPad to map problem areas or field features with reasonably good success. There's another app called iGIS that I have not used enough to comment on, but it's worth checking out. If you use your iPhone, I would recommend considering an after-market phone case that contains an additional battery to provide you with more hours of GIS field scouting.

Take advantage of previous year's yield maps to physically direct you to specific spots in a field to continue your hunt for YIFs. Target those field areas for specific soil sampling. Target those areas to intentionally scout the following crop season.

Do you have access to aerial imagery during the growing season? Recognize that aerial imagery by itself often cannot identify the cause of visual differences in a field. That is usually your job using the imagery to guide you to spots in the field.

The bottom line with this discussion is..... Get out into your fields during the growing season, identify problem areas early while the evidence is still there to aid diagnostics, and figure out what's going on with your crops!

### *Key factors to consider*

Even though I hinted earlier in this treatise that you should not blindly believe any “expert” who has never been on your farm, here are a few key factors I can offer to you for your consideration as you go about the business of identifying the important YIFs for your farm.

#### *Field drainage*

Throughout Indiana, naturally poorly-drained soils constitute a major perennial challenge to establishing vigorous stands of corn by virtue of their effects on the success and uniformity of rooting and plant development. The adequacy of field drainage (tile or surface) greatly influences whether corn will produce 200-plus yields or nothing (ponded out) or somewhere in between.

By improving tile or surface drainage in a field, you can reduce the risks of ponding or soggy soils, loss of soil nitrate by denitrification, and soil compaction by tillage and other field equipment. Reducing these risks enables more successful root development and stand establishment of the corn crop, which in turn will enable the crop to better tolerate stresses later in the growing season.

#### *Supplemental water*

Some soils in the eastern Corn Belt suffer from the opposite problem of drying out too easily when rainfall is inadequate. Obviously, fields with those soils will usually respond to supplemental water provided by above-ground irrigation (center pivots, shotguns, rows) or below-ground supplementation by virtue of pumping water back into tile drains or drainage ditches. Either choice requires informed decision-making relative to irrigation scheduling based on crop demand and soil water availability (Joern & Hess, 2010). Maintenance and proper operation of center pivot irrigation systems is crucial to optimize efficiency in terms of irrigation costs and crop benefit.

#### *Hybrid selection*

Most of us spend too little time evaluating the documented performance of potential hybrids for use in our operations. Look at any hybrid trial that includes “good” hybrids from a range of seed companies and you will easily see a 50 to 100 bushel range in yield between the top and bottom of the trial. Mind you, this spread from high to low occurs in variety trials where supposedly every hybrid entered into the trial is a “good” hybrid. I doubt that seed companies enter “bad” hybrids on purpose.

The key challenge is to identify hybrids that not only have good yield potential, but that also tolerate a wide range of growing conditions (Nielsen, 2010). The best way to accomplish this is

to evaluate hybrid performance across a lot of locations. University trials are good for this exercise (Iowa State Univ, 2011; Devillez, 2011). If you use seed company trials, be aware that often there are few competitor hybrids included in variety trial results.

Recognize that no hybrid wins every trial in which it is entered. Look for hybrids that consistently yield no less than about 90% of the highest yield in the trial no matter where they are grown. For example, if the top hybrid in a particular trial yielded 230 bpa, then look for hybrids in the same trial that yield at least 207 bpa ( $230 \times 0.90$ ). That may not sound like much of a challenge, but you will be surprised how few hybrids will meet that goal when evaluated over a lot of locations.

Once you've identified some promising hybrids based on their consistency of performance, then concentrate on other important traits like resistance to important diseases in your area of the state.

**Manage trash in no-till** If you no-till corn on soils that are poorly drained, then you simply must strive to manage surface "trash" to enable drying / warming of surface soils, facilitate effective planter operation, and improve crop emergence / stand establishment. Aim to burn-down winter annual weeds or cover crops before their growth becomes unmanageable. Use row-cleaners on the planter units to remove a narrow band of "trash" from the seed furrow area. Avoid planting "on the wet side" to minimize the risk of furrow sidewall compaction or topside compaction.

#### *Avoid soil compaction*

If you improve soil drainage, you will also minimize the risk of working or planting fields "on the wet side" and, therefore, the risk of creating soil compaction with tillage or other field operations that can limit root development. Minimize the number of tillage trips, consider strip-till or no-till systems. Remember, though, that no-till or strip-till is not immune to the risk of soil compaction.

#### *Continuous corn or not?*

Frankly, continuous corn simply does not yield as well as rotation corn. Numerous long-term rotation trials have documented this across a number of states. The yield drag is especially likely for no-till corn after corn. Folks who claim to do well with continuous corn are often fairly aggressive with their management of the stover from the previous crop.

Corn stover delays the drying / warming of the soil and thus delays crop emergence and development. Corn stover (including old root balls) often interferes with planter operation, causing poor / uneven seed depth or seed-2-soil contact and thus causes delayed or uneven crop emergence. Decomposing corn stover immobilizes soil nitrogen early in the season and can retard corn growth and development early in the season until root development reaches a critical mass. Corn stover can intercept soil-applied herbicide and reduce the effectiveness of weed control. Finally, corn stover harbors inoculum of important diseases like gray leaf spot or Goss' wilt.

Any way you look at it, a continuous corn cropping system is fraught with challenges.

### *Starter fertilizer or not?*

Starter fertilizer, especially nitrogen, is important for maximizing corn yields in the eastern Corn Belt. I offer the following explanation and leave it to you to decide whether your situation is similar.

A little background: Young corn plants depend heavily on stored kernel reserves until roughly the V3 stage of development (three leaves with visible leaf collars). At that point, the plants begin to “wean” themselves from dependence on the stored kernel reserves (which are playing out) to dependence on the developing nodal root system. If life up to that point has been hunky-dory, the transition to dependence on the nodal roots will go smoothly and the crop will continue to develop into a vigorous and uniform stand that will tolerate future stresses nicely.

However, if conditions have been challenging during emergence and early stand establishment, then nodal root development has probably been stunted and the young plants will struggle to “wean” themselves from the kernel reserves. Consequently, the plants will appear to “stall out”, their development will become uneven, they will turn light green to yellow, and the resulting stand will not be as vigorous and uniform as you want. Such a stand of corn will likely continue to struggle the remainder of the season. It is the latter situation wherein a robust 2x2 starter fertilizer program will aid the young plants as they struggle in the transition to dependence on nodal roots. Our experience in the eastern Corn Belt suggests that starter nitrogen is the primary important nutrient and starter N rates should be no less than 20 to 30 lbs actual N per acre; perhaps higher than that for no-till continuous corn.

### *Nitrogen management*

Nitrogen management in the eastern Corn Belt is challenging because of our poorly drained soils, ample rainfall, and the risk of N loss by either denitrification or leaching. Consequently, yields are often lower than desired because of inadequate levels of soil N during the growing season, resulting in lower grain income for the grower. Alternatively, growers sometimes apply more N than the crop requires in an effort to mitigate the consequences of excessive N loss on the crop and, thus, incur higher crop production expenses.

Best management practices that target the efficient use of nitrogen fertilizers in corn are well documented (Camberato et al., 2011; Sawyer, 2011) and include avoiding fall N applications, avoiding surface application of urea-based fertilizers without incorporation, and adopting sidedress N application programs where practical. These practices, plus the implementation of a robust starter fertilizer program, will help reduce the loss of soil N and maximize the bushels produced per pound of N fertilizer applied.

## *Disease management*

Warm, humid conditions typical of the eastern Corn Belt during the summer months are conducive for the development of several important foliar fungal corn diseases, including gray leaf spot and northern corn leaf blight. Goss's Wilt, a potentially severe bacterial disease, has "migrated" into Indiana in recent years and represents a potential new challenge for growers in the eastern Corn Belt. Yield losses from these foliar corn diseases can easily decrease corn grain yields by 20% or more.

Best management practices that target efficient management of these important corn diseases are well documented (Wise; 2010a, 2010b, 2011) and include:

- Hybrid selection for good disease resistance characteristics.
- Avoiding continuous corn cropping systems.
- Avoiding no-till cropping systems.
- Responsible use of foliar fungicides (except for Goss's Wilt)
- 

### ***Remember, it ain't rocket science!***

It should be obvious at this point that achieving higher, more consistent yields does not require "rocket science". Rather, we're talking about a lot of common sense agronomic principles that work together to minimize the usual crop stresses that occur every year and allow the crop to better tolerate uncontrollable weather stresses. Other agronomic practices not discussed in this presentation include a sound weed control program that focuses on the use of residual herbicides and an attitude that you will aim to kill weeds when they are small.

Make the effort to identify those yield limiting factors that are most important for your specific farming operation. This requires good crop detective skills and a sound understanding of agronomic principles. Together with your crop advisor(s), work toward identifying and implementing good agronomic management practices that target those yield limiting factors.

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## Getting Your Pastures Off to a Fast Start

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This year with very high hay prices and short supplies, there is a need for early pasture for grazing to stretch tight budgets and short hay supply. One of the few ways to stimulate growth in pasture is the application of nitrogen (N) at or just before pasture spring greenup. Even when N was applied in the early to mid-fall period to stimulate root system expansion and provide pasture grasses with stored N for early spring regrowth, an additional application of N just at greenup can be useful in promoting early pasturage.

A question often asked is whether it's economical and safe to use granular urea on pastures at this time of year. To answer the economics in the question, you need to understand what happens when urea is applied overtop of a pasture. If conditions are favorable, urea applied to a pasture can react with water from the soil or vegetation and the ever present enzyme, urease, to convert into ammonium carbonate. Ammonium carbonate is a very unstable form of fertilizer N that breaks down spontaneously into ammonium [(NH<sub>4</sub><sup>+</sup>) or ammonia gas (NH<sub>3</sub>) if the pH is alkaline), water, and carbon dioxide. The ammonium then is either taken up by plants, attaches to the cation exchange sites on clay and soil organic matter, or is acted on by the nitrifying bacteria to become nitrate (NO<sub>3</sub><sup>-</sup>). If conditions favor it staying ammonia, this is lost to the atmosphere and effectively raises your cost per pound of N. Urea frequently has the lowest cost per pound of N but if much N loss occurs the savings will be eliminated.

Conditions that favor ammonia loss besides the presence of plant material that provides the urease enzyme, include warm temperatures (especially 70 degrees F. and higher), high humidity or a moist soil surface, and high soil pH where the prill or urea granule rests on the soil. On Delaware soils where the pH is often maintained between 5.5 and 6.5 for pastures and where air and soil temperatures are cool to cold at this time of year, the loss of N from urea fertilizer is minimal. In fact when I worked in the Deep South, pastures or hay fields were fertilized with urea rather than ammonium nitrate all the way into April as long as the temperatures did not warm up into the mid to upper 70's. Through March at least in Delaware, fertilization with urea should be the most cost effective way to provide N for pastures since losses will be minimal.

What about animal health concerns? Since urea like other fertilizers is a salt, animals can become ill if they gain access to bags of urea fertilizer and consume too much of it. As long as the applicator practices safe handling and storage principles and ensures that the fertilizer is evenly spread without large clods, animal safety should be ensured. For those that prefer to err on the side of more caution, we suggest that they keep animals off a fertilized field until it has received from ¼ to ½ inch of rainfall. Rainfall or irrigation water will move the urea quickly into the soil eliminating any concerns for animal health; and, at the same time, will reduce or eliminate the concern with ammonia volatilization.



Another way to get pastures off to a fast start which also plays into the above health concern is to keep animals off pastures early in the greenup period to promote more growth. As an analogy, think of a tiny little tomato seedling. It can double in size a number of times but until it reaches a critical size the doubling amounts to only a very small increase in dry weight of the plant. Pastures that are grazed even before the permanent grasses green up in the spring will produce little useable forage compared with a pasture that is fertilized and then allowed to grow to a height of 3 to 4 inches before being lightly grazed, rested a couple of weeks and then grazed again. If the grazing animals are removed when 3 inches of pasture remains, recovery and the pounds of dry matter produced per day will be much greater than for a pasture kept constantly at a grazed height of 0.5 to 1 inch. It may mean using more hay initially but once the pasture reaches that 3 to 4 inch height, it often will produce more feed per day than your animals will consume.

Once you begin grazing a pasture, the best thing you can do to promote growth is to practice rotational grazing where you allow animals on a subdivision of your pasture for a short period, usually no more than 3 to 5 days at most, and then remove the animals to another subdivision while the plants in the recently grazed subdivision rest and recover and renew growth.

Another suggestion is to take that soil test sample you've been meaning to get and send it in for analysis. Soil tests should be taken at least every three years and as often as every year at the same time of year each time. The soil test will help you decide if you need to correct a pH problem or apply nutrients to relieve any nutrient deficiencies. If the pasture soil pH level has declined below 6.0, an application of lime will help both grasses and legumes grow better.

I mentioned N fertilization earlier. How much N should you apply? This does depend a bit on the pasture you are fertilizing and your goal for that pasture. Where you either have too much legume (clover) or where you have so little clover that is isn't contributing N to the surrounding grass, an application of about 100 lb urea per acre (this is about 46 lb N/acre) will stimulate grass growth helping to reduce the percentage legume in the pasture or will replace the N lacking when legumes are grown with grasses. This rate should be enough to jump start the pasture grasses without a risk of overfertilization and risking damage to the environment. On pastures where maintaining the legumes presence is important, you should apply only half the rate of urea (50 lb urea per acre). At this rate of N, the legume can continue growing and will not slough off the bacteria nodules that help the legume by fixing atmospheric N (N<sub>2</sub> gas) in a plant available form.

## **A Quick Note on Cover Crop Management**

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In many areas of Delaware, this winter has not only been lacking in significant snow cover but also marginal to deficient in rainfall resulting in soil moisture levels that are at risk of becoming short as we move to corn planting season in April. Although the forecast doe call for rainfall this week, growers who have established cover crops on their 2012 corn fields will need

to carefully monitor their soil moisture levels. Cover crops when spring growth begins can remove a large amount of soil moisture in a relatively short space of time. This is not only because of their rapid growth rate in the spring but also because they have a well-developed and often deep root system already established. Cover crops can remove not only surface moisture but the subsoil moisture we often depend on to hold corn during early- to mid-summer drought conditions.

If rainfall between now and early corn planting time remains below normal, growers should think seriously about killing cover crops early before too much soil moisture is removed. If using a systemic herbicide to kill the cover crop, you should also account for the week to two weeks it will take for the crop to die when determining the timing of herbicide application versus soil moisture levels.

Finally, a number of growers around the state planted the tillage radish or daikon radish as a cover crop this past fall. Although the weather was cold enough on some fields in New Castle County to winter kill the tillage radish, not all fields were completely killed. I suspect that the same is true in the lower counties of Delaware. You should carefully monitor these fields so you can make the decision on whether or not you will need to spray these fields with an herbicide to clean them up in time for corn planting time. Again, you should also monitor the subsoil moisture levels since this crop can send roots very deep into the soil. If it remains alive, a large amount of the subsoil moisture may be lost through transpiration as the radish enters the reproductive stage later this spring.

## Notices and Upcoming Events

**March 26, 2012**

**Crop Management Webinar: Pesticide Adjuvants and Entomology Preview of 2012**, Noon-1 pm. Registration information: <http://www.cvent.com/d/bcqlc> For more information, contact Charlie White, Penn State, 814-863-9922

**April 2, 2012**

**Crop Management Webinar: Herbicide Mode of Action and Herbicide Resistant Weed Update**, Noon- 1 pm. Registration information: <http://www.cvent.com/d/bcqlc> For more information, contact Charlie White, Penn State, 814-863-9922

**April 7, 2012**

**Southern Piedmont Equine Extravaganza “Putting Science into Practice”**, Va Tech’s Southern Piedmont Center, Blackstone, VA. Va Forage and Grassland Council. For more information, please contact Ms. Margaret J. Kenny at 434-292-5331 or via email at [makenny@vt.edu](mailto:makenny@vt.edu)

**April 9, 2012**

**Crop Management Webinar: Managing Herbicide Drift and What’s New for Weed Control**, Noon- 1 pm. Registration information: <http://www.cvent.com/d/bcqlc> For more information, contact Charlie White, Penn State, 814-863-9922

**May 17, 2012**

**Grazing for Profit with Sheep: Jim Gerrish Field Day**, Roger Johnson Farm, Hancock County, Tennessee. For more information, please contact Shirley Childs at NRCS A-4, 9737 Cogdill Rd. Suite 152C, Knoxville, TN 37932-3381

**July 26 and 27, 2012**

**Penn State Agronomic Field Diagnostic Clinic**, For more information, contact Dwight Lingenfelter, Penn State, 814-865-2242

**August 14-16, 2012**

**Ag Progress Days**, Rock Springs, <http://agsci.psu.edu/apd> For more information, contact Bob Oberheim, Penn State, 814-865-2081

**October 1-4, 2012**

**8th Eastern Native Grass Symposium**, Charlottesville, VA. For more information, please contact Ben Tracy at 540-231-8259 or via email at [bfracy@vt.edu](mailto:bfracy@vt.edu)

**Newsletter Web Address**

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

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

or

[www.mdcrops.umd.edu](http://www.mdcrops.umd.edu) Click on Newsletter

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