2020 Northeast Pasture Consortium Conference Proceedings
January 15-16, Lake Morey Resort, 82 Clubhouse Road, Fairlee, VT

Eighty people attended and participated in the Northeast Pasture Consortium (NEPC) Conference held at Lake Morey Resort in Fairlee, Vermont. This was our best turnout since 2017. This was helped by a Cedar Tree grant received by the University of Vermont that was used to bring collaborators of that grazing lands project together to attend this conference and financial support from USDA-Agriculture Research Service. The federal budget was passed and signed into law just before Christmas 2019 so this allowed the highest attendance of grazing lands specialists from USDA-Natural Resources Conservation Service in some years. Several of them used this occasion to meet immediately after the Conference to discuss several pressing grazing lands issues. Our Conference was also providentially sited and timed to avoid any big winter storms for a change by adjourning two days ahead of a major snowstorm that swept across the Northeast.

Our Conference covered many of the research and education priorities that our stakeholders have asked us to work on. It also featured a first time session on pasturing pigs which is gaining in popularity around the Northeast. They are small herds, usually being an added livestock enterprise to diversify the pasture produced products being offered by the farm. This was followed-up by the Vermont Grazing and Livestock Conference that convened on January 17 at the same venue with a farmer group discussion session on pasturing pigs on the morning of January 17. Eleven continuing education units (CEUs) were approved for Certified Crop Advisers and Certified Forage and Grassland Professionals by ASA-CSSA-SSSA and the American Forage and Grassland Council, respectively for our Conference technical sessions.

The conference was opened by Executive Director, Jim Cropper at 8:00 AM Wednesday, January 15. He gave a brief introduction of the Conference and told the audience that he would be passing out sign-in and -out sheets for Certified Crop Advisor CEUs and at the end of the technical sessions on January 16 at 10:00 AM the signup sheet for Certified Forage and Grassland Professionals. Due to the large attendance, we skipped our usual round of introductions of all those in attendance, but Jim introduced all the members of the Executive Committee. Then, Jessica Williamson of the Executive Committee and Penn State Extension Forage Specialist, asked for a show of hands from the audience on what group they represented: USDA-ARS, Extension, USDA-NRCS, farmers, University researchers, agri-business, and nongovernmental organizations. We were particularly heartened by the number of farmers attending. Sid Bosworth, Principal Investigator for the Northeast Pasture Consortium (NEPC) project, then introduced and handed out a *Future of the NEPC* questionnaire for everyone in attendance to fill-out and return to the registration desk.

Session 1 - The Fescues – Soft-leaved and Meadow

This technical session began at 8:30 AM. **Jessica Williamson** moderated this session and was the first speaker. She presented "Tall Fescue: Effects on your Operation and Managing your Pastures". It is a cool-season grass that covers an estimated 40 million acres of pasture and hayland in the US. It is said that due to the presence of a toxic alkaloid in endophyte-infected tall fescue, it causes the second largest annual economic loss to the cattle industry in the US. It is adapted to nearly all of the Northeast except for northern Maine. It is the main pasture forage grass in the Mid-South of the US as the endophyte fungus that produces the alkaloid makes the grass heat

and humidity tolerant. It is the only cool-season grass that does well in this part of the Nation and supports a large cow-calf beef industry in the Mid-South. It may cause livestock health problems and reduce average daily gain (ADG), but the cow-calf industry here might not even exist if were not for endophyte-infected tall fescue (E+).

Tall fescue at full vegetative height

The endophyte fungus in tall fescue has the scientific name, *Neotyphodium coenophialum*. It has a symbiotic association with tall fescue. When looked at under a high powered microscope, the fungus appears as very thin threads coursing through its leaves between plant cells. It produces an ergot alkaloid called ergovaline which is toxic to animals grazing infected tall fescue. Yet, ergovaline has a positive effect on the host fescue. It makes it more winter hardy, drought resistant, heat tolerant, and better adapted to poorly drained soils. In other words, it can grow just about anywhere it is planted. It is also produces more forage than most other common pasture cool-season grasses.

The ergovaline gets eventually concentrated in the seedhead of tall fescue. It causes vasoconstriction that shrinks the blood vessels especially restricting blood flow to peripheral body parts in livestock grazing tall fescue where the blood vessels are smaller in diameter than elsewhere in the body. As a result, there can be sloughing of hooves, ears, and loss of tail switches. Fescue toxicosis also causes abortions and dystocia (difficulty calving), fat necrosis around intestines, and agalactia (lack of colostrum and milk production).

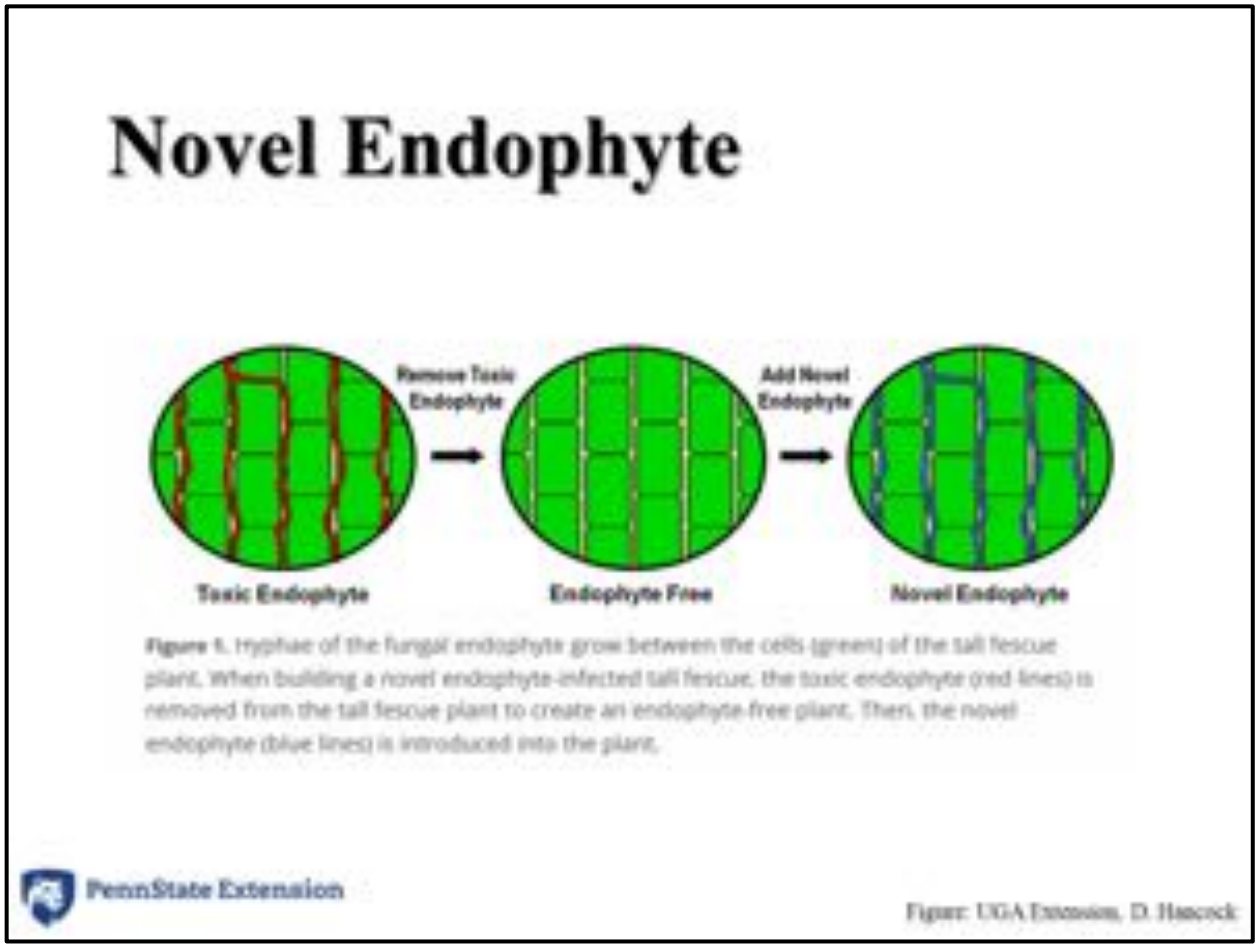
Angus steer with low grade fever standing in water to cool off. Often times cattle will wallow in mud to cool down.

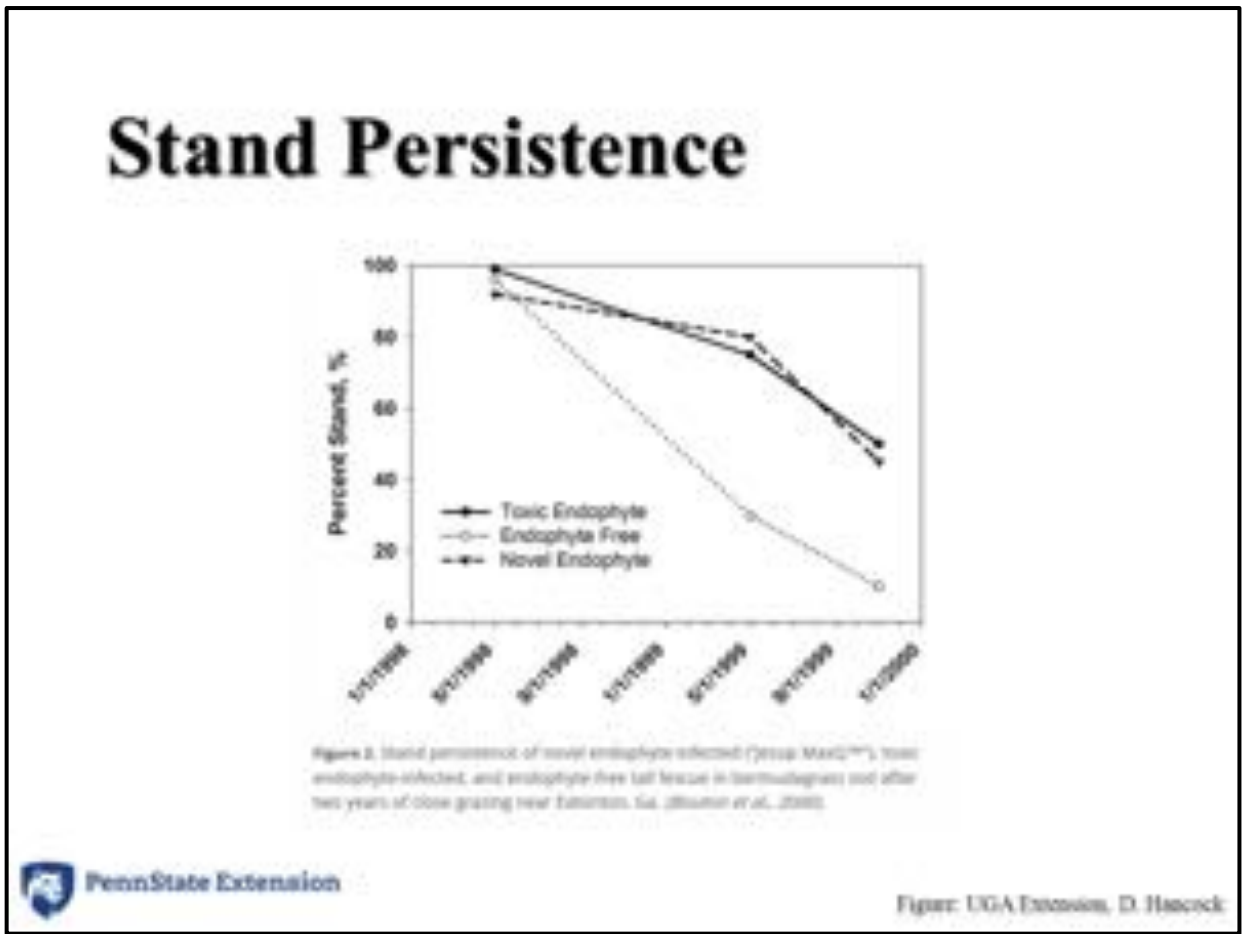
Symptoms of fescue toxicosis are retention of winter hair coats into warm weather, increased body temperatures, labored breathing, and decreased animal performance (lower ADG, reproductive efficiency, and milk production).

Table 1. †Summary of the effect of E+ tall fescue on cattle. Data derived from multiple research trials where pastures contained 70% or more E+ tall fescue.

Performance Metric	Effect on Production	
Pregnancy rates	Decreased	15-40%
Milk production	Decreased	25%
Weaning weights	Decreased	65- 85lbs
Time spent grazing	Decreased	20%
Forage intake	Decreased	25-40%
Average daily gain	Decreased	0.3-1.2 lbs/day
Water usage	Increased	25%
Body temperature	Increased	1-4°F

†Paterson et.al, 1995

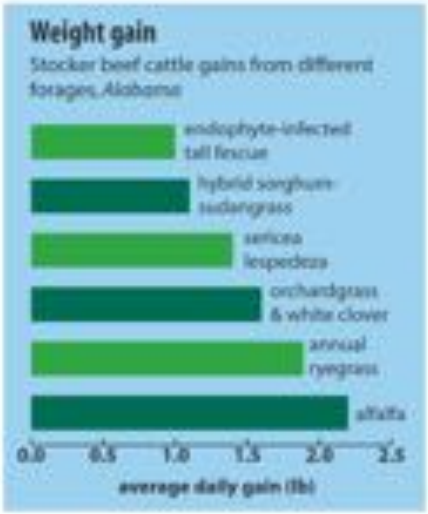




Endophyte-free tall fescue (E-) varieties were produced in mid-twentieth century. Unfortunately, this resulted in a nonpersistent tall fescue. As shown above, when interplanted into a bermudagrass sod, the E- tall fescue virtually disappeared in two years. E+ tall fescue (toxic) and the novel endophyte were equal in survivability growing in a bermudagrass sod. (Editor's Note: They actually would fare much better if not in a bermudagrass sod as bermudagrass being a warm-season grass and growing in Georgia is too competitive to cool-season grasses. They are at war with each other in North Carolina. When left to their own devices, bermudagrass wins out on south and west aspect slopes while tall fescue wins on east and north-facing slopes in naturalized permanent pastures. This is due to differences in soil surface temperatures, warmer on southern and western exposures and cooler on northern and eastern exposures. The higher temperature on the warmer slopes will also cause a greater loss of soil water there than on the cooler slopes.)

Part of the reason for lower ADG on E+ tall fescue is due to the ergovaline as rumen intake of the ruminant decreases as rate of passage is slower through the digestive tract than with other forages (See following graph) or E- and novel endophyte tall fescue. Rumen fill occurs sooner. Steers at weaning weighed sixty pounds more when grazing novel endophyte versus E+ tall fescue in a Georgia study. Heifers were about fifty pounds heavier at weaning coming off of novel endophyte tall fescue. E+ tall fescue stockers were nearly 100 pounds lighter entering a feedlot than stockers coming off of E- and novel endophyte pastures. They remained 100 pounds lighter after 120 days.

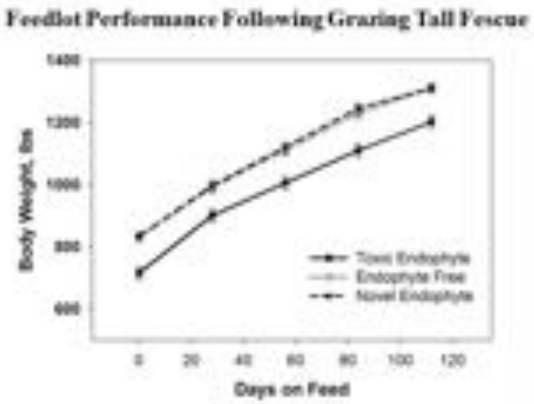
Animal Performance



PennState Extension

Ball et al., 2001. Understanding Forage Quality

Animal Performance



PennState Extension

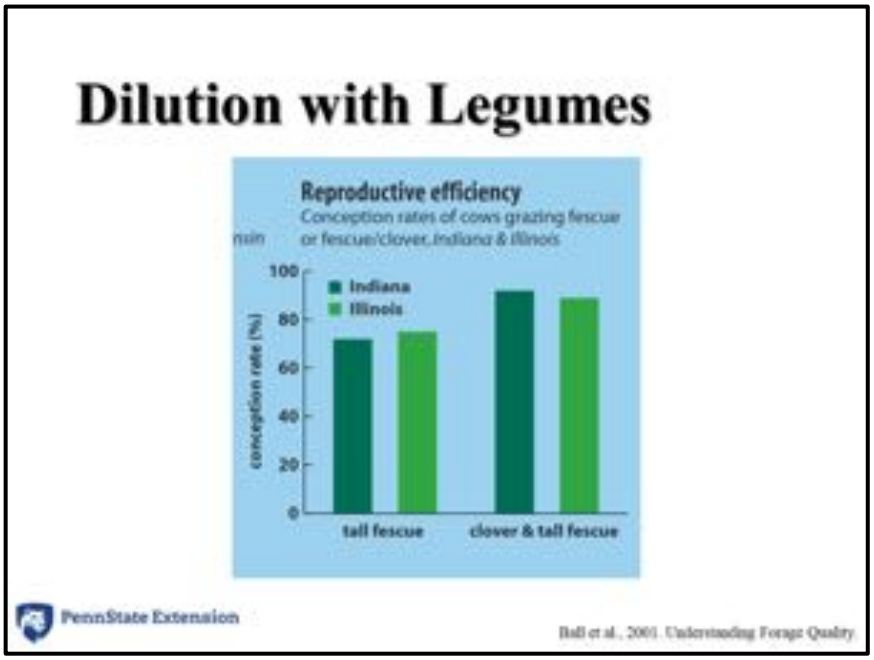
Figure: UGA Extension, D. Hancock

The adjacent table shows a variety of options to reduce the incidence of fescue toxicosis. Rotational grazing and mowing can help reduce ergot alkaloid concentrations in vegetative tillers. They redirect stored carbohydrates for regrowth instead of alkaloid production. Rotational grazing maximizes consumption of leaf blades if livestock are removed before grazing into the leaf sheaths at the base of the plants. Greater concentrations of ergot alkaloids are in the leaf sheaths than in the blades. Leaving a 4-inch stubble height over most of the paddock will avoid much consumption of leaf sheaths. A high stocking density that causes all the tall fescue to be grazed uniformly will suppress seedhead production in the spring and make the regrowth more uniform over each paddock so that spot grazing is not continued over the pasture season (Editor's Note: Livestock favor previously grazed areas over poorly grazed areas that contain dead and less succulent leaves and seed stalks. Spot grazing encourages them to graze previously grazed areas lower than leaf sheath height. This takes a high degree of management and may mean moving them sooner than planned to avoid grazing into leaf sheaths or increasing stock density if not evenly grazed. In the latter situation, leaving them on the currently grazed paddock longer will not work without losing ADG. Once spot grazing is established, they are loath to clean-up the under-grazed areas up as they may be contaminated with fresh urine and dung by that time. They seem to rather want to starve than eat forage that they initially rejected.)

Renovating an E+ tall fescue pasture is a project that takes some thoroughness. The year before, it is ideal not to let the E+ tall fescue go to seed. This means even cleaning out fencelines with an herbicide that kills the fescue before it heads out. The rest of the pasture can be grazed, but not allowed to form any seedheads. Clipping the pasture as needed is justified before seedheads form and throw pollen to be extra sure no viable seed is produced that year. Then, in the fall of the year spray before a hard freeze to kill the tall fescue in the pasture. The following year plant a smother crop such as forage sorghum-sudan cross or other preferred forage annual that will suppress weed and E+ seedling growth. This way the pasture is still available to produce forage for grazing or machine harvest. Before seeding the pasture to a novel endophyte variety, one more contact herbicide spray operation should be done if a few rogue E+ tall fescue plants are still present. A late summer seeding or a next year spring seeding can be done after the clean-up spraying is completed and planting time and re-entry intervals as required are observed. Although this project can be done to minimize loss of the pasture while it is being renovated,

there will be some down time during the process. It is best to do whatever amount you can do yearly over a period of years if it is a goal to eliminate all E+ tall fescue on the farm while not having to cut livestock numbers dramatically. One pasture per year might be the best way to go. It spreads the risk of a seeding failure for one reason or another if done one pasture per year until satisfaction is complete. Only each individual can weigh if renovation will pay for itself in better ADG, milk flow if a dairy farm, or reproductive efficiency for brood mares and other livestock.

Short of complete renovation interseed legumes into E+ tall fescue pastures. The so-called dilution effect of having a strong legume component in the pasture sward has shown to increase reproductive efficiency. With red clover, it recently has been shown that supplementing Biochanin A, a naturally occurring isoflavone in red clover, improved average daily gain (ADG) of grazing beef cattle by 0.2 lbs./day compared to a non-supplemented group (Harlow et al., 2017). Biochanin A is a vasodilator counteracting the effect the ergovaline alkaloid has on constricting blood vessels. It is also hypothesized that Biochanin A modulates the rumen microbial population to increase protein availability (Flythe and Aiken, 2017). It may also potentially alter hormonal balances to favor weight gain due to the estrogenic effects of Biochanin A. Incorporating optimal levels of red clover (30% of total forage mass) into tall fescue pastures could be a management tool for producers to improve ADG efficiency and profitability in pasture-based beef systems.



Protein (pelleted soybean hulls) supplementation of cattle on E+ tall fescue pastures has given an increase in ADG of 0.5 lbs. /day in a research paper by Carter, et al., 2010, Prof. Animal Scientist. Another way to get more protein in the diet goes back to having a good legume component in an E+ tall fescue pasture. On paddocks in the Northeast protein content in grass-only pastures is often already above the needs of the livestock as urine and dung are more evenly distributed over the pastures than in continuously grazed pastures. It is worth taking a forage sample in for a forage analysis before doing purchased protein supplementation. As can be seen in the next graphic, protein content in E+ tall fescue can be dramatically increased just by suppressing seedhead formation.

Spraying for Seedhead Suppression

Seedhead Suppression with Metsulfuron

Table 3. Effect of seedhead suppression on stocker cattle and forage quality of pastures grazed. Data were collected from 2009-2012 in three separate studies conducted by the USDA-ARS Forage Animal Production Unit, University of Kentucky.

	Chaparral™ Treated	Non-suppressed
2009-2010		
Steer ADG (lbs/steer/day)	2.1 lbs	1.48 lbs
Crude protein	14.4%	11.6%
In vitro dry matter digestibility	70.6%	71.7%
2011-2012		
Steer ADG (lbs/steer/day)	2.1 lbs	1.24 lbs
Crude protein	14.2%	9.9%
In vitro dry matter digestibility	72.2%	66.4%
2011-2012		
Steer ADG (lbs/steer/day)	2.39	1.86
Crude protein	18.6	14.8
In vitro dry matter digestibility	78.3	72.6%

(Aiken et al., 2012; Goff et al., 2012a, Goff et al., 2012b)

PennState Extension

Figure: E.S. Flynn and P.B. Burch, uknowledge.uky.edu

Spraying for Seedhead Suppression

Seedhead Suppression with Metsulfuron

Table 2. Effect of seedhead suppression on 205 day adjusted weaning weights of calves and breed back of cows. Data were collected from three different locations owned by Whitewell Land and Cattle Co. At each location the pastures were split into two paddocks so that half the herd would be on a Chaparral-treated paddock (tall fescue seedheads suppressed) and the other half would be on a GrazonNext HL treated paddock (non-suppressed).

Location	205 Day Adjusted Weaning Wt.			Cow Pregnancy Rates	
	Chaparral Treated	Non-suppressed	difference	Chaparral Treated	Non-suppressed
Farm 1	473 lbs	418 lbs	+55lbs	95%	80%
Farm 2	483 lbs	463 lbs	+20lbs	95%	70%
†Farm 3	476 lbs	459 lbs	+17lbs	Equal at 91%	

†Heavy spring grazing on treated and untreated paddocks resulted in seedhead suppression through grazing, thus the non-treated paddock behaved similarly to the suppressed paddock.

Adapted from Boyer et al., 2015

™ Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow

PennState Extension

Figure: E.S. Flynn and P.B. Burch, uknowledge.uky.edu

Seedhead suppression with Metsulfuron is also a good way to avoid seedhead formation if embarking on a renovation program to get rid of E+ tall fescue in pastures. It improves ADG and cow

pregnancy rates while not allowing any viable E+ fescue seed to be set in the year prior to seeding a smother crop the year after. In the study shown in the table above, Farm 3 heavy spring grazed both treated and untreated pastures to suppress seedhead formation, therefore an organic farm might be quite successful in suppressing seedhead formation by just grazing heavily in the spring when tall fescue ordinarily forms seedheads. Unlike a jointed grass like timothy, it only flowers once a year. This means to hit only one pasture at a time. A general recommendation is renovate less than 25 percent of your E+ tall fescue pastures a year anyway.

How do I know if the fescue in my pasture is toxic…? There are endophyte testing laboratories throughout the US. Oregon State's Forage Information System website has a list of laboratories, but is dated as of January 2008. It is a starting point to contact a laboratory before sending any samples in to confirm they still conduct the tests, the turn-around time, and to ensure that contact details, prices, and analyses have not changed. In addition to those labs listed by Oregon State, the University of Tennessee Soil, Plant, and Pest Center also can test for endophyte. They have a form that you can get on-line that can be used for various forage test procedures. The endophyte detection test costs fifteen dollars. It gives specific instructions on how to collect a tall fescue sample.

(Editor's Note: Why don't farmers get rid of E+ pastures? Living with E+ tall fescue requires cattle with a high level of tolerance to it and environmental adaptation. Many tall fescue belt beef cattle farms have been successfully selecting for fescue-tolerant cattle for years, or maybe if the cows did not die or lose extremities or not breed back, it just happened over time that the herd became tolerant to E+ tall fescue. These cattle have shown to be adaptable to a wide range of environmental conditions and thrive in low-input production models in conjunction with sound grazing management mentioned earlier. Light colored beef breeds seem to be more susceptible to ergovaline than dark breeds. This may explain why Black Angus are so prevalent in the tall fescue belt. The black coat of hair would seem to be not ideal in a hot, sunny, humid climate in summer. However, they will seek to wade in water or shade if it is available. It is also best, if buying replacement cattle, to purchase local cattle that have gained tolerance to grazing E+ pastures.)

Jerome Magnuson was the second speaker in this session. He is the Forage and Organic Specialist for DLF Pickseed NA, in Halsey, OR. The title of his presentation was "Advances in Tall Fescue Breeding". He started his presentation with an analogy about tall fescue growers' perceptions about tall fescue by likening their perceptions to 3 blind people feeling different parts of an elephant with one touching the trunk, another its tail, and the third person one of the legs. The person's experience with tall fescue may make them hate it, love it, or be ambivalent about it. They may only be familiar with one aspect of it depending on the variety they were dealing with and the environment it was placed in. He covered some of its varying varietal characteristics and some pitfalls of current nomenclature and ways of determining leaf softness.

He also explained why DLF Pickseed is located in Oregon. The Willamette Valley is ideal for grass seed production as it has rich soil and ample rainfall, but has a 60-day period with no-rain just as the seedheads on cool season grasses have emerged. This allows the harvest of high quality seed.

One personal bias of tall fescue is often based on cow preferences. Dairy cows grazing E+ tall fescue dominated pastures will tend to avoid it in the eastern US if there are other grasses or legumes growing in association with it and do not milk well on it if given no other choice. (Editor's Note: For instance, here is a quote from *Forage Fescues in the Northern USA*, "Where tall fescue was introduced in Wisconsin, it was found to be less palatable than most other grasses. It frequently set seed because it was not grazed, creating increasingly large patches of unpalatable forage in pastures. Between the animal health problems seen in the South and the observation that cows preferred other grasses, tall fescue was avoided by Wisconsin farmers.") However, this is not true in Oregon where dairy cows will eat E+ tall fescue. Perhaps less alkaloid is produced.

Jersey dairy cow on E+ tall fescue pasture in Oregon.

Today there is a lot of discussion about leaf palatability concerns. An on-farm trial for animal preference and adaption included these four general types of tall fescue by highest rank to lowest:

- Traditional leaf - most preferred
- Soft leaf second
- Traditional types next
- Coarse leaf (Fawn) last

The traditional leaf is a wide leaf found on E+ tall fescue and other tall fescues that are either E- or novel endophyte varieties. Soft leaf tends to have a more lax, narrower leaf blade. Coarse leaf typified by Fawn, an E- variety, is least preferred by livestock. It has a raspy leaf edge and the leaf is not easily sheared off when grazed. Although an E- variety, it is avoided since it is so wiry. Coarse leaf is not the best descriptor for a tall fescue leaf blade as it conflates leaf width and toughness (feel in the mouth). Tuscany II, an E- tall fescue, is between soft and coarse but is preferred by grazing livestock due its high sugar content. In this grazing trial, Tuscany and white clover was the most preferred plot. A soft leaf perennial ryegrass was also in this trial.

Factors that affect forage quality and preference:

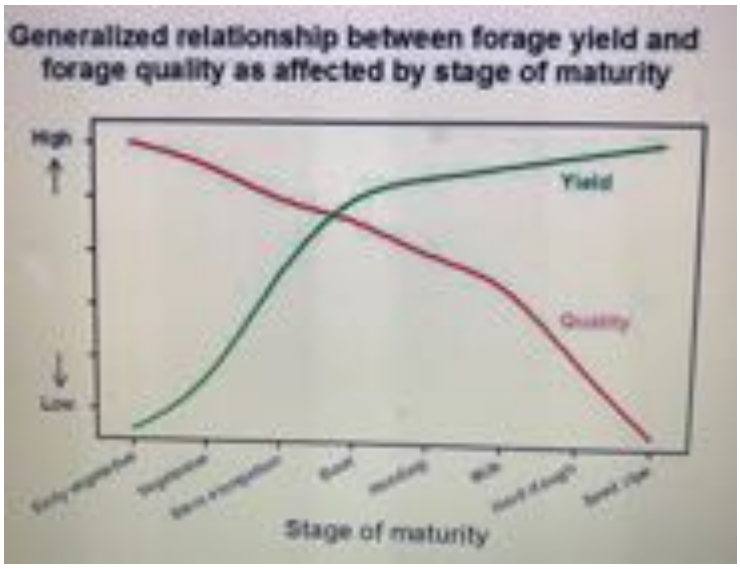
- Taste
- Soft leaf
- Variety Maturity
- Fiber Digestibility
- Silicate Content

Taste is a preference issue. It is a broad in scope based on the feel of the leaf (rough edges, hairiness [e.g. velvetgrass]), its shear strength (not easily removed from the plant crown or chewed), alkaloid content which imparts a bitter taste and more than likely causes post-ingestive feedback (the animal is not feeling so good after eating it), and other anti-quality factors such as coumarin

(smells great but is bitter [e.g. sweet clover and sweet vernalgrass]). New tall fescue varieties can be more palatable than perennial ryegrass.

Leaf texture is a qualitative trait measured and defined by plant breeders according to how harsh or soft the leaf texture feels by running the index finger over the leaf blade. This is can be highly subjective, but currently there are no other simple techniques available. Three categories established are:
- VVS (very, very soft leaf texture),
- VS (very soft leaf texture), and
- H (harsh leaf texture).

Soft leaf tall fescue varieties can run the gamut in softness and to a certain extent they are very imprecisely measured.



Range in maturity causes grazing discrimination. This can be a critical reason why tall fescue is avoided if it is earlier maturing than the other grasses in the pasture sward. Its quality is on the decline especially if it is producing seed stalks. Otherwise, as leaves mature later on in the growing season, they will be lower in sugar and tougher. Every grass going into reproductive maturity is avoided. Orchardgrass headed out is avoided and is highly criticized by graziers because it is unpalatable at that point. However, timothy, sweet vernalgrass, smooth bromegrass, redtop, and other grasses once headed out are also avoided. Jointed grasses, such as timothy, that head out more than once in a season are likely to be more of a problem if not rotationally grazed. (Editor's Note: If cutting grass for hay/balage, the graph above shows that it really needs to be cut at boot stage for the best combination of yield and quality.)

Range in maturity among tall fescue varieties is two weeks. Older USA genetics are early maturity varieties (Alta and Fawn) and are also coarse (harsh) type. (Editor's Note: Alta was selected for its tolerance of salinity and used in western US states on saline soils.) European genetics extend the maturity range and are typically soft leaf varieties.

Persistence of tall fescue varieties is dependent on several factors. Repeated grazing of European tall fescue varieties that are drought-stressed will deplete plant populations severely and is likely

to kill the pasture completely. Mediterranean varieties are likely to be more tolerant of grazing during drought, but grazing at such times still should be avoided. In the southern US, E+ and novel endophyte tall fescues are needed for heat tolerance persistence. In the northern tier of US states, endophyte-free (E-) varieties will persist well. (Editor's Note: From *Forage Fescues in the Northern USA*, "We have observed no effect of fungal endophytes in either toxic or animal-friendly forms on persistence or yield of tall fescue in Wisconsin." , and "Endophyte-free varieties of tall fescue will avoid the toxicosis issues and should have good survival if they have performed well in local variety trials.") South of the northern tier of US states, it will be a matter of elevation of whether or not E- tall fescue will survive as well as E+ or novel endophyte tall fescue. Higher elevations will reduce the need for an endophyte tall fescue. Some tall fescue varieties are more susceptible to winter kill than others, so in the northern tier of the US states use varieties that are winter hardy, such as Festival and Kora.

Tall fescue is a high yielding cool season grass, but select varieties that are adapted to the farm's area. It is best to look at forage trials done at various land grant universities that have climate and soils similar to those of the farm it is going to be raised on. Select varieties that are best adapted and give the best or similar yield to others in the trial. (Editor's Note: Penn State has conducted forage trials for many years at two locations in the Pennsylvania, Rock Springs in the mountains and Landisville in southeast PA. Cornell University at Ithaca, NY also has trial results for the major cool season grasses including meadow fescue over many years.) Use early maturity varieties on southern slopes in the Northeast to get an earlier start on grazing. Use a later maturity variety to stage growth for rotational paddocks so that the stage of maturity stays about the same from the early grazed paddocks to the later ones at least for the first round of grazing each year to avoid seedhead formation before the livestock get to the paddock.

Forage quality is measured four ways:

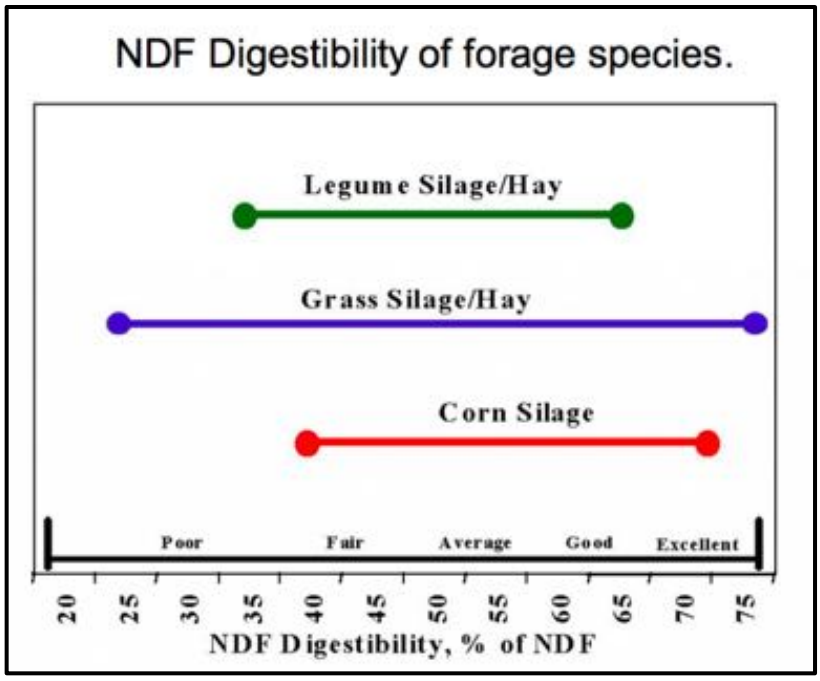
- ADF (acid detergent fiber),
- NDF (neutral detergent fiber),
- NDFD (neutral detergent fiber digestibility, and
- WSC (water soluble carbohydrates).

There are nuances to forage quality with tall fescue:

- Fiber digestibility in relationship to soft leaf and maturity,
- WSC versus fiber digestibility, and
- Differs whether it is grazed versus harvested feed.

(Editor's Note: ADF measures the amount cellulose in the forage plant's cell walls. NDF measures the cellulose and hemicellulose in the cell walls. NDFD is the digestible fraction of the hemicellulose and cellulose. Grasses have a very wide range of NDF digestibility because grass species are so diverse and are utilized at extreme ranges in maturity (e.g. grazing vegetative grass versus feeding straw). Grasses grown under cooler conditions or in northern latitudes have higher NDF digestibility than those grown further south or under hotter conditions. Within a growing season, grass forages can change as well, much of it due to going from cool to hot back to cool temperatures and the attendant soil moisture conditions. Forages are evaluated for NDF digestibility for

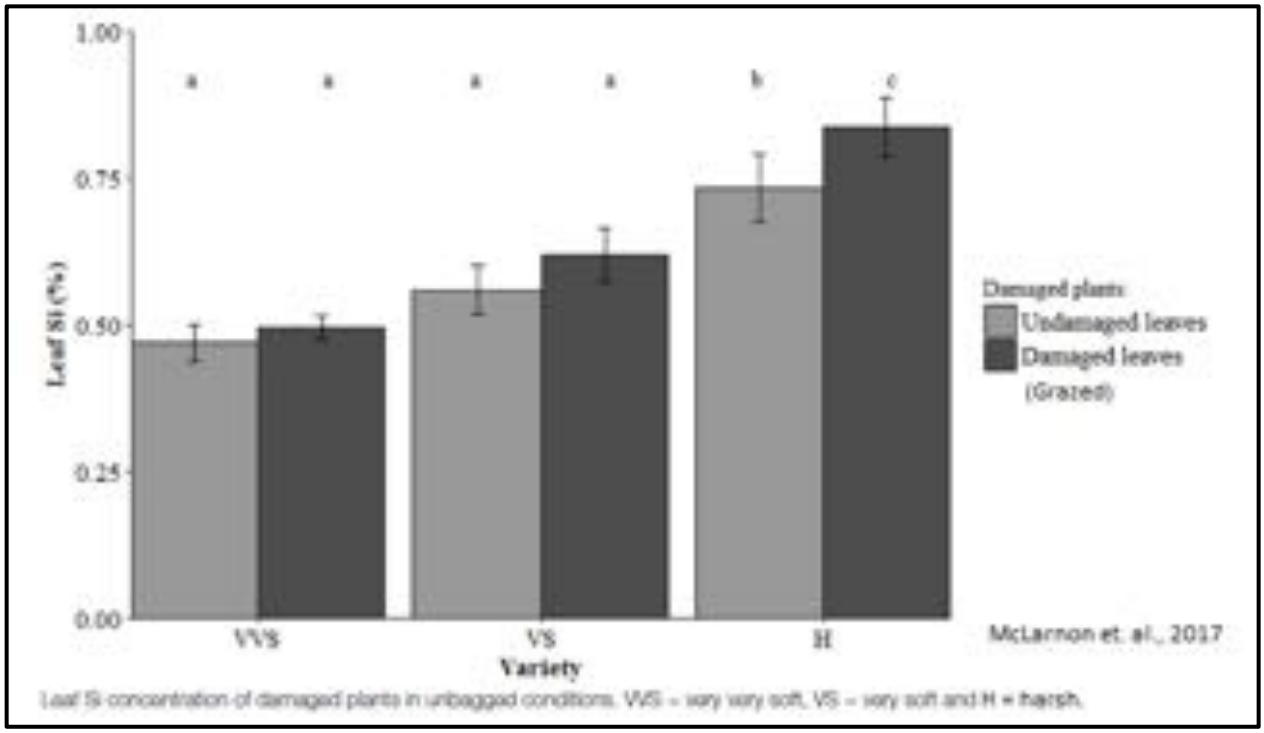
primarily two fundamental reasons: First, research has demonstrated that lactating dairy cows will eat more dry matter (DM) and produce more milk when fed forages that have higher NDF digestibility. Second, while lignin and acid detergent fiber (ADF) have been used in the past to estimate the potential digestibility of NDF and total forage digestibility, recent research has demonstrated that ADF and lignin do not account for all the variation in NDF or forage digestibility. WSC measures the sugars and starch (carbohydrates) of the cell contents, the mono and disaccharides, oligosaccharides, fructans, and starch. WSC is totally digestible while fiber is partially digestible. Soluble fiber is digestible. It slows down rate of passage through the gut. Insoluble fiber is not digested, and speeds up the rate of passage through the gut.)



Seed of newer soft leaf tall fescue varieties have been blended to achieve a higher level of NDFD blend. With laboratory analyses, Barenbrug identified significant differences in the amount of fiber (NDF) and its digestibility (NDFD) between improved varieties. STF-43 is a combination of varieties to provide exceptional levels of digestible fiber per pound of dry matter fed. Fed to high-producing animals, such as lactating dairy cows, STF-43 provides energy derived from digestible fiber as well as the valuable effects of fiber which together promote rumen health and productivity, and, in turn animal health and productivity. Tall fescue or any other grass grazed in the vegetative stage of growth will have NDFD in the excellent range as shown above. As grasses mature, whether or not they produce seedheads, NDFD will drift downward. Once some leaves start to senesce (turn yellow), NDFD will drop into the fair to poor range quickly.

Silicates in tall fescue appear to be a herbivory defense mechanism (Hartley & DeGabriel, 2016). Van Soest et. al. back in 1968 found an increase in silicates led to a decrease in digestibility. In 2016, Cougnon et. al. found that soft genotypes had fewer trichomes (2.74 mm−1) on the leaf margins than coarse genotypes (9.03 mm−1), but there was no relation between leaf softness or trichome number and digestibility ($R^2 = 0.05$), nor between silica content and softness or digestibility ($R^2 = 0.09$). In advanced breeding programs, it becomes difficult to discriminate the leaf softness between genotypes (A plant within a species assigned to a specific intraspecific group based on its genetic makeup). Moreover, there is evidence that the digestibility of the softest varieties is not necessarily higher compared to varieties with coarser leaves. (Editor's Note: How-

ever, the authors do not address palatability in their study. They only mention it as a concern in their opening sentence of the abstract.) They are not aware of any silicate testing in variety development. (Editor's Note: I expand upon silicate content in tall fescue as it is increasingly being found to be a deterrent to grazers. It should be tested for in variety development. Tall fescue has been classified as both a Si accumulator and a nonaccumulator indicating its Si uptake in the natural environment is not uniform. It has the ability to take up and deposit Si upon the leaf epidermis, and that the levels of Si within the leaf tissues and the structures it enriches differ among breeding varieties within the species [very, very soft 0.43%–0.69% Si, harsh 0.46%–0.80% Si] [McLarnon et al., 2017]. Note there is overlap among leaf texture groups. This is due at least in part to the impreciseness of the feel test. It would also explain why a very soft leaf variety may not be any better in palatability that one thought to be harsh. Plants take up Si in the form of monosilicic acid [$Si(OH)_4$] via the roots. It is transported through the xylem and deposited in the leaves to form phytoliths. Phytoliths are solid bodies of silica (SiO_2) found in epidermal layers, both within and between the plant cells [McLarnon et al., 2017]. However, in the McLarnon et al. [2017] research paper, the chart below compares simulated herbivory [damaged] versus undamaged plants of 3 tall fescue varieties selected for their leaf texture characteristics showed a steady increase in silicate from very, very soft to harsh leaf texture in both undamaged leaves and damaged (grazed) leaves. The defense mechanism of silicate build-up after tall fescue is damaged by grazing or some other disturbance is also more muted in the soft leaf varieties than in the harsh leaf variety used in this study.)



(Editor's Notes: In the McLarnon et al. chart above the very, very soft variety has the lowest leaf Si concentration, but is not significantly lower than the very soft leaf variety. The harsh leaf variety has a significantly higher leaf Si concentration when undamaged [ungrazed] state than the

two soft leaf varieties. When damaged [grazed] the leaf Si content rises to an even higher level that is significantly higher than the ungrazed harsh variety and both soft leaf varieties. This would argue that the very, very soft and very soft leaf varieties when grazed would respond very little to increase Si in their leaves whereas the harsh leaf would become even less palatable than it already was before being grazed.

Silicon defenses are deployed as phytoliths or other forms of amorphous silica [SiO_2] in the leaf epidermis, or deposited in spines, trichomes or hairs on the leaf surface. These structures render leaves tough and abrasive and therefore physically deter all herbivores from feeding. In addition, they have been shown to reduce the digestibility of grasses, act as a structural inhibitor of microbial digestion in ruminants, and stimulate other plant defense mechanisms. Adverse effects of silicon on rates of herbivory and animal performance have now been demonstrated on a range of insect herbivores, rodents, and lagomorphs (rabbits, hares, and pikas), and ruminants [Hartley & DeGabriel, 2016]. End of Editor's Notes.)

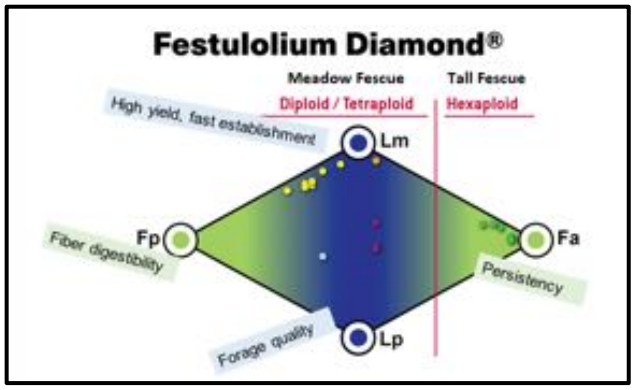
Jerome listed the range of tall fescue types:

- Coarse leaf,
- Traditional leaf,
- Traditional leaf soft leaf, and
- Lax leaf soft leaf.

Perspective from two Oregon producers on using tall fescue was discussed. One uses an earlier maturing tall fescue to get the cows out to pasture earlier in the year. The second producer uses tall fescue to get to pasture sooner and longer into the dry season. The difference in approach is due to the first producer's farm being on class I soils while the second producer's farm is on class II soils more prone to droughtiness.

Role of tall fescue in forage production:

- Widely adapted climate-wise as long as annual rainfall is over 18 inches.
- Widely adapted to soil drainage and soil pH conditions, even saline soils (Alta)
- Drought tolerance response
- Persistence – in for the long haul if proper variety or blend is selected.
- Yield – most productive cool season grass in recent forage trials.



Festulolium is a cross between perennial ryegrass or Italian ryegrass and either meadow fescue or tall fescue (See adjacent figure). It combines the best features of the fescues and the ryegrasses. Perennial ryegrass (Lp in the figure) is well noted to be a high quality forage, but its persistence in much of the US is not very good. Its drought tolerance is low. It winter kills in the northern states (tends to break

dormancy easily during a winter warm spell and gets hammered when it turns cold again). If protected by snow cover, it sometimes gets snow mold and dies. In the South, it can suffer from the summer heat and is susceptible to leaf diseases. *Lolium multiflorum* (Lm in the above figure) is often referred to as Italian ryegrass. It is an annual or biennial depending on where it grows. Obviously, it is short-lived, so not at all desirable in a permanent pasture unless overseeding into a bermudagrass pasture for winter grazing utilization. The two fescues improve upon ryegrass's weak points especially the tendency not to stick around very long. They also maintain forage quality rather than detract from it. Italian ryegrass is fast to germinate, so a festulolium crossbred containing it will produce grazable forage quickly, ideal for emergency pasture or hay use.

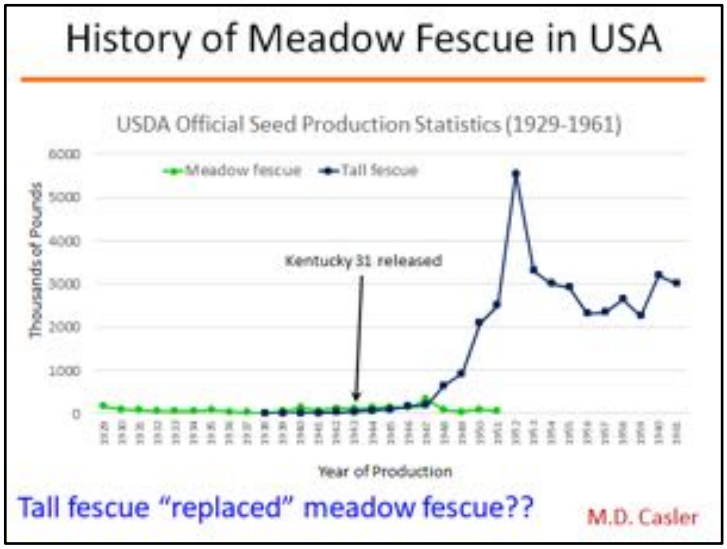
Jerome's concluding remarks were:

1. Tall fescue digestibility and palatability cannot be determined on physical looks.
2. Advances have been made in tall fescue forage quality and palatability

During the question and answer period, Jerome responded to a question about horses being on tall fescue pasture. He stated that most horse owners prefer not to grow tall fescue at all.

The third and last speaker of The Fescues – Soft-leaved and Meadow session was **Jerome Cherney**, E.V. Baker Professor of Agriculture, Soil & Crop Sciences Section, School of Integrative Plant Science, Cornell University, Ithaca, NY. The title of his presentation was "Meadow fescue: A perennial grass option for the Northeast".

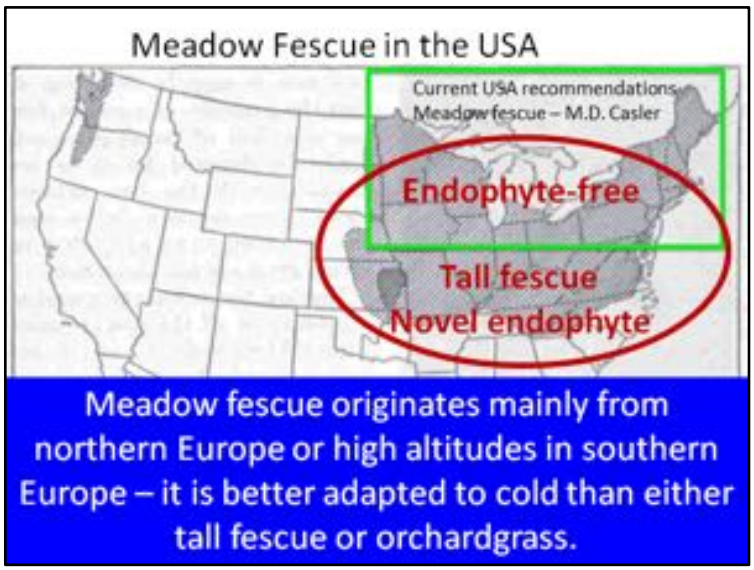
He introduced meadow fescue as a plant that has been around for 11,000 years and thrives in the Northeast, even if it is a slow starter in a pasture or hay field. His forage trials show improvement in forage digestibility when it is sown with alfalfa or other mixtures at one to three pounds per acre. The neutral detergent fiber digestibility (NDFD) is 2 to 4% higher than other grasses. This trait makes it much better in producing milk and daily gain than other fescues. "Just when you think it didn't come up after planting, it'll surprise you," said Cherney. "Don't give up on it."



Jerry has been growing meadow fescue at Cornell for 7-8 years. Mike Casler, USDA, ARS, who rediscovered meadow fescue growing in western Wisconsin, has been selecting it for reintroducing it into US agriculture for 10-11 years. It had naturalized in pastures there and Charles Opitz, dairy farmer, in southwestern Wisconsin found it in a remnant oak savanna pasture in 1990 as an isolated occurrence of an unfamiliar grass. It had the leaf and stem morphology of ryegrass but had the panicle morphology of meadow fescue. He

asked Mike Casler to identify this unknown grass. This spurred Mike on to collect over 4000 samples from over 100 farms. Three different types of DNA analysis were done. Unequivocal identification as meadow fescue (*Schedonorus pratensis*) was the outcome. Meadow fescue was later identified on over 300 WI farms in naturalized pastures.

(Editor's note: The above figure on seed production of meadow fescue posed the question if tall fescue replaced meadow fescue in the US. Reading two heirloom forage books published in the early 20th century indicates that meadow fescue was never used extensively in the US [Piper, 1924] [Wheeler, 1950]. In fact, seed production occurred mainly in four eastern Kansas counties (see darker area in map below), and most of the seed was exported to Europe. Tall fescue "improved" varieties were superior yielding so they smothered meadow fescue in its crib, rather than replacing it. It was grown in New England, the North Atlantic states, and the North Central states. Wheeler [1950] reported that over 3 million pounds of seed were produced in 1947.)



The figure to the left shows the 1909 climatic range of adaptation of meadow fescue (shaded areas). It grows and persists better than tall fescue or orchardgrass in the extreme northern range of adaptation. It is not adapted to southeast US except in the Blue Ridge and Appalachian mountains and Shenandoah Valley. It is also adapted climatically to the Pacific Northwest, west of the Cascade Mountains. Mike Casler narrows the climatic adaptation range in the northeast US to just the green rectangle area.

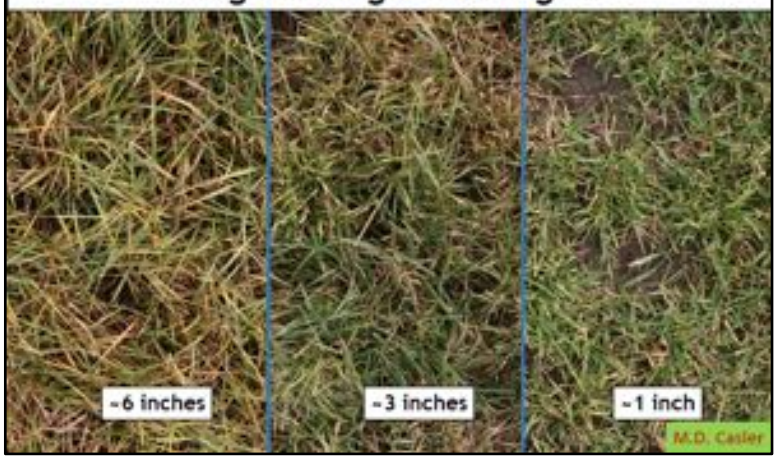
As usual, forage yield trumps forage quality (often overlooked) when agronomists search for new plant materials. However, meadow fescue has a distinct advantage over tall fescue when it comes to quality. It has a fungal endophyte, *Neotyphodium uncinatum*, that is benign to livestock. This endophyte does not produce ergovaline alkaloids as in K-31 tall fescue. Mike sampled 800 plants for endophyte from 8 farms: All plants tested positive for endophyte infection, using enzyme-linked immunosorbent assay (ELISA). There MUST be some fitness advantage! However, the endophyte is short-lived in seed! "Endophyte viability decreased rapidly in all storage environments, going from an average of 29% at the start of the study to 3% after 3.4 years. The endophytes were most durable in freezer storage, while seed stored in room or refrigerator conditions lost almost all viable endophytes. Storage in paper or plastic bags yielded the highest endophyte viability "(Anja Bylin, 2014). (Editor's note: Since these are naturalized stands of meadow fescue, most likely the seed retained endophyte viability until it germinated.)

Meadow Fescue Seeding Rates

- Seeding rate
  - 10 lb/acre in pure stands (Casler)
  - 1-2 lb/acre with alfalfa or red clover (Cherney)

Company MF Seeding Rates	PureStand	Mixes
A	8-12	--
B	15-20	--
C	18-20	3-5
D	25-30	6-15
E	25-35	10-15
F	35-45	2-3
G	35-50	8-10

Effects of three residual sward heights on meadow fescue rotationally stocked at a vegetative growth stage.

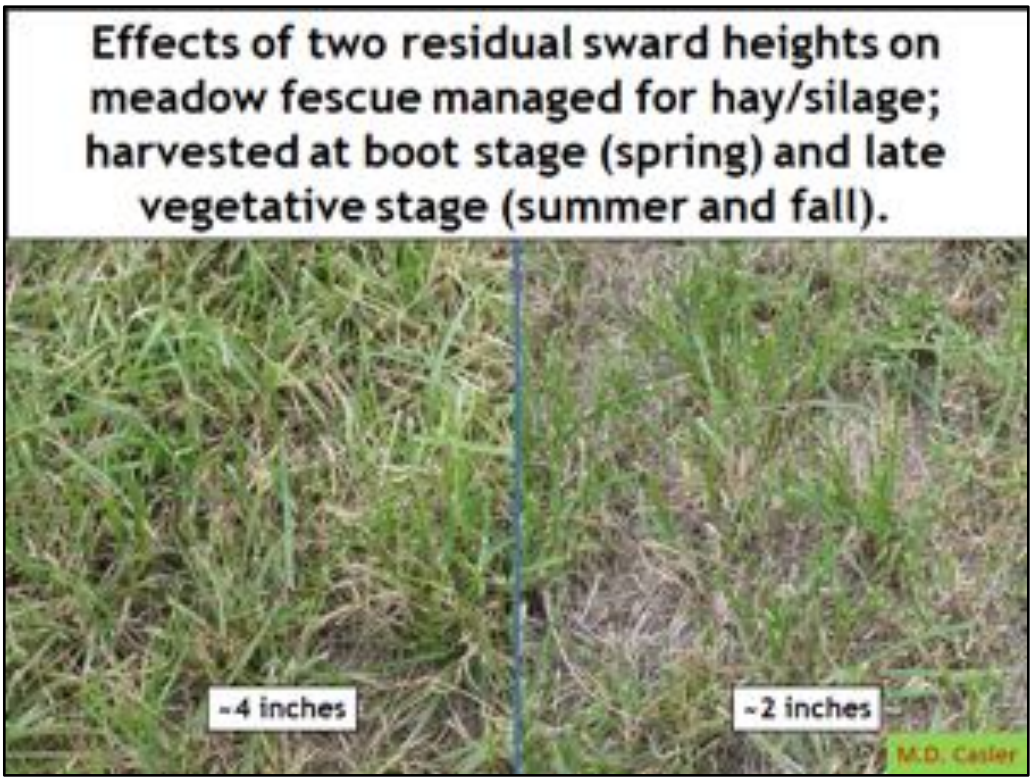


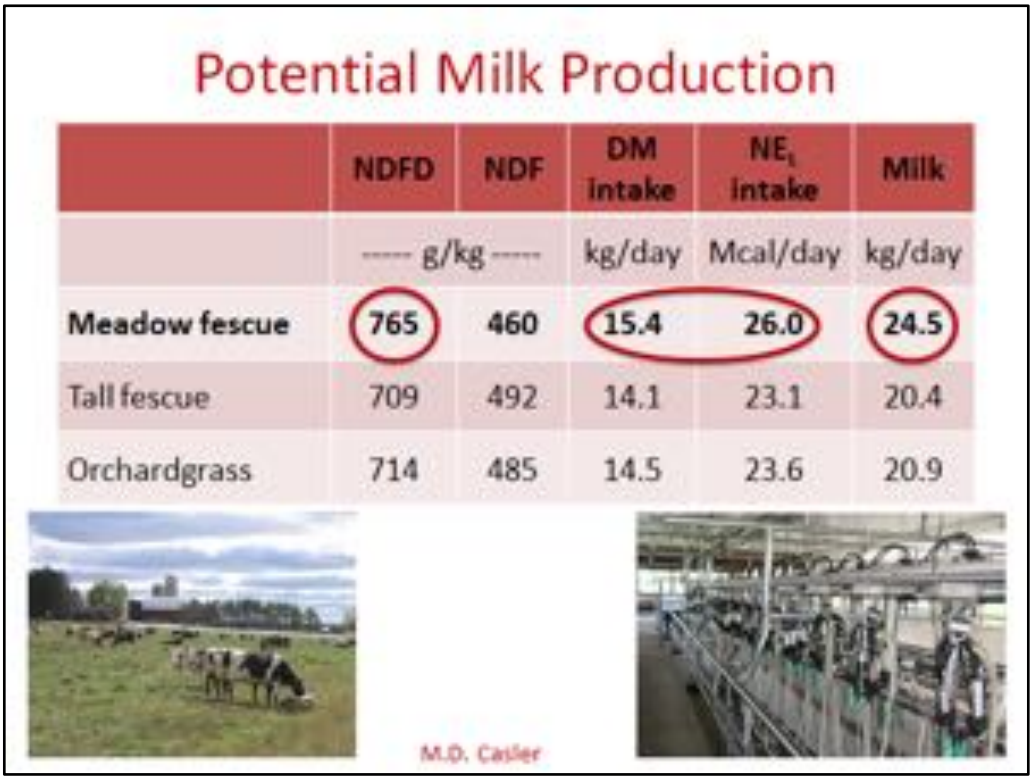
Seeding rates for meadow fescue are all over the place depending on the source. Mike Casler recommends 10 pounds per acre for a pure stand. Jerry recommended 1-2 pounds per acre if seeding it with alfalfa or red clover so as not to compete to much with the legumes. (Editor's notes: One pound of meadow fescue seed has about 225,000 seeds in it [Wheeler, 1950]. Pure live seed (PLS) percentage is 92% for new seed and after 2.2 years is 82%, but over 3 years it is down to 52%. It should be put in cold storage to retain best germination viability (Anja Bylin, 2014). Casler's ten pounds per acre pure stand seeding rate would put down 50 seeds per square foot, or 45 pure live seeds if germination rate were 90%. Even if slow to germinate and grow as a seedling, putting down more seed than this seems overdone. Company F rates are circled in red as being probably best overall of the company rates shown here. The pure stand rate is high, but if germination rate is suspect and seeding equipment and seedbed preparation are also less than perfect, it might ensure a good stand even if seedling attrition was high. Price the seed [≈$145 per 50 lb. bag] and try do a good seeding without mulching the ground with seed.)

Harvest management options:

1. Management intensive grazing (up to 6 events/year)
2. Hay/silage management (3-4 cuts) (or combo)
3. Needs some fertility (100-150 lb. N/acre/yr. or apply manure or sow a legume companion)
4. Overgrazing is highly undesirable, a residual stubble height of ≥3-inch is recommended.

If grazed lower than 3 inches, meadow fescue will begin to thin out. If cut for hay/silage, cutting height recommended is not lower than 4 inches. If cut to leave a 2-inch stubble, will lose stand.

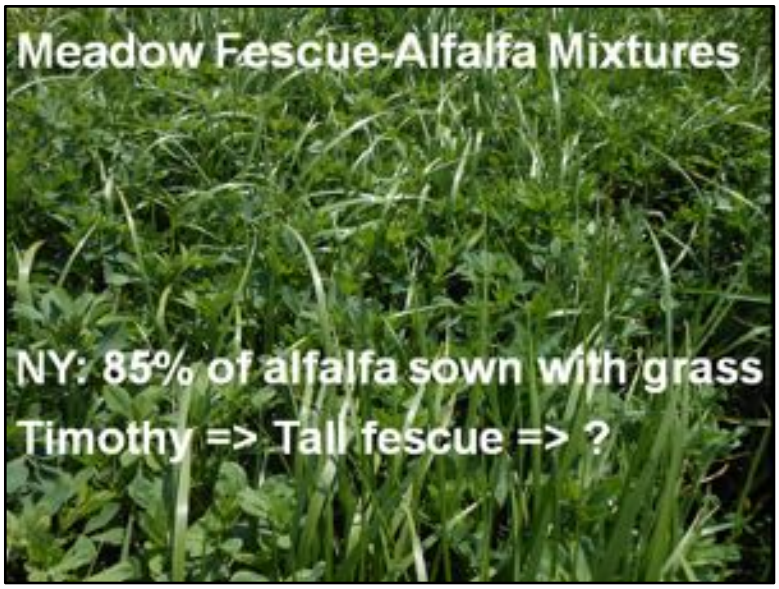




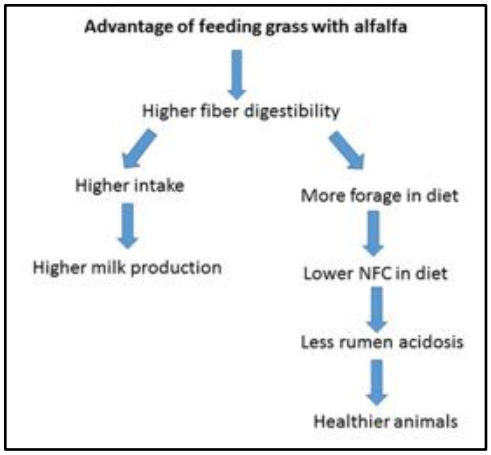
	NDFD	NDF	DM intake	NE_L intake	Milk
	----- g/kg -----		kg/day	Mcal/day	kg/day
Meadow fescue	**765**	**460**	**15.4**	**26.0**	**24.5**
Tall fescue	709	492	14.1	23.1	20.4
Orchardgrass	714	485	14.5	23.6	20.9

Comparing meadow fescue to tall fescue and orchardgrass, its NDF digestibility is considerably higher than the other two grasses. This increases dry matter and net energy lactation intake

allowing milk production to increase over 4 kilograms/day (8.8 pounds/day) over tall fescue and 3.6 kilograms/day (8 pounds/day). (Editor's note: For organic dairy farmers that are feeding their dairy cows an all grass ration, pasturing their cows on meadow fescue could improve milk production over orchardgrass/bluegrass pastures depending on the ratio of orchardgrass to bluegrass. Bluegrass has a much lower NDFD than the others even though it is readily eaten by dairy cows and is definitely preferred over orchardgrass and tall fescue. This may be due, in part, to its usually high to excellent nonstructural carbohydrate (NSC) levels. NDFD and NSC levels both should be considered. A forage type bluegrass variety, such as Ginger, is likely to produce more forage than a wild type bluegrass that is a major limitation to dairy cow intake due to its low stature. Ginger leaves are reported to be twice as tall and wide as other bluegrass varieties.)

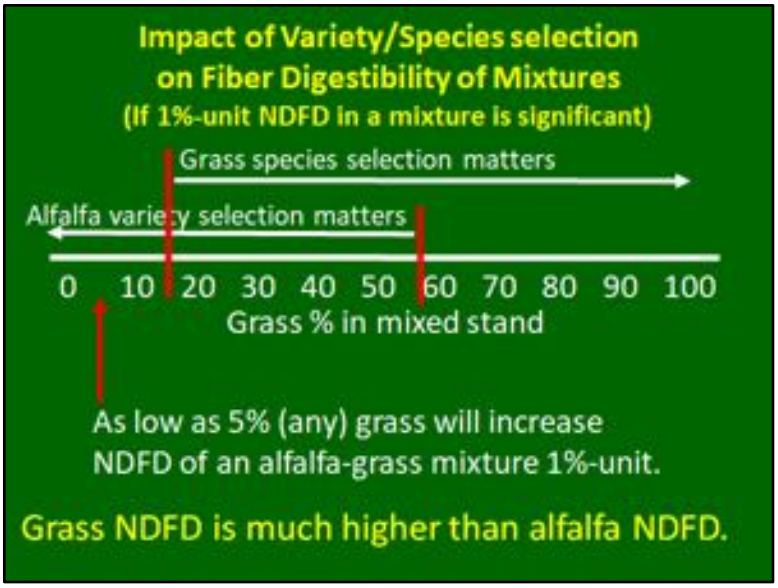


Jerry went on to talk about meadow fescue being seeded with alfalfa for hay production. In NY, most alfalfa stands are seeded with a grass. This is done for a number of good reasons. Most soils in NY are prone to frost heaving. This severs the alfalfa tap root wherever the freeze line in the soil causes the soil above it to heave upward as an ice lens develops at that point. Once the ground thaws out, the heaved soil falls back on the soil below it. This can leave the alfalfa taproot exposed from an inch up to 6 inches depending on the depth of the heaving. The alfalfa plant heaved in this manner usually dies later as temperatures rise (for lack of water) and when harvest equipment rolls over the field (splitting or cracking exposed roots). If grazed, it will suffer trampling and grazing damage. Grass-alfalfa mixtures tend to dry down faster when mowed for haylage or dry hay so the hay crop can be removed sooner to avoid rain damage while curing. It also produces better forage quality.

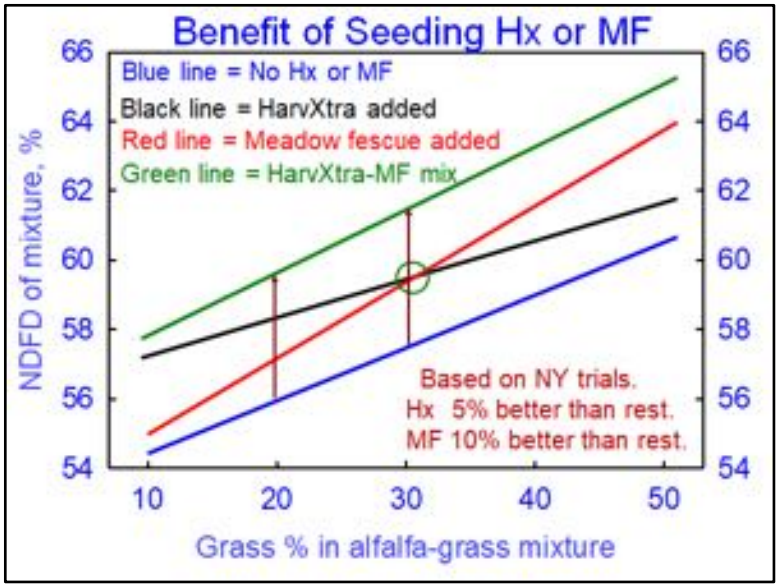


As shown in the diagram to the left, an alfalfa-grass mix has higher fiber digestibility that allows higher forage intake by the dairy cow that creates the condition for higher milk production. Grass NDFD is much higher than alfalfa NDFD. With more forage in the diet, dairy cows fed a grain supplement will have a lesser amount of non-fiber concentrate (NFC) in the diet. This will lessen the chance for rumen acidosis to occur leading to a healthier dairy cow fed in confinement. For dairy, 20-30% grass is the goal. This is why Jerry recommends only a 1-2 lbs./acre seeding rate. In his trials where seeding rates ranged from

a 0.5 pound to 4 pounds/acre, a 1-2 pound seeding rate easily reached the goal of 20-30% of forage dry matter (DM) as grass. He has found the Textrax meadow fescue variety to be ideal companion grass with alfalfa among the 19 different meadow fescue varieties he has observed. It is less aggressive than other meadow fescue varieties while being among the highest in NDFD.

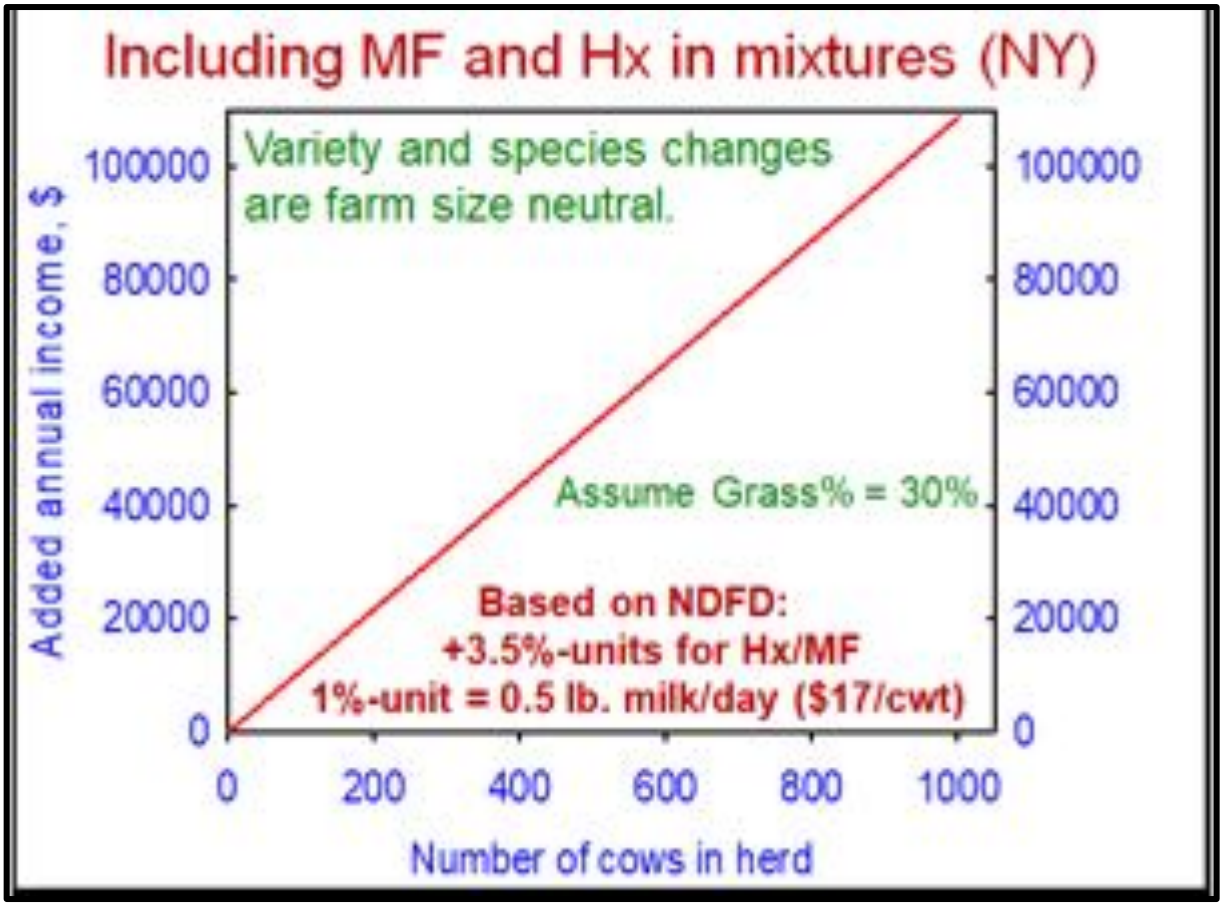


Alfalfa variety selection and grass species selection matters in getting the proper % DM production as grass. Alfalfa has to be aggressive enough not to let the grass take-over while grass species selection has to be done so as not to over-whelm the alfalfa stand regardless of variety selected. If 5% of the DM is grass, then NDFD of an alfalfa-grass mixture will increase by one percentage unit. This is extremely important in producing more milk from dairy cows, as a one percentage unit increase in NDFD produces 0.5 pound more milk/cow/day.



To get the best NDFD in an alfalfa-grass mixture, a combination of a new alfalfa low lignin variety called HarvXtra and a meadow fescue like Textrax is ideal. As shown in the figure to the left, the green line depicts the HarvXtra and meadow fescue mixture that yields the highest level of NDFD achieved as percent of grass increases in the alfalfa-grass mixture. This is an increase of 3.5 percentage points over a higher lignin alfalfa variety and a grass other than meadow fescue stand at 30% grass, 70% alfalfa.

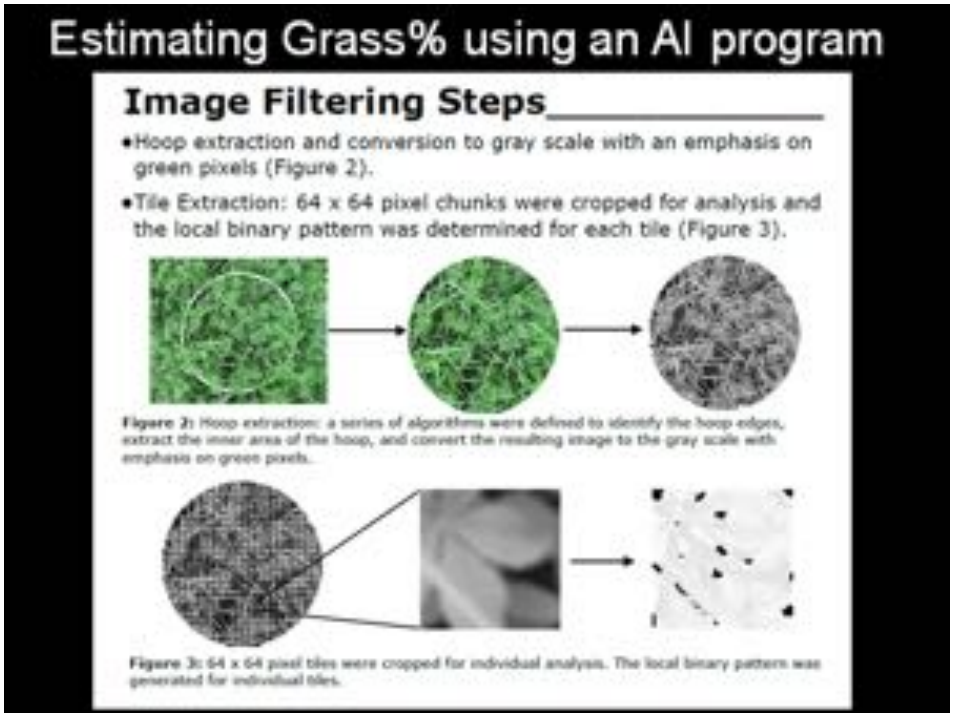
Looking at the added income that comes with having a alfalfa-grass mixture that is 30% meadow fescue and 70% HarvXtra alfalfa, the next figure shows that it is farm size neutral. Small dairy herd or a large dairy herd gets the same boost in income by increasing the NDFD percentage in the forage dry matter fed to lactating dairy cows. See figure below.



The pros far outweigh the cons of growing an alfalfa-grass mixture for hay or haylage. Many of the pros were covered earlier. Winterkill of the alfalfa is primarily from frost heave damage. The more fibrous root system of the grass tends to make the soil less prone to frost heave and rutting up with machinery traffic as easily as it would in a pure alfalfa stand. Alfalfa pests and diseases are less prevalent when a grass is grown with it. Soil health is improved by the greater root mass in the top 8 inches of soil when grasses are present. Organic matter will increase over time and soil structure is likely to improve since stand life is longer so less tillage is involved to reseed. Less erosion on steep hillside fields is likely to occur than it would if it were pure alfalfa, especially as the alfalfa stand thins out but is still an economic stand. On the con side, forage quality is variable from cutting to cutting as

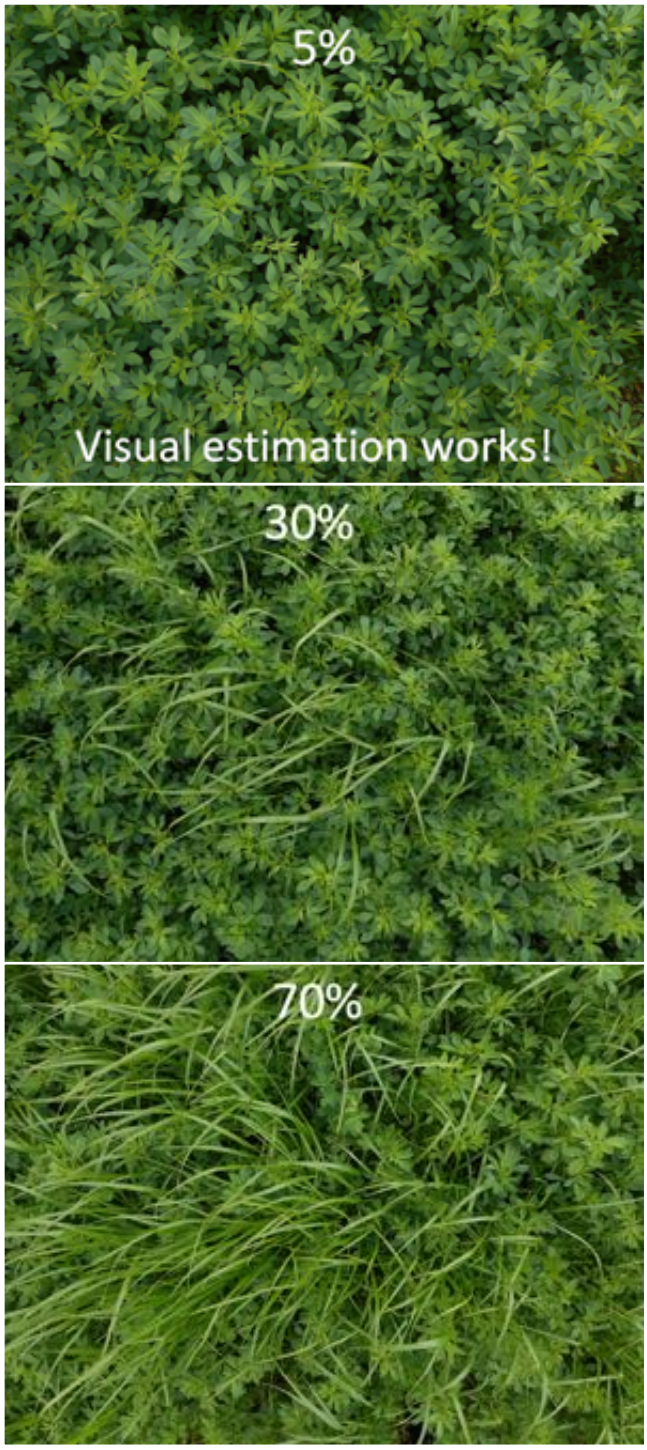
grass and alfalfa content will vary with the weather and time of year. As the stand ages, grass will become a greater part of the DM yield. Weed control is limited as most herbicides to control weeds in alfalfa are likely to kill the grass. Roundup-ready alfalfa varieties could not have Round-up applied to them if grown in association with grasses.

Jerry ended his presentation by outlining his meadow fescue-alfalfa forage trial plans for 2020. He aims to investigate 6 to 8 meadow fescue cultivars at three grass seeding rates that have a range in NDFD and % of grass in the mixture. He would like to expand the number of test sites to perhaps include other states in the Northeast. He feels we need to assess the variability of the mixture response to climatic and soil conditions around the Region.



During this presentation, Jerry talked about a new method of determining percent of grass by weight in an alfalfa-grass mixture using artificial intelligence (AI). This methodology would be

useful to other forage researchers, and agencies, such as NRCS, with their pasture inventory in determining plant species composition of pastures by weight.



A procedure such as the Dry Weight Rank Method does a good job of approximating plant species composition by weight as it ranks the top three plant species in a hoop or quadrat by dry weight using visual estimation by the observer. AI could reduce some of the subjectivity by refereeing the close calls when species rank is hard to determine by eye. This is especially true for legumes and broadleaf weeds that can have a high cover percentage that can lead the observer to overestimate their content by weight. The AI program would likely have to be more sophisticated and highly calibrated for a variety of species.

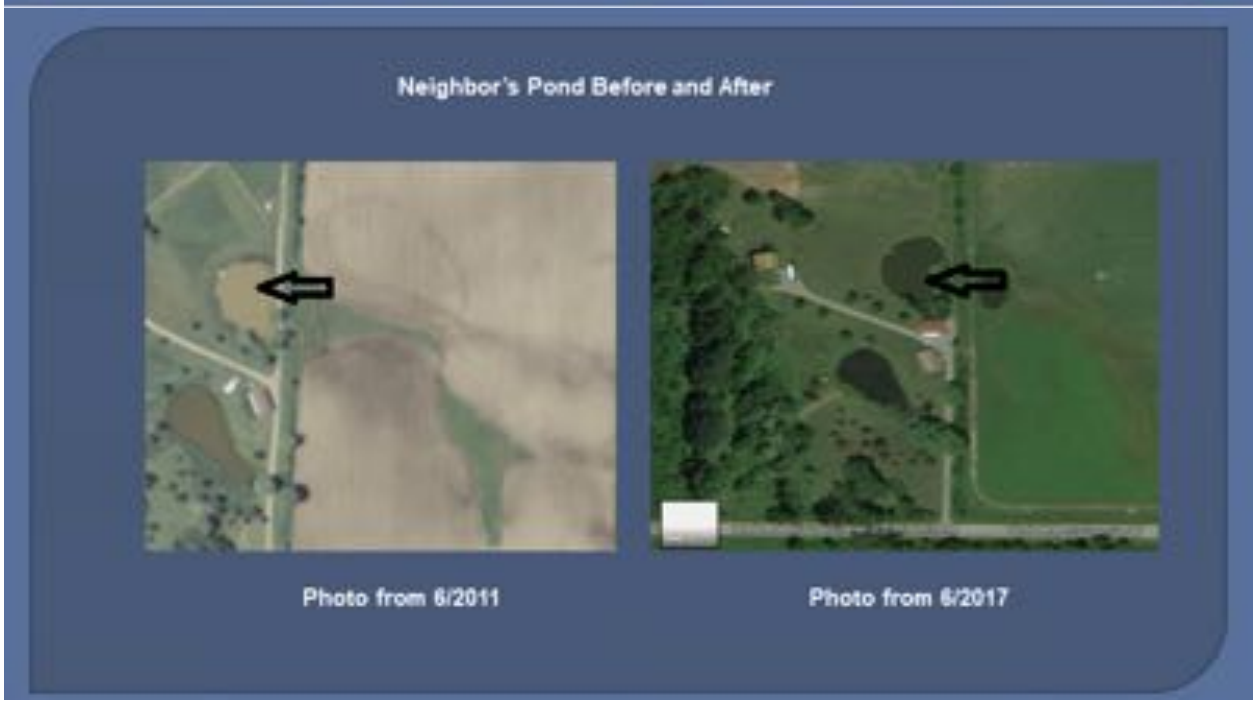
Session 2 – Pastured Pigs – Feed and Grazing Management

This session was moderated by Don Wild, who has raised pigs on pasture. He noted that when pigs were let in a paddock to graze reed canarygrass, they stopped grazing the grass in 3 to 4 minutes. This happened three different times with the same effect. Pigs did not like the alkaloid found in high alkaloid reed canarygrass that is prevalent in naturalized stands of it. Biofeedback is rather immediate with them and they will not graze it any further.

He then introduced **Phil Race**, our featured speaker for this session. Don recruited Phil to speak about his pastured pig operation. The title of his presentation was "Harnessing the Instinctive Behaviors of Pigs on Our Farm". Phil Race, co-owner of Valley View Devons with Sharon Pierce in Nunda, NY is new to farming having started just 6 years ago. Before this, he owned and operated an optical molding company for 25 years and opened and operated an archery shop for 10 years. Phil and Sharon aspire to be a regenerative farming operation with a touch of homesteading. They raise 100% grassfed/finished beef, pastured/woodlot pork, and egg layers.

The practices that they employ on their farm are based on their overall goals, climate, and the time and resources available to them. After their initial decision to undertake this challenge, they traveled to farms that were using methods they thought they wanted to employ, attended conferences and pasture walks, and did extensive reading. Among the publications they read regularly and continue to refer to are *The Stockman Grass Farmer* and *Acres USA*. They also subscribe to the on-line publication, *On-Pasture*. Over time they have also realized that personal observation of the animals and the land is extremely vital. Take the time to reflect and adjust.

Their farm is 250 acres located in western New York, 50 miles south of Rochester, nearby Letchworth State Park. Valley View Devons has been in existence for 6 years. Phil has owned the land for 35 years as a recreational property. It has 40 acres of pasture and 210 acres of hardwoods. They lease 25 acres to produce hay for their Devon cattle. For 60 + years prior to their commitment to regenerative farming practices, the 40-acre pasture was in a soybean/corn rotation. It was plowed annually and treated with herbicides and pesticides. Its fertility was derived from petrochemical-based fertilizers.



The two photos above show the difference in water clarity in a neighbor's pond after the cropland on the Valley View Devons farm was converted to permanent pasture. Muddy pond water in the June 2011 photo versus clear water in the June 2017 photo.

During the grazing season, they employ Managed Intensive Grazing practices. Their cattle are moved at least once daily in order to avoid overgrazing and distribute fertility evenly throughout the pastures. There is now life in the soil. Their soils are recovering from many decades of destructive practices and the healing process is still in progress, but they feel their land is becoming more resilient.

With background laid on how they got their farm in shape to raise beef, hogs, and chickens on pasture, Phil went into detail on his hog enterprise. They chose to raise a heritage breed of hogs

called the Large Black Hog after some initial experimentation with Tamworths. They settled on these priorities for selecting a hog breed that can be raised and thrive on pasture:

- Hardiness and ability to thrive in our particular environment/weather conditions
- Meat quality
- Good maternal instincts (to raise lots of piglets to weaning)
- Ability to forage
- Docility (for ease of handling and moving around pasture), and
- Maintain genetic diversity using heritage breeds (member of the Livestock Conservancy).

Large Black Hog sow with suckling piglets shortly after birth in November

Large Black Hogs on red clover pasture

The Large Black hog is known for its large size and ability to thrive on pasture and forest foraging. This talent is put to full use on this farm as they are on pasture and used in managing the many wooded acres on the farm. The Large Black hog has remarkable maternal instincts. The sows can give birth to and wean large litters successfully. Their piglets have the highest survival rate among hog breeds because of the sow's mothering abilities. Due to their docility, they also move easily when moving them with an electrified break

fence or other means.

Feeding hogs on pasture essentials:
- Vital to supply fresh, clean water
- Supplemental feed required daily

Hogs are not ruminants, but are monogastrics (one stomach). Therefore, there is a limit to how much forage they can eat even among hog breeds that are genetically more disposed to foraging. This is why supplemental feed is required daily. In this operation, only one farrowing of pigs is done per year. The young pigs grow over a year's time before going to slaughter. This means daily supplemental feed amounts can be small compared to farms where 2 litters per sow are normally raised yearly. (Editor's Note: Spring and fall farrowing were common place in mid-20th century whether the hogs were on pasture or raised in total confinement. This requires a full grain supplement for pastured growing pigs. Sows can survive on mostly pasture alone, if legume based, unless suckling pigs. A small A-frame hut could house a sow and her litter when farrowed on pasture. The A-shape kept the sow from laying on her piglets when laying down to nurse or rest.)

Note how polywire is positioned over the water trough to keep hogs from using it as a way to stay cool.

Supplemental Feed (Total cost per ton- $520.00):
Per ton:
- 200 lbs. of corn
- 850 lbs. of barley
- 850 lbs. of triticale
- 50 lbs. of diatomaceous earth
- 50 lbs. of hog mineral

Hogs consume 3 percent of their body weight (BW) in food per day. When finishing them for 3 weeks, they can eat 5-6 percent of their BW. Supplemental feed and pasture grasses/hay are available year-around. In addition:

- May - September
  - Woodlot forages
- May – November
  - Garden vegetables grown on the farm
  - Sweet corn
- September – January
  - Apples
  - Pumpkins (natural dewormer)

Pig Feed from farm grown pumpkins and neighbor's apple orchard rejects. Pumpkin patch in right picture.

Phil had three different methods of moving pigs depending on the circumstance.

Under 400 pounds, with front-end loader & crate

Over 400 pounds, walk them to distant point.

Moving pig herd to adjoining paddock by providing some good stuff

When on pasture, fencing for pigs is a permanent high tensile electric fence perimeter with a single strand poly line, set at 12” to 14” on step-in posts inside the high tensile perimeter fence. A strand set at 6” is used for predator control to protect piglets. See picture below.

In the woods, the fencing is poly line strung on step-in posts. This single strand is at approximately 12”-14” in height. Electricity is provided using a marine battery. See picture below.

The piglets are trained at 3 to 4 weeks of age to respect electric fencing. At first, they jump forwards until they learn to back-off instead.

Their breeding program is set up to accomplish the following:

- Litters are timed to take advantage of when forage is most plentiful - April to December.

- Boar and sow breed on a July 1st timeframe.
- Farrowing is at the beginning of November.
- In April, piglets weighing 30-40 pounds are moved into an area where grasses are more readily available.

A well-thought out infrastructure is needed to farrow (give birth to) piglets. They use a 5 x 8 ft. metal Quonset type hut made by Port-A-Hut. A farrowing bar is installed along the wall in the interior to prevent, or at least reduce the possibility of, the sow from lying on piglets. A "pig safe" heating pad is installed off-to-the-side under the farrowing bar for the piglets to keep warm since they are born in November. For the first couple of weeks, they leave a light on as another safeguard.

Interior of farrowing hut showing farrowing bar and the red heating pad with piglets taking a nap on it.

Phil outlined some hog duties and responsibilities to remain on the farm.

- Must breed yearly for farrowing in November,
- Compost aerators from April 1st to May 15th (animal instead of machine),
- Manage woodlot for regeneration (must be 80 lbs.): May 15th- September 15th, and
- Till undesired areas of pasture for reseeding from September 15th to November when processing is scheduled.

Pigs aerating waste hay while foraging in beef cattle winter sacrifice lot. Note leanness of pigs.

On April 1st, their hogs move into a 1 ½ acre winter cattle sacrifice area. Their main purpose is aerating the waste hay and loosening up the soil to prepare it for seeding. On May 15th, the pigs are moved into the woodlots and the area is reseeded.

Aside from raising healthy animals to provide healthy, tasty pork for the table, woodlot management has become an important purpose for having pigs on the farm. They have a 200-acre woodlot that has been in the New York state 480A program for 30 years. Property taxes on these acres are reduced by 80 percent. The major obstacle with putting livestock in the woods was the 480A forestry program. When housing animals in a woodlot environment:

- It must be good for the timber.
- It must be good for the soil.
- It must be good for the water.
- And, It must be good for the animal.

Ordinarily the program does not allow animals in the woods. Cattle can damage the bark on trees especially at the ground line where their hooves can cause wounds there, allowing insects to invade and rot to develop. They can damage the bark further up by using the trees as rubbing posts. They also can severely damage small saplings if they rub against them and even break off the leader. However, Phil worked with a professional forester to plan to use hogs as timber stand improvement (TSI) facilitators. Hogs root up the soil, making seed to ground contact more sure. They also consume seedling beech and ironwood trees that are undesirable species growing in their woodlot. The hogs are moved quickly to avoid compacting the soil and tree damage.

In the middle of the photo, a tread-in post fence divides a before and after hog rooting event. Unwanted tree seedlings are destroyed and a good seedbed for oak regeneration is left.

A May time frame is used to begin stocking hogs in the woodlot for two reasons: Young pigs are now around 80-90 pounds, and it is the most effective way of controlling undesirable species (beech and ironwood) when their energy is above the ground.

Observations made in the first year:

- The pigs were much happier in the woods because it was so much cooler (upwards of 20º F.).
- Weight gains were better.
- Need for supplemental feed decreased.
- Better ground to seed contact caused better germination of acorns.
- The pigs were spreading their fertility.
- And, one negative, a solution was required to prevent tree damage. (They found that hogs go for the moss growing on the base of white oaks (primarily) that damages the bark if they are allowed enough time to do extensive rooting and feeding at the base.)

Pigs lying in the shade of woodlot trees on recently rooted ground to cool off.

They have made two changes to their woodlot program from the initial year:

- Perform TSI work **AFTER** pigs have rooted an area (They use the trimmings to protect new seedlings from deer browsing).
- Once the seedbed is created, pigs should not enter this area again for a significant period.

Photo to the left shows several oak acorns lying on bare soil caused by the rooting of hogs earlier in the year. Only wildlife will have access to these acorns as the hogs will not return to this area for several years. With 200 acres of woodlot, the hogs have a lot of work to do to improve timber stands by weeding out the undesirable trees and preparing a good seedbed for the favored species here, oaks.

They return their pigs to pasture from September 15th until harvest on November 15th for these reasons:

- Hunting season (bow and then rifle season for deer, too unsafe in woodlot)
- Temperatures have moderated and sunlight more accessible to keep pigs comfortable.
- And, it is not a desired time for TSI work.

In closing, Phil went back to his presentation title: "Harnessing the Instinctive Behaviors of Pigs". Pasturing is a very difficult process with an animal that likes to root, especially a breed that was selected for rooting behavior. Pasture pigs in areas that need to be reseeded. They prepare the ground for the following spring without using herbicides. This is why he chose to keep them in the woodlot most of the summer. It was good for the woodlot and the pigs. Meanwhile, most the pasture acreage is left unrooted except for areas in most need of being renovated. Hence, their pig schedule:

- Breeding - July 1st
- Farrowing - November 1st
- Composters - April 1st- May 15th
- Woodlot - May 15th- September 15th
- Pasture - September 15th- November 15th
- Harvested - November 15th

They love to do farm tours to build community and educate young people about pasture farming.

The editor is deeply gratified with the great graphics used in putting together the PowerPoint presentation by Sharon Pierce. It was very good documentation of pigs on pasture and woodlot.

Session 3 - The Do's and Don'ts of Silvopasture

This session was moderated by Daimon Meeh, USDA, Natural Resources Conservation Service, Dover, NH. He put this session together as he felt as others have in the Agency that some landowners had a misconception of what silvopasture is. He arranged to have three speakers address this issue so people will better understand what is involved in practicing real silvopasture management.

The first speaker was Kate MacFarland, Assistant Agroforester, USDA National Agroforestry Center, Burlington, VT. Her presentation was entitled: "Silvopasture: Site and Management Considerations". Kate began her presentation with a definition of silvopasture. Silvopasture is an agroforestry practice that intentionally and sustainably produces trees (or shrubs), forage, and livestock in a single integrated system. The USDA-NRCS Conservation Practice Standard 381 for silvopasture defines it further as "Establishment and/or management of desired trees and forages on the same land unit". There are two paths to silvopasture:

- **Pasture to Silvopasture**: trees are deliberately introduced or enhanced to a forage production system
- **Forest to Silvopasture**: forage crops are deliberately introduced or enhanced in a timber or tree crop production system.

Forest to silvopasture with grass introduced

Pasture to silvopasture with rows of trees introduced and protected from grazing and trampling

Two definitive characteristics of silvopastures are:

1. Management of the livestock type, timing, and impact maintains forage and tree health and rooting zones that stabilize soil in silvopastures.
2. Trees are actively cultivated in silvopasture systems and stem density is controlled to encourage forage and tree vigor.

In order to effectively do the first characteristic, **long rest periods** are needed in the Northeast. Often livestock are only in a silvopasture for a few days (1-7) over the course of a growing season. This has to be done to protect the tree rooting zone, its trunk, and any lower branches until sufficient tree growth is achieved to have enough canopy for vigorous photosynthesis. Silvopasture requires both grassland expertise and forestry expertise to be effectively managed.

Silvopasture is not:

- Single trees in pastures
- Turning livestock into the woods
- "Feedlots with trees"

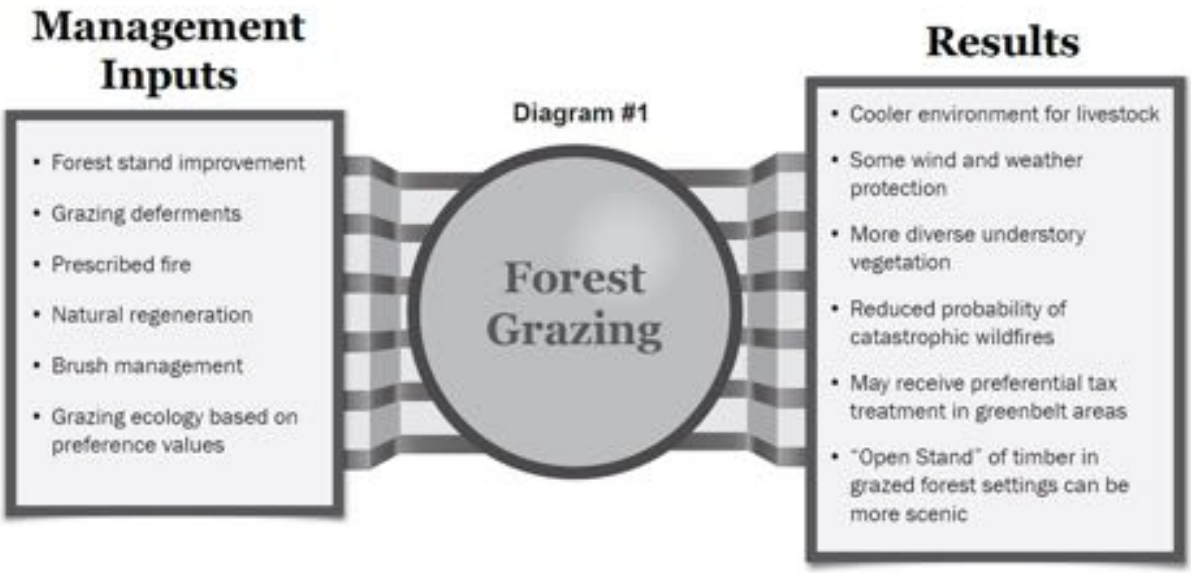
Why not? Problems with root compaction, tree girdling, soil degradation, and livestock parasite problems.

Picture on the left was taken in early spring and the cattle are already seeking out shade wherever a lone tree stands. This is particularly the case where endophyte-infected tall fescue is dominant in the grass stand. This is not silvopasture because the trees will never be of merchantable value and may die from root compaction or girdling anyway. Often times animal wastes accumulate here concentrating nutrients under or near trees and lessening deposition in the open grassy areas, over-fertilizing trees and under-fertilizing grass.

This picture is a forest with virtually no forage base after repeated long term grazing and occupation by cattle. The mature trees are still alive, but there are other examples in the Northeast Region where many mature trees die from too much traffic compaction and root and bark damage.

This is definitely a pig feedlot with trees. No understory to eat so all the feed eaten comes from hauled-in feed. This area most likely is adjacent to an open bare ground feedlot where the feed can be easily put out for the pigs. This is done for pig comfort alone; therefore, it is not silvopasture. There is no forage base. The trees are being severely stressed and eventually, one by one, they will die.

Silvopasture is not forest grazing, which often has the goal of supporting the native ecosystem. Forest grazing was what Phil Race was doing on his farm's woodlot.



Steps needed for turning pasture to silvopasture

1. Gather a team of people with the right expertise.
2. Assess the site.
3. Select trees appropriate to site conditions.
4. Make sure these trees also meet manager goals: produce a light shade, produce desired products (nuts, timber, syrup), high value, deeply rooted (lots of near or at surface roots not good, easily hurt by compaction and hoof damage).
5. Determine planting configuration: shade management, mowing, fencing, product growth and harvest.
6. Weed control: mechanical, herbicide, mulch, and
7. Protect trees from grazing animals until well-established and then graze rotationally on a one day – 3-day occupancy, and then use a long return interval.

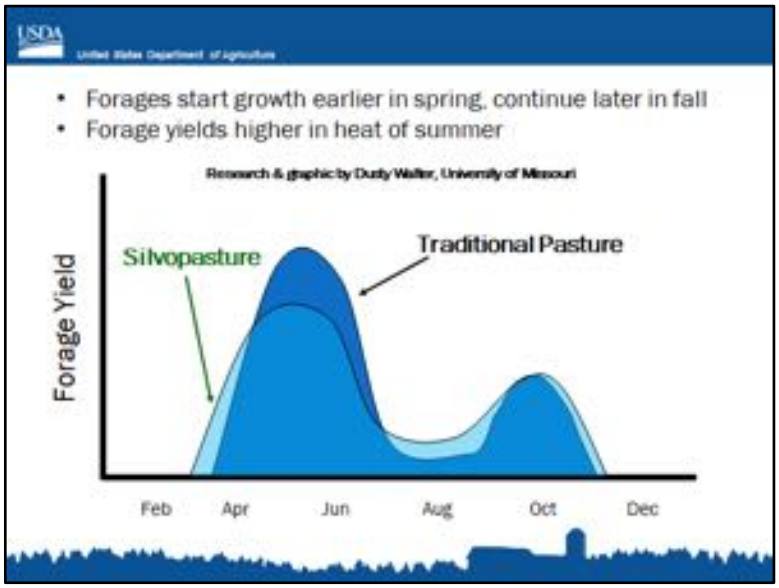
Steps needed for turning forest to silvopasture

1. Gather a team of people with the right expertise.
2. Assess the site.
3. Select the highest quality trees to remain as crop trees (thin for quality).
4. Modify stand density to allow adequate sunlight to reach the ground (thin for light).
5. Meet the germination requirements for target forage species.
6. Manage the system to avoid negatively pressuring desirable plants and forage (seasonal short duration rotational grazing).

The benefits of silvopasture are the following:

- Incentive to manage woodlands, especially on farms
- Vegetation management: reducing invasive plant species threats

- Aesthetically pleasing, important to landowners
- Management for forage can benefit trees
- Can support high quality forage and diversify animal diets
- Improve forage availability during the summer slump
- Improved nutrient distribution of animal wastes as area is shade neutral.



The livestock benefits of silvopasture related to reduced heat and cold stress are:

- Improved animal condition,
- Improved milk production,
- Improved breeding efficiency,
- Improved feed intake, and
- Improved weight gain.

Reduced heat stress: Shade is probably beneficial any time Temperature-Humidity Index (THI) is above 72, especially if livestock are grazing endophyte-infected tall fescue. Below is the temperature -humidity index chart that can tell the livestock producer when to stock livestock on their silvopasture acres.

(Editor's Note: In the eastern United States, it does not take a lot of humidity at high temperatures to cause livestock heat stress. At 80° F., 40% relative humidity yields at THI of 73. During the warmer months, average relative humidity levels are usually 55% or higher, such as at noon local time in July. If they seek shade, they eat less and drop in weight gain and milk yield.)

Figure 1. Temperature Humidity Index (THI)[1] for Dairy Cows. Modified from Dr. Frank Wierama (1990), Department of Agricultural Engineering, The University of Arizona, Tucson, Arizona.

DEG	RELATIVE HUMIDITY																				
F	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
75														72	72	73	73	74	74	75	75
80							72	72	73	73	74	74	75	76	76	77	78	78	79	79	80
85			72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	84	85
90	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90
95	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
100	77	78	79	80	82	83	84	85	86	87	88	90	91	92	93	94	95	97	98	99	
105	79	80	82	83	84	86	87	88	89	91	92	93	95	96	97						
110	81	83	84	86	87	89	90	91	93	94	96	97									
115	84	85	87	88	90	91	93	95	96	87											
120	86	88	89	91	93	94	96	98													

NO STRESS
MILD STRESS
MEDIUM STRESS
SEVERE STRESS

The economic benefits of silvopasture are:

- Multiple use, multiple revenue,
- Short term and long-term income sources,
- Risk management: livestock and wood economic boom/bust cycles do not coincide (unlike crops and livestock), and
- Ease of harvesting timber when the time comes (can be felled and removed with less damage to surrounding trees and interference by them in the harvest operation).

The challenges of silvopasture are many:

- Without proper management, high risk of short- and long-term environmental failure,
- Not easy,
- Not right for many sites,
- Requires highly skilled managers and consultants,
- Silvopasture systems change over time requiring management changes,
- Forest regeneration (some solutions: long term livestock exclusion, linear fencing of tree rows or individual fencing of trees), and
- May have considerations for tax and land use programs.

In the picture to the left, individual trees that were planted in a pasture being converted to silvopasture were fenced to keep cattle away from them. This is not an easy task and must be looked after to make sure the fence has not been damaged and rendered useless or more harmful. Linear fencing of trees would not be feasible in a plantation setting as the pasture corridors would be very long and narrow, and a lot of fencing. Windbreak plantings spaced much further apart might be a better situation.

Silvopasture site requirements should conform to these principles:

- **Site quality**: site capable of growing agricultural crops and/or quality timber.
- **Access**: Relatively easy to reach the location with materials, equipment, and livestock.
- **Erosion concerns**: Site can tolerate managed grazing during heavy rainfalls with negligible long-term impacts.
- **Hazards**: No significant risks such as deep gullies, flood-prone streams, etc.
- **Terrain/"fence-ability"**: Site can be enclosed with a secure fence with minimal clearing and excavation.
- **Water**: Potable water is readily available on location for livestock.
- **Size/shape/location**: Area is adjacent to existing grazing operation, large enough to justify the investment in developing it, and a shape that allows for efficient fencing.

Silvopasture also requires a manager that:

- Is already comfortable practicing rotational grazing,
- Has the time/labor available to move animals often,
- Is comfortable working with a system that changes over time,
- Is willing to work without a recipe (adaptive management),
- Has a team: foresters need grazing knowledge and vice versa, and
- Likes working with and learning from others.

USDA
United States Department of Agriculture

Acres of Forest Grazing in New England

State	Land in pasture	Woodland pasture	No. of farms using woodland pasture*	% of total pasture acreage that is woodland pasture
	(ac)			
Connecticut	72,018	21,081	1,056 (24)	29
Massachusetts	85,760	17,837	1,093 (59)	21
Maine	118,980	27,105	1,103 (58)	23
New Hampshire	46,446	12,647	706 (54)	27
New York	985,494	146,995	5,286 (186)	15
Rhode Island	10,098	2,281	198 (7)	23
Vermont	195,000	37,100	1,184 (68)	19
Region	1,513,796	264,846	10,626 (456)	17

Of total pastureland in the region, 1 in 6 acres (17%) is woodland pasture. In the New England states, the proportion of woodland pasture to total pasture area is more than 1 in 5 (22%). These data are from the Census of Agriculture, but the management of these pastures was not addressed (Vilsack and Clark 2014).
* Number of farms self-identifying as practicing alley cropping or silvopasture is parenthesis

Orefice, J., and J. Carroll. 2016. Silvopasture, it's not a load of manure: differentiating between silvopasture and wooded livestock paddocks in the northeastern United States. *Journal of Forestry*: 2017.

Examples of silvopasture include these choices:

- Introduce trees to a pasture,
- Introduce or enhance forage in a timber or tree crop system,
- Most people using silvopasture have some silvopasture pastures and some without trees: It is not all or nothing, and
- They stock with different kinds of livestock: cattle, goats, sheep, poultry, and other grazers.

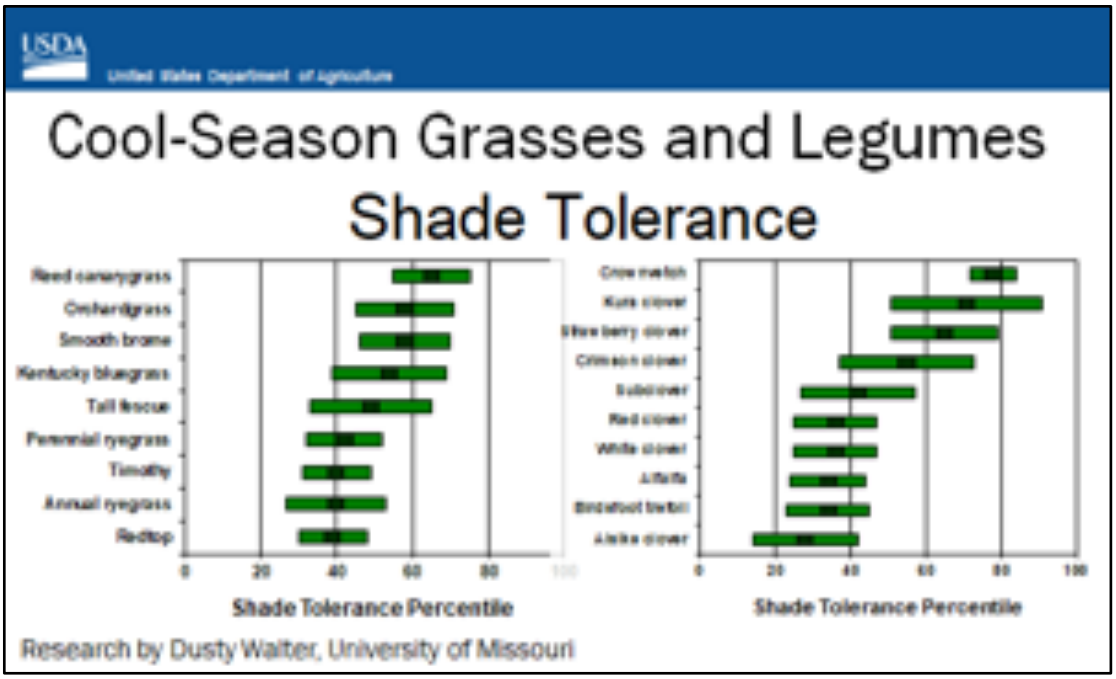
Kate listed some of her conclusions concerning the adoption of silvopasture:

- Opportunity for some but not all: sites and people,
- As in everything, site characteristics, design, and management matters,
- Start small, and
- We are still learning about how to best fit silvopasture to northeastern ag systems and forests – please learn with us. Recommends **Cornell Forest Connect website** for info.

Under 50% shade, cool season grasses and forbs (includes legumes):

1. Increase or maintain yield, and
2. Improve quality:
    - Reduced lignin and improved digestibility,
    - Increased, or no change, in ADF, NDF, CP, and
    - Improved N content (careful with this, can get too high as nitrate).

(Editor's Note: Similar results were achieved at the Appalachian Farming Systems Center at Beaver, WV when they looked at forage yields and quality on their research silvopastures.)

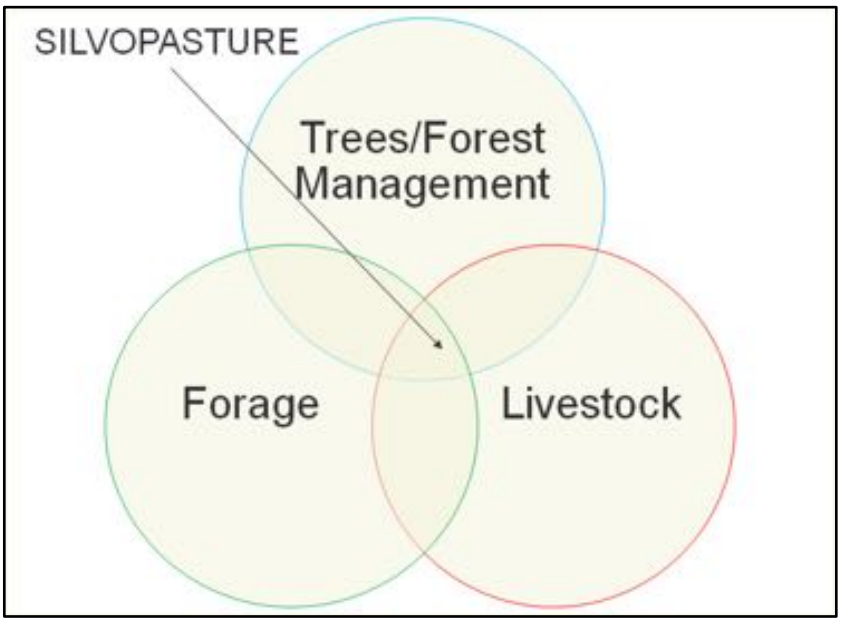


The last PowerPoint slide shown by Kate was on shade tolerance of grasses and legumes to show which ones can be used in seeding forests that have been thinned to provide enough sunlight to reach the forest floor to grow shade tolerant forages. Orchardgrass ranked second to reed canarygrass, but is the best shade tolerant pasture grass of the two from a management standpoint. Smooth bromegrass was a bit of a surprise, but perhaps does alright in diffuse shade. On the legume side, most of the legumes grown in the Northeast are not very shade tolerant except for crownvetch. Perhaps some of the wild vetches are similar in shade tolerance that have naturalized in some New England pastures. Kura clover has not fared well in getting established here. The next 3 clovers below Kura clover are adapted to warmer climates than exist in the Northeast.

She also recommended *Silvopasture Guide* by Joe Orefice.

The second speaker in this session was **Jeff Jourdain**, consultant forester of Jourdain Forest Management, from Becket, MA. The title of his presentation was "Experiences Establishing Silvopasture from a Forest". This is the most common pathway for developing a silvopasture in the Northeast. Most farms here can be forestland rich and pastureland poor. Some of the forestland may be mostly stocked with low-value trees. Silvopasture can be used to open up the canopy to grow grazable grass while culling out the low-quality trees and keeping the better quality trees.

Jeff started out his presentation from a forester's perspective: Long history of being trained that livestock and forests do not mix. "Domestic grazing animals not only retard natural reproduction but compact the soil by trampling, injure natural cover, and expose the surface to erosion." "Grazing injury is a distinct threat to forest management and must be considered with other destructive factors in any protection plans." (Introduction to Forestry, Sharpe et al 1976.)



This is an old mantra that still holds true if silvopasture management is not followed with the guidance of a forester and a logger that can be trusted to do thinning and removal of slash well so as to do the least harm to the soil and remaining trees. A professional forester is key as they can better recognize the trees that are merchantable or not. They also know how much basal area should remain behind to grow grass well and release the merchantable trees from unwanted competition from invasives and low-value trees. As Kate said, Jeff reiterated to be

realistic in how many acres you want to convert to silvopasture as it is scalable. If things go well, more acreage can be included later if site conditions allow it and you wish to have more. Silvopasture requires follow-through to ensure that it remains productive for both trees and forage growth. More thinning is likely to be needed to keep the basal area within guidelines (so that canopy openness remains about the same with time). Silvopasture requires patience as forage productivity may take some time. Long-time forests may have very acidic soils that are detrimental to good forage production. Liming the area to lessen soil acidity likely will be required.

In the diagram above, silvopasture works well when forest management, forage management, and livestock management are all considered equally important on silvopasture acres. Notice the three overlap in a small portion of each. The forest will be thinned to a less dense stand that if it were only managed for trees. Forage production will be less in silvopasture than an open pasture even though its quality might improve due to influence of shade cooling the climate the forage is growing in. Livestock production in turn would be higher (higher stocking rate) if it were open pasture and perhaps some other means of shade, if needed, were available.

The forestry must be sound. No resource is managed to the detriment of the others.

So how do we go from these three forest situations (a grazed forest with no understory, an ungrazed forest with a heavy understory, and a mixed hardwood-softwood forest) shown above to get to a silvopasture shown in the picture below:

Angus cattle in a silvopasture - dense pasture in a young, open tree stand

Its starts with a plan. What do we have to work with? Identify the forest resource. Hardwood? Softwood? Volumes? Stocking (trees) levels? Then, Where is it? How do we get to it? And as importantly – You need to identify your goals and objectives. The planning stage and the implementation must meet your goals. And of course – SOUND FORESTRY. Leave the best quality trees!

One of the parts of planning is putting the 'team' together. Find a forester you can work with and a logger who you can work with. Both have expertise in areas most landowners have little know-how and experience in.

Establishing silvopastures takes care, planning, and management. More management than running livestock on open pasture as you need to look out for the trees as well as the grass. This may require longer rest periods between grazing events and perhaps different seasonal grazing and rest strategies depending how weather events, tree species, and forage species affect them. You will also need: Dedication, investment, time, patience, and most of all **Reasonable Expectations**.

Jeff gave some examples of scale of silvopasture operations. Scalable – ½ acre to???? There is a 170-acre cut going on in NY. Mill River Farm – New Marlborough, MA 3 acres. Silvopasture for goats using hardwood bolts for shitake. Prairie Whale Restaurant – Great Barrington, MA 6-acre

silvopasture for pigs for the restaurant. These projects just do not have enough volume to justify a large commercial operation.

Identify trees to be cut and as importantly which trees to be left. Trees with blue spray paint on them are to be removed.

So, we know what we have for a resource , we have a suitable plan as to what and how much we need to cut, and we have identified the trees to cut or leave. Now how do we get the trees out of the woods? Starting with equipment needs - Depends on where you are located, markets, and landowner goals and objectives. If you are in an area where whole tree harvesting is carried out, this will leave you with one of the 'cleanest' sites for a silvopasture. Chipping is common in Central Mass [Quabbin area], portions of NH, and ME. VT? It is not common in Western Mass or the remainder of southern New England. Some of the equipment is shown below.

Feller-Buncher in operation

Skidder for removing logs and slash

Chipping is a highly efficient way to get rid of small diameter and low value wood products. It can also be marketable. See picture below where a skidder is hauling slash to a chipper.

Skidders come in different sizes and configurations. A grapple skidder is a large machine. It windrows or stockpiles tree tops and is efficient and cost-effective. Anticipate 6 to 8 slash piles on 30 acres.

Farm tractor logging is an option. Fit equipment to the size of the operation. Tractor uses a front-end loader and a fork-lift on the back. More labor intensive but utilizes farm machinery more completely and saves on hired labor and equipment.

You are looking to get as 'clean' a site as possible to allow for the movement of livestock. Avoid stony sites unless you plan to remove surface stones as well. If you are seeding it for silvopasture, this allows grass seed to come in contact with soil for better germination. A 3-point hitch spin broadcast seeder is called for using a small tractor or use a hand spinner in really tight areas. See newly seeded site at the left. Not much room to get in between and around closer spaced trees.

Another concern for harvesting/utilizing sunlight is the midstory/understory. Low shade is often harder to work with than high shade. Since it is understocked forest to begin with, cull rate is going to be low. Some trees will have to remain even if not of high quality until canopy gets denser and needs to be opened up more to grow grass well by culling a few more poor quality trees.

Follow-through is important. Without follow through you end up with……Well, an incomplete project.

Now for some not so positive experiences:

This photo shows a silvopasture site about 2 years after cutting. No grazing, no fencing. This area was cut hard to remove hemlock affected by hemlock woolly adelgid (HWA). It was not seeded to grass. Heavy pin cherry seedling and regrowth has occurred with other volunteer woody undergrowth present. This site would be difficult and expensive to restore to seed to a forage mixture. Follow-through did not occur.

Similar situation here. Not only was the site not seeded after thinning tree stand and removing slash, there is not enough livestock (goats) placed on the site for them to browse enough to keep up with the growth rate of the ferns and other browse on the site. Understory is redeveloping. No interior fencing to confine goats to small areas which would help increase stock density to at least clean-up portions of the whole silvopasture. Then, seed heavily browsed areas as goats are moved to a new area.

Establishment of forage/grasses should be immediately after harvesting cull trees and slash. Wintertime harvest is ideal so that the silvopasture site can be seeded in early spring. Site disturbance has the most exposed soil right after harvest, and there is the least amount of understory competition available. Since stumps are left, quick regrowth from those stumps can occur since there is a big root reserve to make them explode. Some seedlings are sure to survive and seeds/acorns of trees are going to spring to life too as more sunlight reaches the forest floor.

In Jeff's closing remarks, he quotes three sentences: "Thinning wooded areas to adequately open the forest canopy is the single most important factor to develop and sustain a productive silvopasture" [Chedzoy & Smallidge]. "Whether thinning for silvopasture or for 'traditional' forestry – forest management is predominantly light management" [Smallidge]. Brett Chedzoy of Cornell Cooperative Extension and Angus Glen Farm recommends starting small. As he puts it 'Better a small train wreck than a big train wreck'.

Jeff then gave this additional tip in getting forage seed out on silvopasture. Use hay with live

seeds of desirable forages (Not mulch hay quality). You can place round bales on undesirable plants/invasives to smother or destroy them with hoof action by feeding livestock.

Cattle feeding on two round bales placed on late winter silvopasture site. Both are set close to bramble patches.

Round bale feeding site in early spring on silvopasture

The hay bale feeding area enriches the soil with waste hay organic matter. Livestock waste will be concentrated around this feeding area to feed grass growing around it. As the season progresses, any hay seeds left in the waste hay will germinate readily as the waste hay retains moisture in the soil below it. Once the seeds sprout, they will have abundant moisture and nutrients to grow quickly.

The final speaker of this session was **Kevin Ogles**, Grazing Lands Specialist, USDA-NRCS, East National Technology Support Center, Greensboro, NC. His presentation was revised from the one listed in the Conference agenda to "Silvopasture: Land Manager Verbal and Non-Verbal Communication". He did this to stress the point that there is confusion on what silvopasture really is. Some people say they are doing a form of silvopasture when they really are not. It is not necessarily to deceive others or themselves, but their visualization of what silvopasture is. He gave this analogy. A simple thing like a lawn mower can be visualized by people in many different ways depending on their experiences over their lifetime. A lawn mower can be a gas-powered push mower, an electric cord push lawn mower, a reel type push lawn mower, and perhaps a battery-powered push mower. Then, there are self-propelled push type lawn mowers that only need to be directed by the user. Then, as the yard size or area to be mowed increases, there are riding lawn mowers of various sizes and designs for homeowners and yard maintenance people. There may even be mowers that are pulled by a tractor or all-terrain vehicle by highway maintenance crews and other people needing to cover a lot of ground or on very steep sideslopes.

So, Kevin started out with a few examples of what silvopasture is not with some great visuals. The first one Kevin displayed was used by Justin Morris in his presentation in 2018 on pasture soil health, but Kevin's second slide beats that one for showing what can happen in a grazed woodlot on a steep hillside depending on what is fenced off for woodland pasture to avoid very steep terrain in constructing the fence. Below is that slide. No caption sound bite does it justice, so as editor I explain what it depicts.

(Editor' Notes: The picture above shows a typical woodland pasture that I have seen everywhere that I have traveled in the US for NRCS - which is nearly all of it. This is why, as Jeff Jourdain said earlier, foresters in general are against having livestock, especially cattle in the 'woods'. This is NOT silvopasture as the woods, the cattle, and the open pasture are all losers in this situation. The fence around it costs more than the amount of forage produced for livestock consumption. Whatever number of years is picked to pay back fencing costs, even if the fence were to last 20 years before posts rot or rust off at the groundline or the wire gets too rusty and brittle, the fence would not pay for itself. Then, there is the maintenance which can be considerable if the cattle are trying to find something to eat on the other side of the fence, and they **will** find an opening or make one. Meanwhile, the forest is degrading. Money is lost as an opportunity cost because the fence is not protecting the woods, but actually contributing to its decline.

This picture also shows a form of erosion that occurs wherever cattle are forced onto a steep slope with a pliable (plastic) soil. It is called cattle terracettes. "Terracettes are a combination of repetitious bench, path-like, and riser, slope-like, features that exist on pastured hills with >15° (27%) slope in semiarid environments of the western United States as well as throughout the world."(Mark Corrao, 2016) Note in the picture above that the cattle are all treading across a steep slope, most of it is less than 27% but it is in a wetter climate. They have created a series of parallel cowpaths at short intervals down the slope. As a cow path deepens from compaction, it captures rainwater and runoff running down the slope. The soil below it becomes more saturated, and with further animal traffic, it begins to slump downhill due the force of the steps the cows exert on the path and the increased plasticity of the soil under it (wetter so more malleable). "Increased antecedent soil moisture conditions on terracetted sites as opposed to non-terracetted sites may lead to increases in runoff or erosion, at least partially, from plant root impedance and soil structural alterations resulting from compaction."(Mark Corrao, 2016) The erosion here comes mainly as soil slump or creep, and it is created by cattle. It would not have occurred on this slope without cattle traffic going across it repeatedly. The more they traverse the slope; the worse it gets. Near the top of the grassed part of the steep slope, a large soil slump has occurred on the steepest portion of the slope. This may be caused by a haul road. There are several cattle using this as a walkway. The rest of the cattle herd are more dispersed on several parallel cowpaths. There are four cattle actually trying to scrounge for grass a few feet downslope of the large slump. They all graze upslope. They cannot graze downslope because they are not giraffes; hence, the short intervals between paths. The rest of the herd realized the futility of finding much to eat on this slope and are merely crossing it, hoping there is something on the other side. Good luck with that.

The last comment about the above photograph is that it was taken in early spring. There is little to no grass, so why are the cattle there? We look at the woods in the background. There is no understory left. The forest is a dense stand of trees so when the hardwoods leaf-out, the sunlight now reaching the forest floor will not occur. This is woodland pasture with little thought about management or the consequences.)

The next photograph Kevin presented was one of some Angus cattle standing or lounging in a dense stand of evergreens. The thought here was to give them natural protection from winter's cold weather and get them out of the wind. This takes into consideration the livestock, but it is the only thing being considered. No out-of-pocket money to house them there. Just hope they do not poke themselves in the eye on a dead branch. They look cozy there, but the trees are getting pruned of their branches, and sadly, their roots. No worries about the forage, they are just hay bales anyway.

Kevin's next picture is at a woven wire/barbed wire fence shot into a heavily utilized woodland pasture with a tree stocking density that makes it inhospitable to forage production. The livestock should be in the field where the photographer is. The fence could then protect the forest. This woodland pasture though might be a good candidate for silvopasture if soil drainage is good and there are potential quality trees still left in it. It needs to be thinned of some of it trees to open up the tree canopy. There is some scattered sunlight reaching the floor now, but is well short of what is needed to grow forages for grazing. Below the two strands of barbed wire and to the left of the steel post, the woven wire is beginning to sag due to cows putting their heads and necks between the lower barbed wire and the woven wire. As the cows reach for a bit of grass on the

photographer's side of the fence, they push down on the woven wire, and in an attempt to reach further through the fence, the cows can push forward and deform the woven wire even more. Eventually, it will be a way to escape. Note cattle browse line at bottom of the tree canopy.

This photo shows a full canopy pine forest. This too could be thinned to open up the canopy. However, it may have a very acidic soil that would hinder forage production greatly if not limed to raise the soil to near neutral in acidity. Some acidic soils also have high levels of soluble (exchangeable) aluminum (AL) in them that is toxic to most cool season pasture grasses and legumes causing them to fail to grow or grow poorly. Only native warm season grasses are tolerant to high levels of exchangeable AL.

This picture shows a declining orchard in a nice stand of grass. The trees are past their prime so rather than going to silvopasture, it might be better to decide on pasture if the goal is to raise some livestock on it rather than cropping it. It would be less labor intensive than renovating it as an orchard that will need to be carefully maintained to grow merchantable fruit or nuts and not done overnight.

To the left is a well-kept nut tree plantation that is grassed, but mowed instead of being grazed. This could support a few grazing animals if the landowner were so inclined. It would need fencing, exterior and interior. The grazing enterprise would be done primarily to keep the grass short so as not to compete with the trees for moisture and to aid in harvesting the nut crop. Judging by the way each tree is mulched around their base, most likely a livestock program is not in the cards with this landowner.

Kevin showed us another picture of a pine windbreak between two closely-mowed grassy fields. This windbreak is treated better than most with each tree being mulched around its base. A paved highway was in the foreground and the grass mowed to its edge. No fencing visible anywhere. To utilize the two grassy areas as pasture, fencing was have to be installed, perimeter and interior. The windbreak could be protected with fencing on both sides that are installed at the edge of the tree dripline. The trees are tall enough to cast shade on one grassy area so it could act as shelter for getting out of the sun and possibly the wind depending on direction for each side of the windbreak. It would not be silvopasture.

Here is an existing pasture that has a lot of bare ground and is weedy. This pasture needs some pasture management first before raising the idea that it be planned as a silvopasture. First things first. Take baby steps with this landowner. Go for a more simple pasture management plan rather than putting silvopasture complexity on top of it. Trees would have to be planted and protected from livestock damage. Is that likely to happen, seeing the condition the pasture is in now?

This landowner is doing things right with their pasture. If the landowner were interested in doing silvopasture to provide some shade for the cattle, they would likely be successful with it. They are taking the time and effort to be the best of pasture managers. They would approach silvopasture in the same manner if they decided to give it a try.

Kevin ended his presentation showing the conference attendees a well-grassed and maintained silvopasture with primarily pole-sized trees growing on it. Grass is lush. It is early spring so most of the forest floor is bathed in sunshine. This is a successful silvopasture that promotes a healthy young forest, a lush forage sward, and healthy goats and sheep. As time and weather permit, a bit more slash could be picked up to grow more grass. A small chain saw and a cart behind a ATV is all that is needed to haul away some firewood.

Poster Paper Break Session

Between Session 3 and Session 4, an hour-long poster paper session was held while people had access to refreshments. The poster paper session informs stakeholders about ongoing Regional research and education projects. This year's 15 poster papers were the most that we have had at a single Conference and covered many diverse topics: the efficacy and accuracy of in-field brix measurements on forage crops, production management practices on organic grass-fed dairy farms, updating the pasture condition scoresheet, the implications of mob and rotational grazing systems on plant diversity along with forage yield and quality, evaluating compaction BMP effects on soils, environmental assessments of grass-based dairy production, soil carbon storage in pastures, using a grazing chart as a planning and monitoring tool, evaluating water quality BMPs in the Chesapeake Bay Watershed, prebiotic effects on health-promoting dairy bacterial cultures, and converting low-grade sheep wool into pellets that can be used as a slow-release nitrogen fertilizer for vegetable farms. Fourteen abstracts of these papers are presented below.

Livestock Management

Survey of Production Management Practices on Organic, Grass-Fed Dairy Farms in the United States

M.A. Snider*[1], S.E. Ziegler[2], H.M. Darby[2], K.J. Soder[3], A.F. Brito[4], B. Beidler[5], S. Flack[6], S.L. Greenwood,[1] and M.T. Niles[§7]

[1]Department of Animal and Veterinary Sciences, University of Vermont, Burlington, VT 05405
[2]University of Vermont Extension, University of Vermont, St. Albans, VT 05478
[3]USDA-ARS Pasture Systems and Watershed Management Research Unit, Curtin Road, University Park, PA 16802
[4]Department of Biological Sciences, University of New Hampshire, Durham, NH 03824
[5]Beidler Family Farm, Randolph, VT 05061
[6]Sarah Flack Consulting, Enosburg Falls, VT 05450
[7]Department of Nutrition and Food Science, University of Vermont, Burlington, VT 05405
[§]Corresponding author: mtniles@uvm.edu

During the last decade, organic dairy production has rapidly grown in the United States with the consumer market for organic milk growing from 1.9% to 5.0% of total milk sales. However, many organic dairy producers are currently facing economic challenges due to the fluctuating milk market and a decline in milk prices. This, as well as personal philosophy and a need for sustainability, has led some organic producers to shift towards grass-fed dairy production and the grass-fed milk market, which is growing faster than many other dairy sectors. Demographic and management data regarding organic dairy production have previously been reported, but there is a

*Presenter

lack of research outlining commercial use of grass-fed organic dairy production practices and producer-identified research needs. The objectives of this study were to 1) assess information regarding current production practices, including herd health, economic data, milk production, and producer knowledge on grass-based dairy farms, and 2) identify areas of research and outreach to advance the organic, grass-fed dairy industry across the United States via survey methods.

A survey questionnaire was mailed to 351 grass-fed dairy farms throughout the United States. Producers were asked to report on farm characteristics and demographics, forage and animal production practices, and producer perceptions regarding management practices. The survey response rate was 46.7% with the majority of respondents farming in NY, OH, WI, PA, and VT; the remaining farms were located in IA, MD, VA, OR, MN, NH, MA, FL, KS, NJ, and IN. Surveyed producers were an average age of 47.6 years old, 10 years younger than the national average. Over 60% of respondents reported that they identified as part of the plain community, correlating with the percentage of producers that indicated that they never utilize technology on the farm.

The average farm consisted of 219 acres of pasture and an average herd size of 49 cows: equating to 4.47 grazed acres per mature dairy cow. In total, 63% of producers reported needing to purchase additional forages; this indicates that the estimated average 4.47 acres per cow is not producing all necessary forage. Most farms (96.3%) reported that they have been certified organic for an average of 10.3 years and grass-fed (84.2%) for 5.1 years. The majority of producers reported utilizing grazing systems in which cattle where moved to new paddocks twice or more daily with an average of 197 grazing days per year (minimum 140 d – 360 d); this wide range is most likely dependent on geographic location. Producers that indicated that they were at least satisfied with their milk production (71.8%) also indicated a high level of knowledge in understanding forage quality test results, growing higher energy forages, and strategies for improving forage quality. These same producers indicated that on a scale of very unsatisfied to very satisfied, they were at least somewhat satisfied with pasture qualities, such as soil health, forage quality, and yield. From these perceptions and demographic data, needs for additional research identified include creating financial and production benchmarks to help expand adoption and marketing of grass-fed production systems and products.

Assessing the efficacy of in-field brix measurements for forage sugar and energy content

Eric D. Billman*[1], Kathy J. Soder[1], Jeff Horst[2], Kristi Balk[3], and Aimee N. Hafla[4]
[1]USDA-ARS, Pasture Systems and Watershed Management Research Unit, Building 3702 Curtin Road, University Park, PA 16802-3702
[2]Laboratory Production Manager, Agri-King, Inc., Fulton, IL
[3]Laboratory Production Assistant, Agri-King, Inc., Fulton, IL
[4]Beef Nutritionist, Agri-King, Inc., Fulton, IL

In recent years, some dairy and livestock producers have been using Brix refractometers, which

*Presenter

measure the refractive index of dissolved solids, to provide an estimate of forage sugar and energy content without needing to rely on expensive laboratory testing. However, little validation of the Brix Index has been conducted in forage crops, leading some to question the efficacy of the system for forages. The objective of this study was to compare and validate Brix readings with wet chemistry values, and determine if the Brix Index is a reliable way to assess forage sugar content. Four sampling periods occurred on a 25 - 30-day basis between May and August 2019. At each sampling, eight alfalfa and orchardgrass samples were collected, with three Brix readings per sample measured on a digital Brix refractometer. Samples were flash-frozen, freeze-dried, and analyzed via wet-lab analyses for total and individual sugar concentrations and nutritive value (Agri-King, Inc., Fulton, IL). Brix values were correlated with lab analyses in SAS 9.4. Brix values were either: a) negatively correlated ($P < 0.01$) to wet-lab analyses of total sugars (-0.65), glucose (-0.64), and fructose (-0.68) in orchardgrass, or b) not correlated ($P > 0.2$) to total sugars, glucose, and fructose in alfalfa. Conversely, Brix values of both orchardgrass and alfalfa were positively correlated ($P < 0.01$) to NDF (0.57 – 0.58) and hemicellulose (0.42 – 0.55), along with ADF of alfalfa (0.54). There was no correlation between Brix values and commercially-used metrics for forage quality, including TDN, RFV, and RFQ. These findings indicated that the Brix index is not a reliable way to assess the sugar content of forages. Producers should consider more accurate methods of analysis for assessing energy content of pastures.

Pasture Management

Updating the Pasture Condition Score

Sarah Goslee*, Ecologist, USDA-ARS, Pasture Systems & Watershed Management Research Unit, 3702 Curtin Road, University Park, PA 16802-3702

The original Guide to Pasture Condition Scoring, written by Dennis Cosgrove, Dan Undersander, and James Cropper, and published by the NRCS in May 2001, has been used intensively nationwide. While the ten indicators in the original guide remain useful, practical experience has shown that some aspects could be revised to improve the applicability of the pasture condition score across the full range of pastures found in the US, and to ensure that the indicators can be consistently applied in the field. This revised guide, produced by NRCS and ARS personnel working together, merges scientific accuracy and practical reliability to ensure the best possible tool for understanding the condition of the nation's pasture resources.

Mob & Rotational Grazing in the Northeast: Diversity, Yield, and Quality Implications

Eric D. Billman*[1], Jessica A. Williamson[2], Kathy J. Soder[1], and Danielle M. Andreen[2]
[1]USDA-ARS, Pasture Systems and Watershed Management Research Unit, Building, 3702 Curtin Road, University Park, PA 16802-3702
[2]Assistant Professor of Forage Management and Graduate Research Assistant, Department of Plant Science, Penn State University, University Park, PA

*Presenter

Introduction of novel grazing management systems has the potential to significantly alter pasture species composition, productivity, and forage quality. This is due to forage crops that may not be adapted or well-suited to increased or reduced grazing frequency and intensity. Mob grazing, a system developed in the western United States, has been rising in popularity over recent years, but has yet to be assessed for forage production systems in the Northeast. The objective of this research was to compare changes in species diversity, yield, and forage quality between a mob grazing system (MOB) and a traditional rotational grazing system (ROT) for the region. Eight, 0.10-ha plots were established in 2014 as a randomized complete block with four replications, and seeded with alfalfa (*Medicago sativa* L.), white clover (*Trifolium repens* L.), orchard grass (*Dactylis glomerata* L.), narrowleaf plantain (*Plantago lanceolate* L.), and tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort]. Mob-grazed (MOB) plots were grazed twice year^{-1}, (70 – 90-day interval), and rotationally-grazed (ROT) plots were grazed four to six times year^{-1}, (when sward height reached 25 cm). At the conclusion of four years, alfalfa stands were 30% greater ($P < 0.01$) under MOB than ROT, and forage grass stands were 10 - 60% greater ($P < 0.01$) under ROT, depending on species. The different management systems also resulted in significantly greater yield ($P < 0.01$) in the MOB systems at individual harvests, but greater cumulative annual yield under ROT. Finally, forage fiber quality was less desirable under MOB grazing, with greater ($P < 0.01$) ADF and lignin concentrations. These results suggest that ROT may be more well-suited for northeastern grazing systems, as it provides a benefit to forage quality and cumulative yield per year, but that MOB grazing may be more desirable if the larger per-harvest biomass can be efficiently used by livestock.

Evaluating compaction BMP effects on soil properties and demonstration of soil moisture monitoring for compaction prevention in heavy clay soils of the Northeast

Joshua Faulkner[1], Juan Alvez*[2], Josef Gorres[3], Kristin Williams[4]

[1]Adjunct Assistant Professor, Department of Civil & Environmental Engineering, Farming and Climate Change Program in the UVM Extension Center for Sustainable Agriculture
[2]Extension Research Associate, UVM Extension Center for Sustainable Agriculture, Pasture & Livestock Program
[3]Associate Professor, Department of Plant & Soil Science, College of Agriculture & Soil Science
[4]Agronomy Outreach Professional, Champlain Valley Crop, Soil and Pasture Team, Middlebury, VT, University of Vermont, Burlington

Soil compaction can be a significant yield-limitation and conservation concern due to poor drainage, increased runoff, reduced soil aeration, and decreased root penetration. The compaction problem is common, especially in cool, humid regions with heavy clay soils, such as the Northeast. To remediate deep compaction, producers often employ deep tillage, or subsoiling, in an effort to loosen soil to reduce bulk density and allow for deeper root penetration and improved perco-

*Presenter

lation of soil water. Management practices that involve less soil disturbance, such as cover cropping, or rotational grazing have also been suggested and are being used as approaches to remediate and prevent compaction by improving overall soil health and 'bio-drilling'. This project also established a soil moisture monitoring network in a rotational grazing system that could be remotely monitored by the farmer in real-time to guide herd management for compaction prevention over a two-year period.

The goal of this project was twofold: (1) to monitor overall soil health and penetration resistance associated with various biological and mechanical compaction alleviation methods; and (2) to monitor the impact of biological and mechanical compaction alleviation methods on ability of compacted soil layers to transmit water. We evaluated mechanical (i.e., deep tillage) and biological (i.e., cover crop mixes 1-3) approaches to compaction remediation in pasture/hay systems in two Vermont farms over three years. Treatments were completely randomized within three blocks in two farms with Vergennes and Covington Clay soils. When we performed the same analysis adjusted by LSD, under depth class 0-4 inch, it yielded further differences on year 3, on HH farm, as follows: Mix 3 was more advantageous than K-L, Mix 1 and Mix 2 ($p=0.034$, $p=0.012$ and $p=0.016$ respectively). Further, the following treatments differ at PR Farm, on year 3 under depth class 0-4 inch: K-L differed from Control and Mix 2, ($p=0.002$ and $p=0.035$ respectively); Mix 1 differed from Control ($p=0.022$); Mix 3 differed from Control ($p=0.05$).

Climate's Impact on Species Adaptation

The USDA Northeast Climate Hub: A Regional Source for Adaptation Information

Curtis Dell*[1], David Hollinger[2], and Erin Lane[2]

[1]USDA-ARS, Pasture Systems and Watershed Management Research Unit, Building, 3702 Curtin Road, University Park, PA 16802-3702
[2]USDA-Forest Service, Northeast Regional Climate Hub, 271 Mast Road, Durham, NH, 03824-0640

Changing rainfall and temperature patterns and the probability of a greater frequency of extreme weather events with a changing climate presents increasingly greater challenges for farmers, foresters, and other land managers. While a wide range of currently available information sources, technologies, and conservation practices are available to help producers adapt to our changing climate, finding the right approach to address commodity-specific local issues can be difficult. The USDA Northeast Climate Hub works across USDA agencies and with partner universities to help provide land managers with the information they need to address those challenges in the Northeastern US. The poster highlights the climate adaption information products available through the Northeast Hub including vulnerability assessments, adaptation workbooks for crop production and forestry, factsheets summarizing research findings, and the "As If You Were There" video series on adaption approaches for a range of commodities and locations.

*Presenter

Educational & Technical Assistance Programs

Grazing Guide

Sarah Goslee*, Ecologist, USDA-ARS, Pasture Systems & Watershed Management Research Unit, 3702 Curtin Road, University Park, PA 16802-3702.

The Consortium website (http://grazingguide.net) presents NEPC information and newsletters, research and extension updates organized by state and by keyword, and a calendar of events. Reference material includes short-, medium-, and long-term weather forecasts, updated daily, and the second edition of the book, Pasture Plants of the Northeastern US. The Grazing Guide has space for photos and videos, and can be found on Facebook and Twitter (and soon Instagram). We invite you to submit photos, research and farm reports, and upcoming events. What else would you like to see?

Grazing Charts

Troy Bishopp*, Regional Grazing Specialist (East) at Upper Susquehanna Coalition, 851 Chemung St., Horseheads, NY.

Environmental Assessment of Grass-Based Dairies

An Environmental Assessment of Grass-Based Dairy Production

C. Alan Rotz*[1], Michael Holly[2], Arron de Long[3], Franklin Egan[3] and Peter J.A. Kleinman[1]

[1]USDA-ARS, Pasture Systems and Watershed Management Research Unit, Building 3702 Curtin Road, University Park, PA 16802-3702
[2]Mechanical Engineering Department, University of Wisconsin–Green Bay, Green Bay, WI 54311
[3]Pennsylvania Association for Sustainable Agriculture, Harrisburg, PA 17102

We compared all-grass, grass supplemented with grain, and full confinement dairy production systems using a whole-farm model and found that for many environmental sustainability indicators, the grass-based systems had smaller environmental impacts per unit of farmland but larger impacts per unit of milk produced compared to confinement fed systems. Grass-based dairy production, which relies heavily on grazing and use of forage crops, is growing primarily due to reported human health benefits of the milk produced and perceived environmental and animal welfare benefits. Data and information on production practices were gathered from eight dairy farms in Pennsylvania. Four of the farms grazed and fed only forage, and four supplemented the forage with some grain. From the information obtained, each farm was simulated with the Integrated Farm System Model to verify proper representation of their production practices. Due

*Presenter

to variation in climate, soil characteristics and management practices, a comparison of the two grass-based farm types showed no significant differences in environmental impacts. Farms of the same size using each production strategy along with a more traditional confinement fed production system were then simulated using the same climate and soil conditions for a better comparison. Predicted nitrogen and phosphorus losses to the environment, fossil energy use, water use, and greenhouse gas emissions were less from the grass-based farms compared to the confinement operation. Due to lower milk production on the grass-based dairy farms, nutrient losses and greenhouse gas emissions expressed per unit of milk produced were generally greater than those of the confinement system. Within the grass-based dairy systems, the system that supplemented with grain had slightly lower nitrogen and phosphorus losses per unit of farmland compared to the grass-only system, and much lower losses and emissions when expressed per unit of milk produced. Total production cost was less for the all-grass dairy than the grass with grain dairy. With a greater milk price, the all-grass system provided greater profitability per unit of land used and per unit of milk produced compared to the confinement farm of similar size. These data indicate that grass-based dairy farms can provide environmental benefits to a local water-shed, but due to a lower efficiency in milk production, they may increase the aggregate environmental impacts of regional and global supply chains.

Implications of Soil Carbon Storage in Pastures

Soil organic matter and its role in building and maintaining healthy pastures

Curtis Dell*, Research Soil Scientist, USDA-ARS, Pasture Systems and Watershed Management Research Unit, Building, 3702 Curtin Road, University Park, PA 16802-3702

Increasing soil organic matter (SOM) has been seen as a means to sequester atmospheric carbon and reduce concentrations of greenhouse gases linked to climate change. While maximizing sequestration of carbon in soils still remains a worthwhile goal, the recent emphasis on soil health has helped to stress the critical role for soil organic matter. Organic matter is the primary soil characteristic that we can improve with management, and it influences a wide range of soil functions and properties. Organic matter is a slow release source of nutrients and improves the soil's capacity to retain nutrients. Soil structure is also improved as SOM increases, improving water and air movement. In addition, SOM typically increases the plant-available water holding capacity of a soil. Lands that have been in long-term (25 yrs. plus), well-managed pasture have typically reached an equilibrium point where SOM content is high, but stable. However, conversion of croplands to pasture and renovation of poorly maintained pasture usually results in a large increase in SOM for several years. While established pastures typically do not accumulate additional carbon, it is critically important to recognize the value of the SOM currently maintained in our pasture soils. This SOM is critical for sustaining forage productivity with limited external inputs, and it represents a large pool of stored carbon that would otherwise be found as atmospheric carbon dioxide.

*Presenter

Evaluating Water Quality Best Management Practices in the Chesapeake Bay Watershed

Evaluating Nutrient Management Approaches to Reduce Nutrient and Sediment Runoff from Dairy Farms in Central PA

Ryan Barnes*[1], Heather E. Gall[1], John E. Watson[2], C. Alan Rotz[3], Herschel A. Elliott[1]

[1]Department of Agricultural and Biological Engineering, College of Agricultural Sciences, Pennsylvania State University, University Park, PA 16802
[2]Department of Ecosystem Science and Management, College of Agricultural Sciences, Pennsylvania State University, University Park, PA 16802
[3] USDA-ARS, Pasture Systems and Watershed Management Research Unit, Building 3702 Curtin Road, University Park, PA 16802-3702.

The Chesapeake Bay is the largest and most diverse estuary in the United States. Since the 1960's, the health of the Bay has declined due to excess nutrient and sediment loads, largely from agricultural activities, resulting in large losses of aquatic habitat, wide-spread eutrophication, and hypoxic zones. In 2010, the Environmental Protection Agency established the Total Maximum Daily Load (TMDL) to limit nutrient and sediment discharges to the Bay by 2025. Currently, state conservation programs in Pennsylvania (PA) are actively promoting adoption of riparian buffers to meet TMDL goals. However, given the extensive maintenance that buffers require, this may not be the most appropriate best management practice (BMP), particularly for dairy farmers who are facing significant economic challenges. We evaluated potential benefits and tradeoffs for commonly adopted BMPs in the Bay watershed, including riparian buffers, streamside fencing, cover crops, and manure storage. We developed nine representative dairy farm operations for Mifflin County and conducted simulations using the Integrated Farm System Model (IFSM) to compare nutrient runoff and economic feasibility for each of the BMP adoption scenarios. The nine farms include confined, organic, and Amish farming practices for dairy herds ranging in size from 35 to 150 cows. Results will be shared directly with farmers and landowners in the study county through extension workshops to help inform adoption of the selected BMPs of interest. Further, the results may help inform policies for implementing BMPs on dairy farms across the Chesapeake Bay watershed to help meet the 2025 TMDLs.

Macroinvertebrate Sampling of Halfmoon Creek

Partnership Between Penn State ASM/ERM 309 "Measurement & Monitoring of Hydrologic Systems", Chesapeake Bay Foundation, Centre County Conservation District, and USDA-Agricultural Research Service

Our class partnered with the Chesapeake Bay Foundation (CBF) and a local landowner to better

*Presenter

understand hydrology and water quality in the Halfmoon Creek watershed. When water samples are collected to assess water quality, they represent the quality of the water only at the time the sample was collected. However, macroinvertebrates that use the stream as their habitat can serve as an integrator of water quality over longer periods of time. We conducted a macro-invertebrate assessment at a location in Halfmoon Creek that has been restored with a forested riparian buffer. Buffers help to improve water quality by filtering nutrients and sediment in surface runoff, stabilizing the streambank, and shading the stream. Our macroinvertebrate assessment contributed valuable knowledge to CBF and the landowner, who is a fly fisherman and passionate about stream health.

Continuous Hydrologic Monitoring in Halfmoon Creek Watershed

Partnership Between Penn State ASM/ERM 309 "Measurement & Monitoring of Hydrologic Systems", Chesapeake Bay Foundation, Centre County Conservation District, and USDA-Agricultural Research Service

The Chesapeake Bay has been degraded by excess nutrients and sediment, in part due to agricultural activities, for decades. To improve water quality across the Bay watershed, partnerships among a wide range of stakeholders are critical. Our class partnered with the Chesapeake Bay Foundation (CBF) and a local landowner to better understand hydrology and water quality in the Halfmoon Creek watershed. We generated continuous hydrologic data at two locations, including water level, rainfall, air temperature, water temperature, and dissolved oxygen concentration, for two months during the Fall semester. These data will be utilized by CBF, as well as the USDA and the Centre County Conservation District, to help determine appropriate best management practices to improve water quality locally and in the Chesapeake Bay.

Finding Marketable By-Products from Pasture-Raised Livestock

Early Findings on Wool Pellets as a Fertilizer for Vegetable Farms

*Kimberly Hagen, Grazing Specialist, Center for Sustainable Agriculture, UVM Extension, University of Vermont, Burlington Vt.
Susan Hodgson, Agriculture Outreach Specialist, Center for Sustainable Agriculture, UVM Extension, University of Vermont, Burlington, Vt

Kimberly Hagen and Suzy Hodgson of the Center for Sustainable Agriculture were seeking a way to support Vermont's sheep farmers by exploring market options for a use for raw, low-grade wool. A grant from USDA Rural Development, support from the Vermont Agency of Agriculture, Food & Markets, and the partnership and interest of an energetic team of partners made it possible to explore a range of options.

*Presenter

Originally focused on finding a way to process raw wool to meet demands for local and sustainable materials for the building trade, the group came to realize that a use that would not require scouring (cleaning) was what was most useful and sustainable.

After learning that wool could be "pelletized" - compressed into small dense shapes - the team began investigating the process and potential impact for both sheep and vegetable farmers.

Prebiotic Effects on Health-Promoting Dairy Bacterial Cultures

Growth and Short Chain Fatty Acid Production by Potential Probiotic Lactobacilli

John A. Renye, Arland T. Hotchkiss*, and Andre K. White.
USDA-ARS, Eastern Regional Research Center, Dairy and Functional Foods Research, 600 E. Mermaid Lane, Wyndmoor, PA 19038

Prebiotics are nondigestible food ingredients selectively used by beneficial bacteria within the colon to improve host health. Inulin and fructo-oligosaccharides (FOS) are well studied prebiotics that can be metabolized by strains of lactobacilli and bifidobacteria; and are associated with improved digestive health in humans due to the production of short chain fatty acids (SCFA). Prebiotics have also been shown to improve the growth, survival and bioactivities of probiotics, which has led to the development of synbiotics, where pre- and probiotics are delivered together to optimize their beneficial activities. In this study, we screened 87 strains of lactobacilli for their ability to grow with inulin (Synergy 1) or FOS (P95) provided as the sole source of fermentable carbohydrates. Growth in modified MRS broth (no glucose) containing 1% inulin or FOS (m/v) was monitored for 24h in a Cytation 5 multi-mode plate reader (BioTeck). Nine lactobacillus strains fermented both prebiotics, reaching an optical density (OD600) ≥ 1.2, including: L. casei (strains: LC3, 441 and ATCC 4646); L. helveticus (strains: 1842 and 1929); L. lactis FARR; L. paracasei subsp. paracasei 4564; L. acididophilus 1426; and L. reuteri 1428. Bifidobacterium breve 2141 was also screened and fermented both prebiotics reaching an OD > 1.6. High-performance liquid chromatography was used to identify SCFAs in cell free supernatants (CFS) from twenty cultures which reached an OD ≥ 0.5. For the nine lactobacillus strains above, the concentration of lactic acid was between 175-206 mM, and L. helveticus 1929 produced the highest concentration of acetic acid (~19 mM). In the presence of FOS, the highest concentrations of propionic (3.9-6.2 mM) and butyric acids (0.9-1.2 mM) were detected in CFS from L. reuteri 1428, L. paracasei ssp. paracasei 4564 and L. plantarum 23115. With inulin, L. acidophilus 1426 and L. delbreuckii ssp. lactis 735 produced the highest concentrations of propionic acid (4.2 mM); and L. acidophilus 1426, L. paracasei ssp. paracasei 4564 and L. plantarum 23115 produced the most butyric acid (1.0 mM). Results from this study are essential to identify lactobacillus strains suitable for the development of synbiotics utilizing FOS or inulin as prebiotics components.

*Presenter