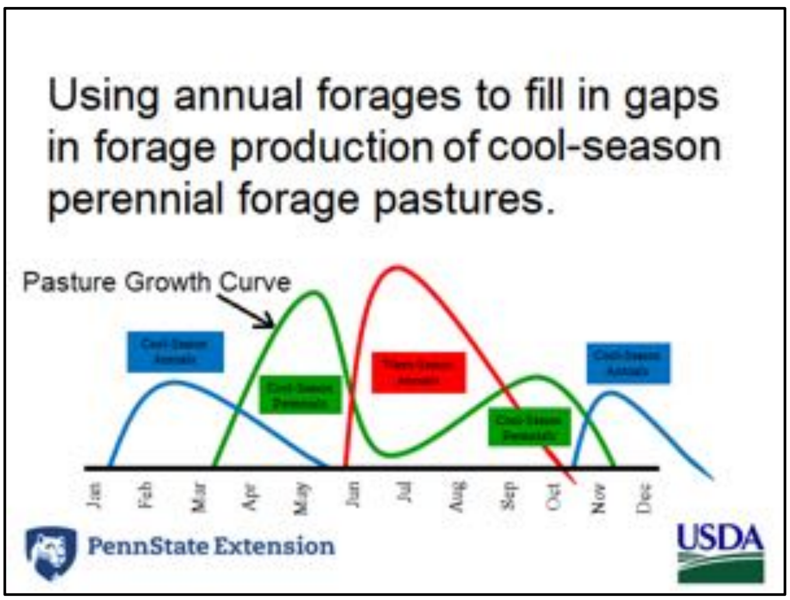
**Session 4 – Getting the Most out of Winter Grazing by Forage Species Selection/Management and Grazing Management**

Jessica Williamson was also moderator of Session 4 and its first speaker as with Session 1. Amanda Grev was the session leader that organized this session and arranged to have 3 speakers for it. Amanda, however, being the pasture specialist for Maryland Extension had Maryland grazing conferences that were scheduled as a long standing commitment the same week as our Conference, so she had to bow out as session 4 moderator.

**Jessica Williamson** presented "Interseeding Forages into Corn to Extend the Grazing Season". Kathy Soder, USDA-ARS Animal Scientist, co-authored the presentation with Jessica. Grazing annual forages bridges the "gap" in cool season perennial pasture production during mid-summer and in late fall and early spring in the Northeast and reduce stored and harvested feed needs and costs associated with filling those gaps that occur when perennial pastures are dormant. The diagram below illustrates where these gaps occur and how annual forages can fill those gaps.




The pasture growth curve is the green line showing the peaks and valleys of forage growth on perennial cool-season grass pastures in the southeastern portion of the Northeast. Hardy cool season annual forages growth curves are depicted by the blue lines that precede the pasture growth curve or peak in late fall – early winter after cool-season perennial forage pastures go into winter dormancy. The red line is the warm-season annuals growth curve. These forages are planted in May and peak in growth by July, and if grazed to allow regrowth, may furnish grazable forage until mid-October unless an early killing frost occurs.

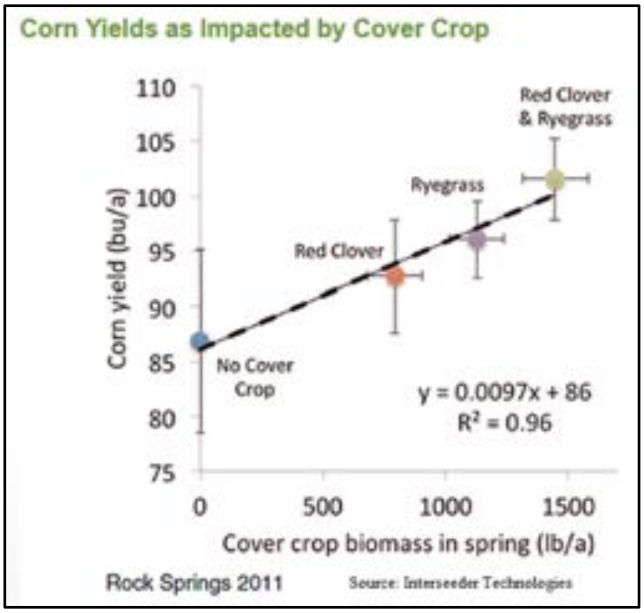
To get a cool-season annual forage off to a good start in a corn field, an interseeder has been developed that prepares a good seedbed for the annual forage/cover crop and sows it between rows of corn. A picture of it is shown below. The procedure for doing this involves these steps:

1. Plant corn as usual.
    - Can harvest as grain or silage
2. When corn reaches V4-V7 stage, drill in interseeded forages.
    - No more than 18" tall
3. Forages grow slowly under the canopy of the corn.

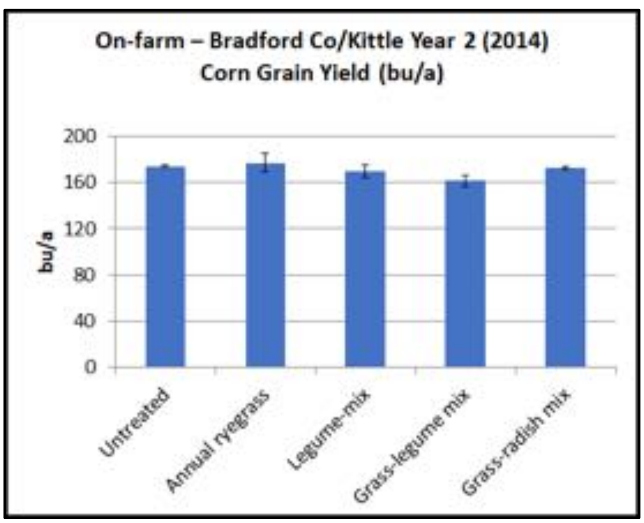
4. When corn is removed, forages "take off" in growth, because they already germinated and have developed a root system and some leaf area.

*Interseeder used to seed a cover crop between rows of corn.*

A research trial done in 2011 at the Rock Springs Experiment Farm near University Park, PA looked at corn yield differences from a control of no cover crop and 3 incorporated cover crops - sowed red clover alone, ryegrass alone, and a red clover and ryegrass binary mixture into a growing corn crop using the interseeder. Corn yields that year were all depressed in the trial probably due a drier and hotter July than usual. However, the more biomass incorporated into the soil, the higher the corn yield was.



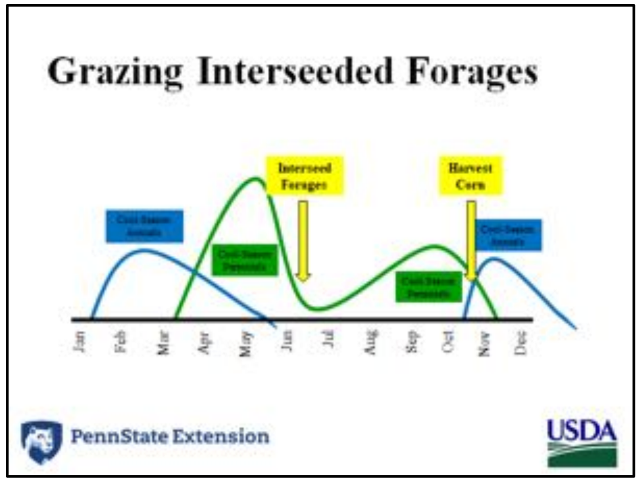

The graph to the left shows a straight line increase in corn yield as more cover crop biomass is incorporated into the soil before corn planting in the spring. Red clover does not produce as much biomass as ryegrass as it is slower to grow in the spring previous to corn planting. The combination of red clover and ryegrass produced the most cover crop biomass and the highest corn yield. These cover crop treatments were not grazed. If a corn crop had been raised on the same trial plot the previous year, the residual nitrogen leftover from growing that corn crop would have benefited the ryegrass and as it decayed fed the residual nitrogen to the 2011 corn crop.




In this on-farm trial done in 2014, all treatments yield essentially the same, a few bushels over 160. This is good in that the use of cover crops did not interfere with the corn yield in any meaningful way if done to avoid depleting soil moisture while the cover crop is still live and growing prior to planting the corn. It also is probably better on cold soils in spring to incorporate cover crop biomass rather than leaving it on the soil surface, as the mulch will slow soil warming. This can hinder early corn growth and delay maturity.

For livestock farmers that have corn acreage that is used for grain and/or silage, inserting a cover crop into the growing corn can also be used as a forage crop, either grazed or harvested for silage. If grazed, the livestock need to have easy access to shelter if weather conditions are cold, windy, and wet. The hardier the livestock are, the better this system will work for grazing in late fall to early winter, provided that the cover crop planted grows enough after corn harvest to be grazable. Short maturity corn is likely to be better than a later maturing variety to get the cover crop released from the corn overstory sooner so that it has more sunlight to grow enough for late fall-early winter grazing. Harvesting the corn as silage would be ideal to get the cover crop released even sooner. The cover crop also would give the soil protection from over winter soil erosion as corn stubble left after corn silage harvest leaves little soil cover. Ryegrass grazed in the fall does not regrow much the following spring prior to corn planting. The second year of the grazing trial, the researchers switched to cereal rye.

The diagram to the left shows the rough time to interseed a cool season cover crop into a standing corn crop. This will vary depending on when the corn reaches the V7 stage or 18 inches high. Stalk damage may occur if it is taller than 18 inches as the tool bar of the interseeder and tractor axles will be reached. This diagram also shows an approximate date for corn harvest. Ideally it would be best to move that back to corn silage harvest time to get more cover crop growth for late fall grazing.




Interseeded ryegrass cover crop in grain corn near harvest time. This is a nice grass stand with enough height to be grazed. Corn harvest will wheel track some of it down, but it depends how much is tracked down by the size of the cornhead used to harvest the corn. Weather conditions will greatly vary cover crop growth. Some years can limit cover crop progress by corn harvest time, such as drought or a late killing frost keeping corn canopy alive well into the fall.

The 2017 Integrating Grazing Livestock and Cropping Systems through Interseeded Forages trial used 102-day relative maturity corn at 26,000 seeds per acre. Ryegrass was interseeded at the rate of 25 pounds per acre when the corn was at V4-V5 stage. 60 dairy heifers, 10 per paddock, grazed the trial plots from December 11-21, 2017. Due to the lateness of grazing, there were some weather issues.

In 2018, the researchers planted cereal rye at 2 bushels of seed per acre instead of ryegrass. They also planted an earlier maturity corn variety (98-day). The cover crop was grazed earlier in the year, in mid-November instead of mid-December, using beef cows instead of dairy heifers. They also had the beef cows graze the cover crop in the spring of 2019 since the cereal rye produced enough spring regrowth for grazing. The cereal rye grew quickly and graze-out required more grazing pressure than was done in the fall of 2018 to allow spring regrowth.

**2017 Fall Forage Yield**

- ❖ Total Forage Availability (Corn residue and ryegrass)
  - 4,950 lbs. DM/ac (100% utilization)
  - 3,300 lbs. DM/ac (65% utilization)
  - 2,475 lbs. DM/ac (50% utilization)
- ❖ Ryegrass Availability (NO corn stover)
  - 1,750 lbs. DM/ac (100% utilization)
  - 1,135 lbs. DM/ac (65% utilization)
  - 875 lbs. DM/ac (50% utilization)

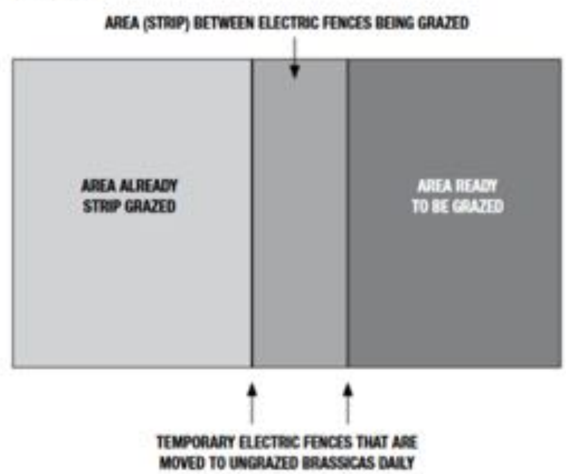
Potential Extension of the Grazing Season in FALL (Corn residue and ryegrass)

- **65% utilization**
  - 132 day/AU/ac @ 2.5% BW consumption (3,300 lbs. DM/ac / 25 lbs./AU/day)
  - Example: A herd of 30 beef cows (~1200 lbs. each) could graze 73 days on 20 acres w/ 65% utilization
- **50% utilization**
  - 99 d/AU/ac @ 2.5% BW consumption
  - Example: A herd of 30 beef cows (~1200 lbs. each) could graze 55 days on 20 acres w/ 50% utilization

**2018/2019 Extension of the Grazing Season**

- ❖ Grazed Nov. 14 – Dec. 4 (20 days)
  - 24 cows @ ~1450 lbs.
  - 6 acres total
- ❖ Grazed April 29 – May 17 (20 days)
  - 16 cows @ ~1450 lbs.
  - 6 acres total

Figure 2. Example of strip grazing method for brassica grazing.



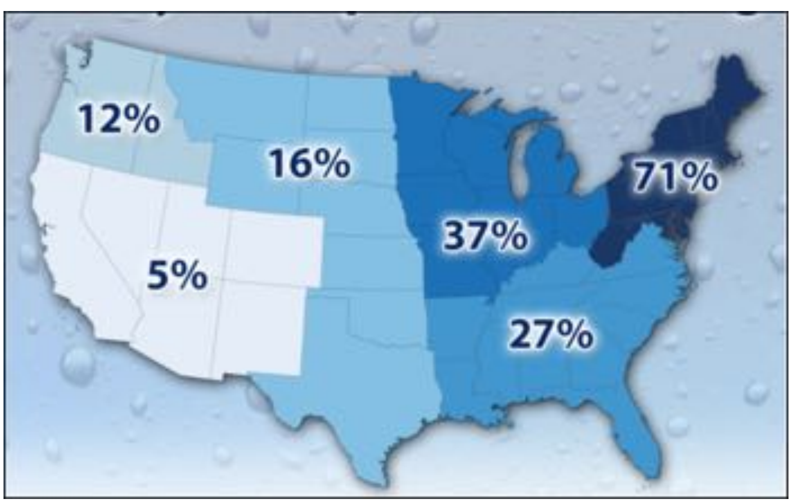

The diagram to the right shows how to strip graze an interseeded cover crop in a corn crop once the corn is harvested. It is done the same way brassicas are grazed, by strip grazing. Two temporary electric single wire fences move forward on a daily basis. The forward fence is moved ahead to open up a new area for grazing, while the back wire fence is used to keep the livestock from regrazing the area already grazed (Editor's Note: This allows the area already grazed to begin regrowth without further leaf area being removed or having its plant crown damaged by treading or grazing). Fifty percent utilization of the cover crop in the fall should be used to promote better spring regrowth. (Editor's note: Realistically, even with strip grazing corn stover, its utilization by cattle only approaches 50 percent. Cows will selectively graze the more palatable portions of the plant first: (1) grain; (2) leaves and husks; (3) cobs and stalks [Farming Magazine on-line, 2016].) Graze out cereal rye cover crop in the last rotation cycle before corn planting in the spring.

How will this fit on a livestock operation?
**Things to consider:**

- Permanent fence needed around crop fields to be grazed.
- Ability to remove livestock during bad weather easily.
- Animal and soil hazard (soil compaction issues)
- Additional fertilizer needed, or is residual nitrogen from corn adequate?
- Acreage to spread manure. Will grazing a cover cropped field upset manure spreading plans?
- Keeps animals out of confinement or sacrifice lot longer into the season.
- Great place for calving/lambing season
- High nutritive value of forage with adequate filler from the corn stover if corn harvested for grain, and
- Hardiness of livestock.

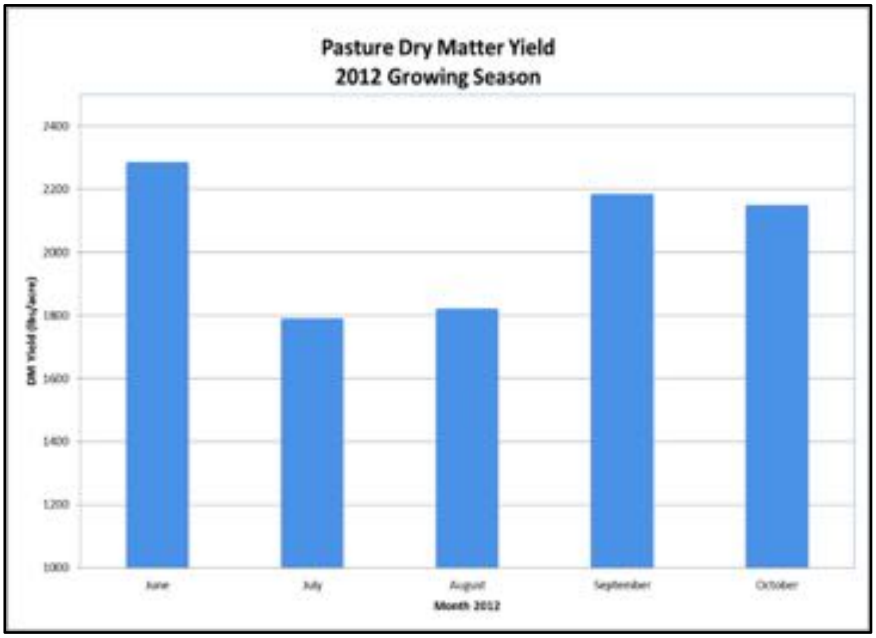
The second speaker of Session 4 was **Heather Darby**, Professor, UVM Extension, St. Albans, VT. Her topic was "Extending the Grazing Season in the Northeast". She started out her presentation posing the question, "Why consider annuals?". She then listed their strong points:

- Drought tolerant
- Cold (or heat – warm-season) tolerant
- Fill gaps in feed (summer slump in cool-season perennial pastures)
- High biomass crop
- Multipurpose
  - Grazing
  - Silage/balage
  - Grain/seed



*Increase in the number of 2" rainfalls per year from 1958 to 2011*

With the rise in incidences of heavy rainfall, growing cover crops can also aid in reducing soil erosion by water runoff rather than leaving cropfields fallow after harvesting a row crop.




This chart shows the typical summer slump that occurs on cool-season forage perennial pastures. It is muted in Vermont as they still produced 1800 pounds/acre in July and August in 2012 as opposed to 2150 to 2300 pounds/acre in the other 3 cool/wet months shown. The summer slump tends to grow more pronounced further south at lower elevations in the Northeast as average daily temperatures rise and spottier rainfall occurs in July and August.

These are the summer annuals recommended by Heather to fill the summer slump:

- Sorghum,
- Sudangrass,
- Sorghum x Sudangrass,
- Pearl Millet,
- Japanese Millet,
- Teff, and
- Corn.

Most of these regrow after grazing if grazed properly to leave adequate stubble height.

Here are the cool-season annuals recommended by Heather to extend the grazing season beyond what a perennial pasture or a summer annual pasture can provide:

- Small Grains
    - Spring or Winter
    - Forage types preferred in most cases
    - Can use mixtures
- Annual ryegrass
- Brassica forage crops
    - Kale, turnips, radish, etc.
- Legumes (seed earlier if possible)
    - Peas, Crimson clover, red clover, other options

Heather went on to show some different cropping system scenarios. The first one involved planting a summer annual, brown mid-rib (BMR) sorghum-sudangrass cross into an existing forage stand. They need to be planted into warm soils that are between 60 and 65°F. At these soil temperatures, the seed will germinate quickly and a dense stand will be established. Under conditions of warm soil temperatures and adequate soil moisture, the forage will be at a 30-inch grazing height 45–50 days after planting. Grazing should begin when the plants are 24–30 inches in height. The grazing pass should end when there is a 6- to 8-inch plant residual. This residual will allow for best plant recovery and rapid regrowth. With this type of management and good growing conditions, a grazing pass can be made every 14–21 days (R. Lewandowski, et al., 2012).

Crop Rotation

Take first and/or second cut of established forage crop (weak stand),
25th of June and 1st of July plant BMR sorghum X sudangrass,
Graze it 3 times,
Leave residue through winter, and
Reseed field in early spring.

Her next example used a cool-season annual, triticale.
Small grains for winter cover crops

- Seed triticale alone on fields renovated in late summer (mid-August to mid-September).
- One graze in spring before reseeding,
- Early feed in fall if weather cooperates.
- Worst case scenario green manure for next crop.
- Reasonable dry matter for early feed.
- Good quality.
- Cows like to graze it, very palatable.

The next scenario used two cereal crops – one spring one and one winter one, oats and triticale.

- Seed oats & triticale together in late summer (mid-August)
- Same as planting triticale – higher seeding rate 150 lbs./acre
- Planting two crops - one for fall, and one for spring grazing.
- Graze oats in fall – Planted August 19th and grazed the first of October. Hard freeze will kill it. Triticale will overwinter.
- High quality and palatable - cows will milk best on oats.
- Same rotation step as before – graze triticale in spring and reseed.

Heather then went into some agronomic details on successfully growing annuals for cover cropping and grazing.

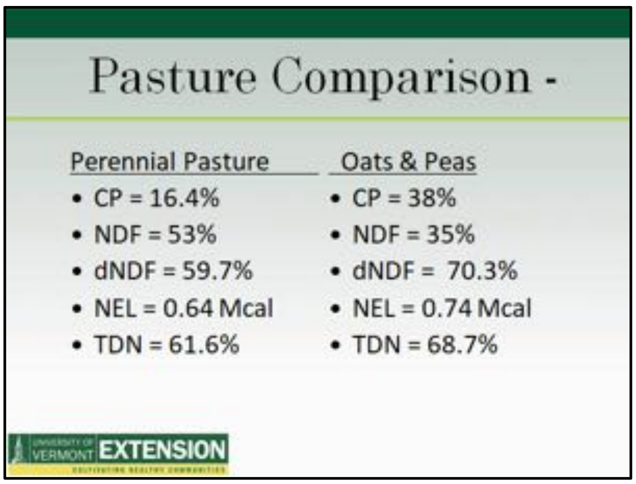
Establishment was covered first taking these things into consideration:

- Grain drill works well but can be broadcast and incorporated with cultipacker or harrow.
- Plant in August for September, October, and November grazing.
- Delayed planting can happen, often poor soil moisture this time of year.
- Planting depth depends on species and/or mixture.
    - Most species fine with ½ to 1-inch depth of planting.

- Seeding rate depends on species.
    - Small grains 100 to 150 lbs./acre
    - Brassica species 5 to 10 lbs./acre
    - Annual ryegrass 15 to 20 lbs./acre
    - Legumes 15 to 20 lbs./acre.

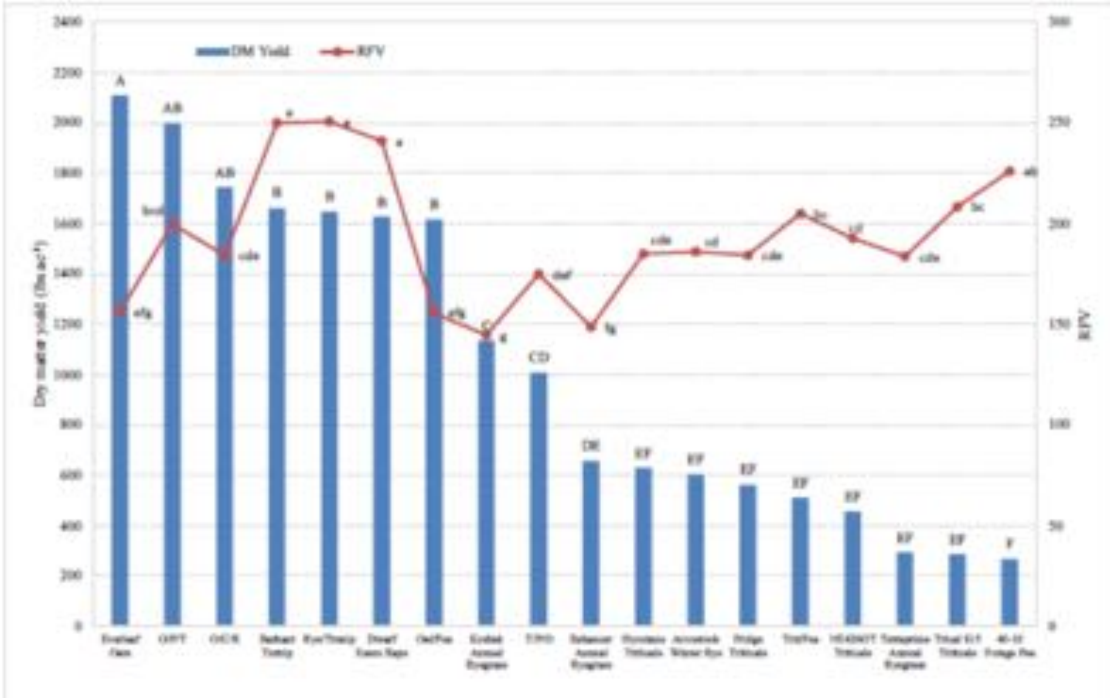
Establishment was followed by soil fertility requirements for annual forages:

- Relatively low nitrogen (N) requirements depending on species – 50 to 100 lbs. of N/ac.
- Prior crop will determine at least N needs.
- Manure application before planting likely adequate.
- The P & K requirements determined from soil test but overall, like other grass species.
- Soil pH should be between 6.0 and 7.0.



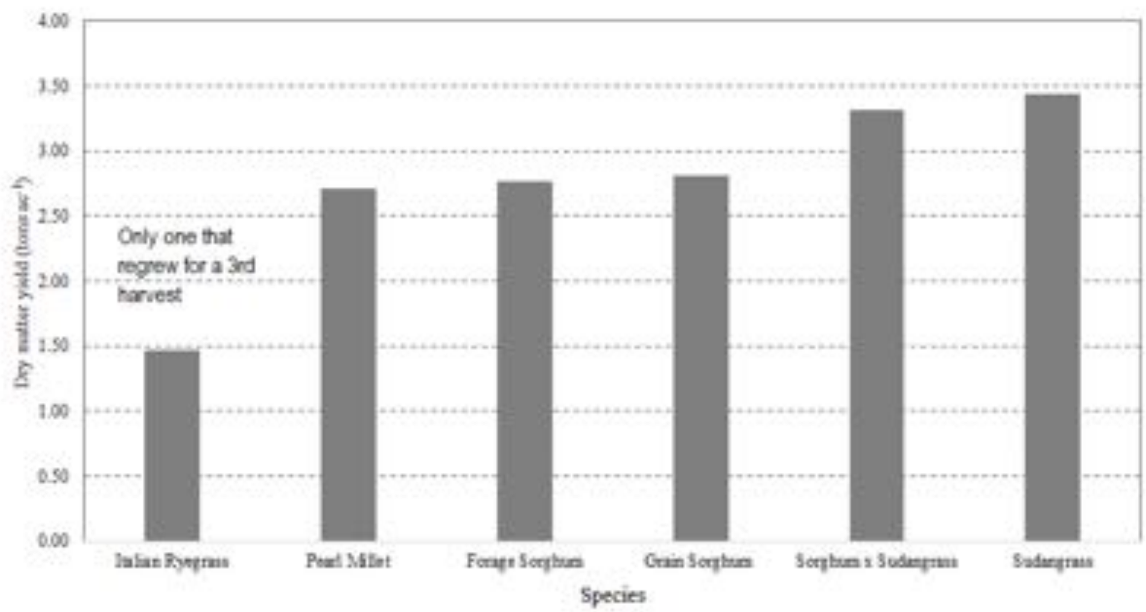

Forage quality of annual forages can be very high. In the table to the left, a typical perennial pasture is compared with an oats and peas mixture. All 5 forage quality parameters are better in the oats and peas analysis than with the perennial pasture analysis. However, the crude protein is really much higher than it has to be for livestock nutritional needs. A bit of roughage in the diet should dilute that some. Good place for grazing corn stover left from grain corn harvest if available on the farm.

Eighteen annual forage species and mixtures were evaluated in 2018 for fall yield and relative feed value (RFV). Oats yield was the highest in the fall and in mixtures with peas or with peas and triticale or with clover and ryegrass provided excellent quality and yield. Winter grains (triticale, winter rye) produce low fall yields compared to spring grains, such as oats. Rape and turnips produced over 1600 pounds of DM per acre in the fall and had the highest RFV's (240-250). Three annual ryegrasses differed considerably in their DM yield. Kodiak, a Westerwold annual ryegrass had the highest fall yield, just over 1100 pounds per acre. Then, it was Enhancer annual ryegrass, a diploid Italian annual ryegrass, coming in at 650 pounds per acre. Tetraprime, a tetraploid Italian annual ryegrass came in a distant third at 300 pounds per acre. Kodiak is a diploid annual ryegrass developed by DLF forage Seeds that is used for grazing, silage, and cover crop and has improved cold tolerance. It has a medium-early maturity. It is said to excel in plant vigor, tiller density and forage yield. In this trial, the hype was proved to be correct. Tetraprime lived up to its claim of being a high quality forage with RFV of 170 while the other two annual ryegrass varieties were slightly under 150. The chart below displays all eighteen species and mixtures showing their fall yields (left Y-axis) and RFV values (right Y-axis). After oats are two mixtures with oats in them. To the immediate right of oats is oats, peas, & triticale (O/P/T); the second one is oats, clover, & ryegrass (O/C/R). Further to the right is a triticale, peas, & oats mixture (T/P/O).




Dry matter yield and relative feed value of 18 annual forage mixtures/species, 2018.

Treatments that share a letter performed statistically similarly to one another.




Spring and Fall Annuals

Sudangrass and a sorghum-sudangrass cross were the highest yielding of the spring and fall annuals, 3.4 and 3.3 tons per acre, respectively. Pearl millet, forage sorghum, and grain sorghum were intermediate in yield ranging between 2.6 and 2.8 tons per acre. The Italian ryegrass was the lowest yielding even though it regrew for a third harvest. It yielded slightly under 1.5 tons per acre.

Grazed Triticale had these statistics below (spring grazing):

| | | | Forage Quality Characteristics | | | |
|---|---|---|---|---|---|---|
| **Triticale** | **DM** | **DM Yield** | **CP** | **NDF** | **dNDF** | **NEL** |
| | **%** | **lbs./acre** | **%** | **%** | **%** | **Mcal** |
| **Grazed** | **21.8** | **1350** | **19.4** | **48.5** | **70.6** | **0.71** |

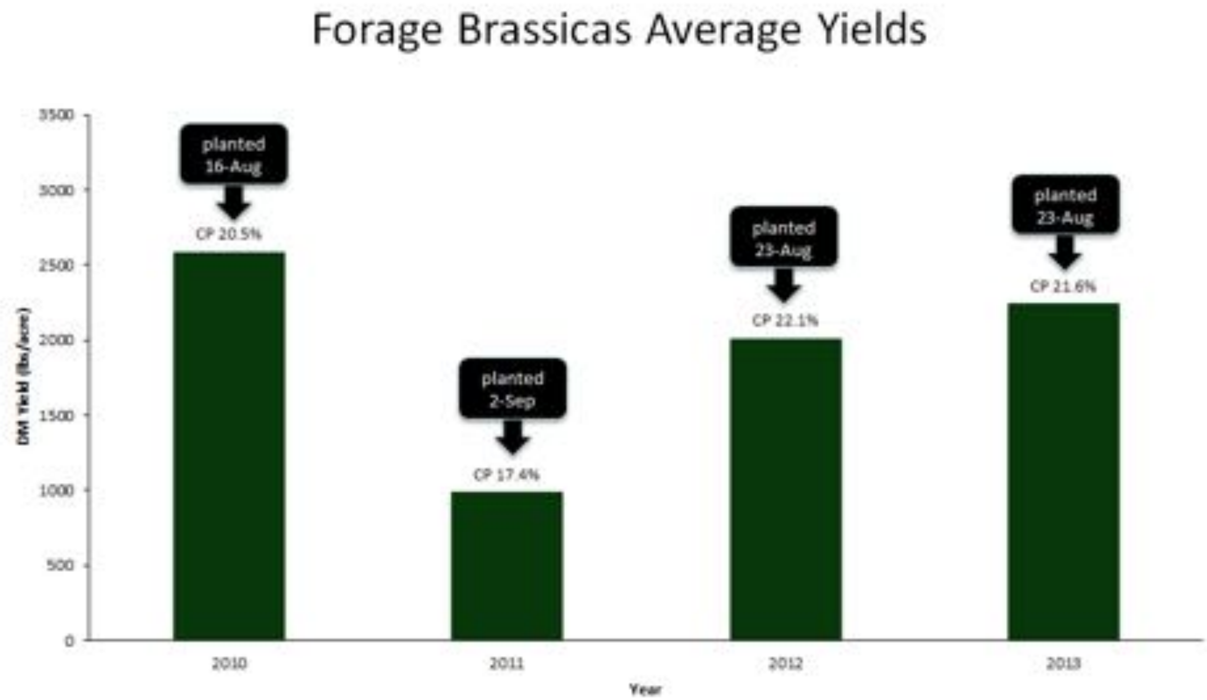
A winter cereal pasture yields more grazable DM than a cool season perennial pasture at first grazing. In one study it provided over 240 pounds per acre more forage at first graze. It does this by beginning spring growth at cooler temperatures than the pasture. If allowed to grow for silage/hay, yield at boot stage can be over 7,000 pounds of DM per acre, and if harvested at soft dough stage, it can yield over 11,000 pounds per acre of DM.

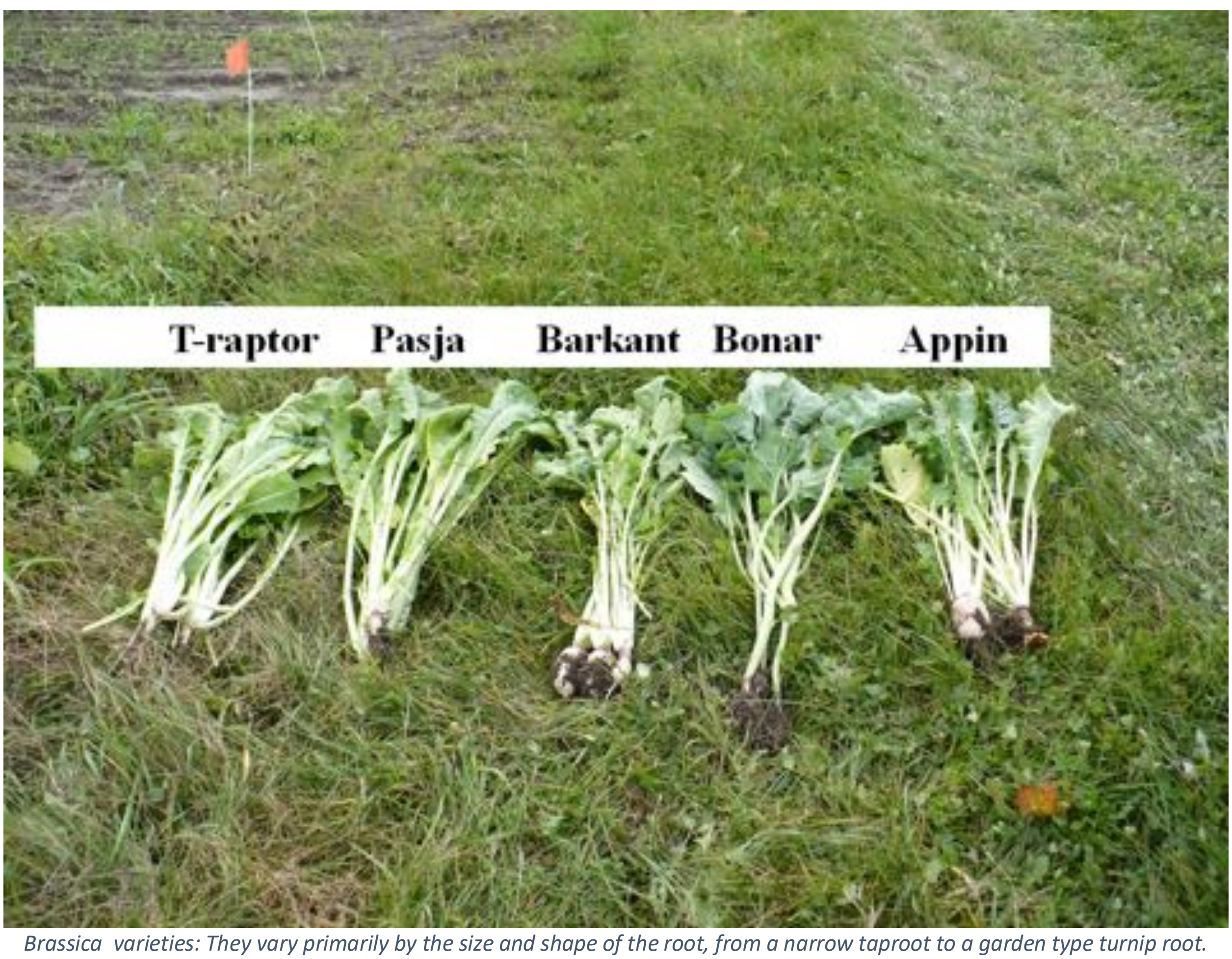
Fall crop Brassicas are exceptional in their yield and forage quality. Guidelines for growing them are:

- Seed no later than mid- August for best yield
- 5 - 10 lbs. per acre seeding rate
- By mid-September 10 inches in height
- Harvest in mid-October
- Potential for multiple harvest times depending on species if crowns are left intact, and
- Harvest when 2 to 3 feet in height.

Brassicas can provide grazing at any time during the summer and fall depending on the seeding date. They are very suitable for late fall grazing. These crops maintain their forage quality, if not headed, well into the fall even after freezing temperatures and may be grazed in the Northeast well into December. Turnips can be grazed twice or more to permit utilization of top growth and roots. Brassicas produce high-quality forage but must be strip grazed or harvested before heading. Livestock will eat the stems, leaves, and roots of turnips, radishes, and swedes. Only the foliage of kale and rape is eaten. They can be grazed more than twice, weather permitting.

Below is a bar chart that compares yield of forage brassicas depending on the date that they were planted. Planting seed on August 16 gave the highest yield, September 2 the lowest yield and August 23, just a week later than August 16 averaged about 500 pounds less DM yield per acre.



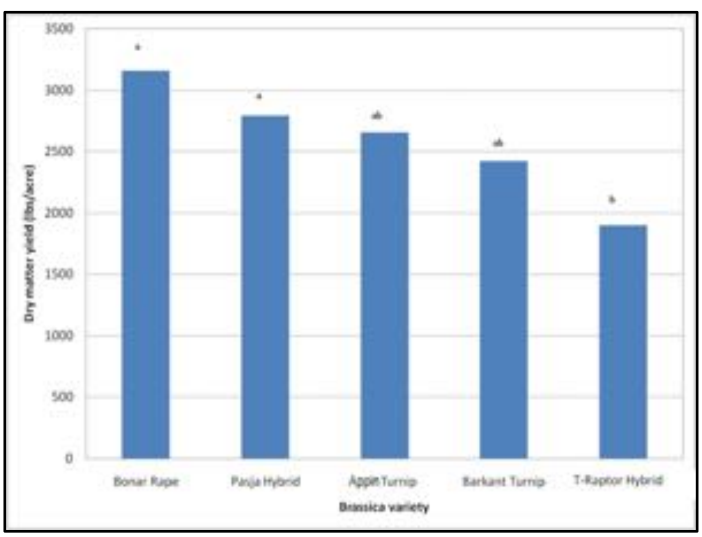

*Brassica varieties: They vary primarily by the size and shape of the root, from a narrow taproot to a garden type turnip root.*

T-Raptor, shown in the picture above, is an early maturing hybrid brassica, a cross between a forage turnip and a forage rape, with 50-70 day crop duration. T-Raptor exhibits a leafy growth habit (higher leaf-to-bulb ratio) and is well-suited to grazing. Pasja is also an early maturing hybrid forage brassica, a cross between a forage turnip and a forage rape. Both can be used as a fall cover crop for soil health purposes, as well as extend the livestock grazing season.

Bonar forage rape, also shown above, is a late maturing rape with short stems and large paddle leaves. It produces very high quality forage yields with the crop ready for grazing in approximately 13-15 weeks after sowing. It can be seeded alone or in seed mixes of clover, turnips, and other brassicas. After a hard frost, the leaves become very sweet and palatable making for great late fall to mid-winter grazing.

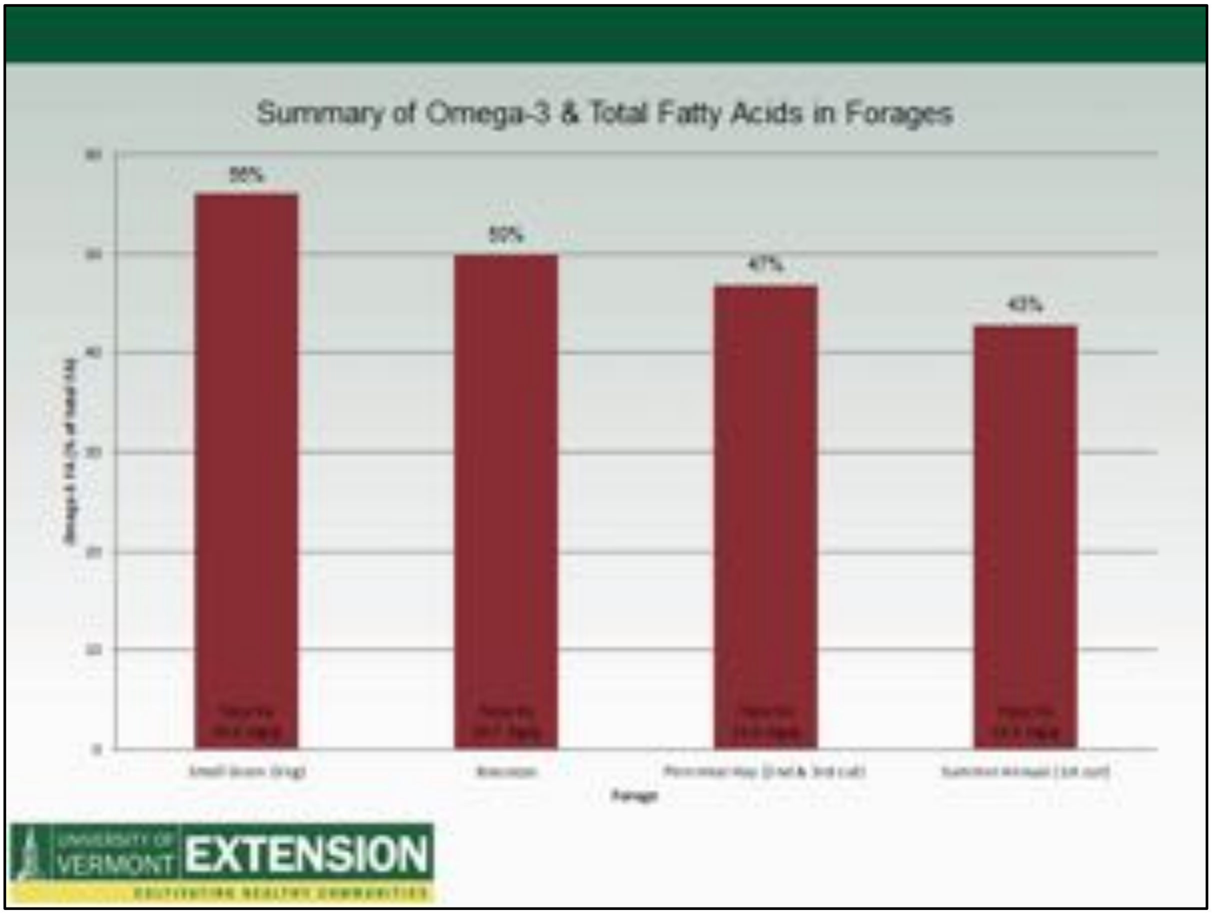
Barkant is a very vigorous diploid turnip variety with a large purple cylindrical root (50 percent of the bulb is on top of ground). Barkant has high bulb yield with good top growth. It also has high sugar content which provides winter-hardiness and increased palatability. Barkant has good tolerance to bolting/heading and under a correct grazing management system can provide multiple harvests with up to 4-6 tons/acre of dry matter production in 60-90 days.

Appin forage turnip is bred for fast, vigorous establishment and quick maturity (60-100 days). It is firmly anchored in the ground for minimum wastage. Appin has a significantly higher proportion of leaf yield to bulb compared to other turnips. Unlike traditional turnips, the Appin bulb has 6 to 10 growing points on top of the bulb allowing for more leaves and better regrowth, and therefore, multiple grazings. It can be grown with oats, annual or Italian ryegrass, sorghum-sudan grass, cereal rye, and other grasses. The high leaf-to-bulb ratio results in a very leafy crop with high digestibility. It can be used to supplement or extend the grazing season when cool season pastures go to dormant. It can also be used as a smother crop to weaken or eliminate an old sod in order to convert older pastures to different species and newer varieties. The leaves on it look like mustard leaves, hence, the alternative name, field mustard.




This bar graph displays how these different brassicas stack up in DM yield in the fall. Bonar rape yields the most while the T-Raptor turnip X rape hybrid produces less than a ton per acre. The leafier brassicas produce the most DM. The bulb type brassicas produce less DM, except for Appin which is leafier due to having more growing points at the top of the bulb. Appin is the middle of the pack for DM yield in the bar graph with a yield of 2600 lbs. per acre.

The last topic Heather shared with us was the amount of omega-3 fatty acid in supplemental forages fed to livestock when cool-season perennial pastures go dormant or are stressed by heat and lack of soil moisture in mid-summer.




In the bar graph above, vegetative small grains, such as oats, have the most omega-3 in them at 11.2 mg/g of plant tissue (multiplying 20 mg/g of total fatty acids (FA) by 0.56). The brassicas and 2nd & 3rd cut hay are equal in omega-3 at approximately 10.3 mg/g. Summer annuals are lower in omega-3 as percent of total FA and much lower in total FA so they provide only 5.5 mg/g of omega-3, half the value of vegetative small grain forage. Although due to rumen fermentation and fat synthesis, having a high amount of omega-3 in the forage does not translate into a big uptick numerically in omega-3 in meat and dairy products, it does bring down the omega-6 to omega-3 ratio to below 4.0 in those products. Current human health guidelines say a ratio ≤ 4.0 is best for cardiovascular health.

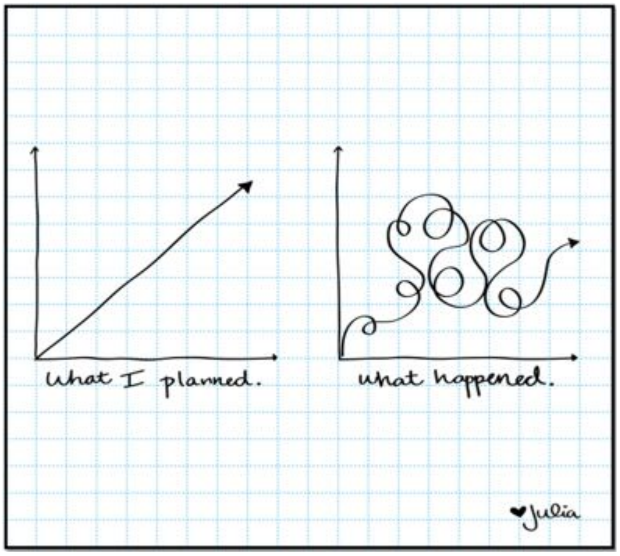
The last speaker of Session 4 was **Troy Bishopp**, Regional Grazing Specialist (East) at Upper Susquehanna Coalition, Horseheads, NY. The title of his presentation was "My Quest for Winter Grazing: The Good, The Bad, and the Ugly".


Troy began his presentation showing what he meant about the good, bad, and ugly concerning winter grazing. The photo to the left above shows plenty of grazable forage under a light coating of snow. Livestock can deal easily with that amount of snow and graze away. The center photo is a deeper snow depth that could be under a glaze of ice. Not impossible for grazing to occur if powder snow, but it involves a lot more grazing effort and more wasted forage from trampling and soiling trying to graze in the snow. The photo to the right shows very severe pugging of the soil near the edge of a winter pasture. The hedgerow/wood's edge at the left edge of the field made a good windbreak so cattle malingered there. If it also caused snow to drift and it melted that would have caused this part of the field to be much wetter than the rest and the ground perhaps only partially frozen. It turned into a quagmire. It is now a sacrifice lot even if not planned to be one.

Troy also remarked that he used the word "quest" in the presentation title, because winter grazing to extend the grazing season is just that "a quest". It can be planned for, but there many unforeseen events that make it not a given. He has had 35 years of grazing experience, but there are still trial and error situations that arise. A 180-day pasture program is what he now shoots for as a minimum. Anything he can get beyond that in extra days on pasture is a win. With his operation of contract grazing dairy heifers and finishing beef on pasture, there is a need to think and plan ahead to avoid major train wrecks. These two cattle types need dairy milk cow quality grazable forage.

He also started out with a clever "disclaimer" statement. "Farmer tested grazing management ideas, experiences, and implementation on a specific land base using educated animals and specific goals. These findings are based on practical science, observation, and hunches. Results may vary depending on a multitude of factors and land management goals which the presenter cannot be held accountable for. Proceed on your own farm with passion, deep thinking, small in-field trials, and further knowledge to substantiate such claims."

Winter grazing is challenging. What you plan to do and what you end up doing can be two completely different things. This is shown in the next figure.




It seldom turns out to be a straight line to the goal of maximizing the intake of winter standing forage. It is more like a snaky piece of fencing wire. It can be a convoluted mess to solve on how to unravel it and harvest all that forage with a grazing animal. Perhaps falling short of how far into the winter it was feasible to really get to before resorting to feeding stored feed until spring that may or may not start on your time line. Conditions for winter grazing can change overnight as shown in the two photos below, from pleasant to downright nasty. One day lots of grazable forage just waiting to be grazed, and the next day buried under snow.

Troy recommended a book by Jim Gerrish called "Kick the Hay Habit, A Practical Guide to Year-Around Grazing". He quoted Jim as saying, "Winter feed costs are the single largest cost in most livestock operations".

The alternatives to extending the season by only stockpiling pasture should be penciled out too!

- Haymaking?
- Hay Once, Graze once in the 60-day late summer – fall growing window
- Plant an annual on cropland for grazing?  (sorghum, brassicas, cover crop)
- Increase stocking rate during the grazing season and forget extending the grazing season
- Graze twice in the 60-day window
- Limit stockpile consumption and feed some to stretch it
- Rent other land?
- Graze after-feed on another farm
- Others to extend your season??????????????

Issues Troy thinks about:

Financial and environmental questions

- The idea of stocking for extended grazing when you are tasked to keep the same number of animals.
- As a contract grazier, he provides extended grazing into winter replacing hay, why can't I ask for more money? $1.20/day versus 2.60/day
- Inter-seeding perennial pastures is not a cost-effective way to increase tonnage.
- Climate Change and the "Perpetual November"
- Wrong pasture species composition, resistance to change with a heavy fescue sward
- How low do you go (grazing height of stubble)?
- Right sizing, Right animal
- What is the best strategy? All grass, or grass with supplementation?
- Sacrifice area, barns, heavy use areas, shelter-breaks, woods
- Are you ready when a storm hits? How much will you force the animals to graze?
- Cost of refitting land in the spring that was badly pugged, and
- Melting grass (losses of dry matter [DM] during winter grazing season)

Troy expounded more on "Perpetual November". Winters are becoming more open, wetter, and warmer so that December and January can be similar to November and even late winter can be mild. It also means a perpetual mud season off and on if mild enough so that the ground does not freeze for very long and thaws, and rains come instead of snow. A series of photos will show how one season varied from day to day.

He reiterated that you must keep monitoring and measuring and thinking. As an example of monitoring and measuring, he gave us an example using one of his farm's paddocks:

**Field 2 1acre**
**8 inches of grass height x 300lbs. DM per inch (based on stand density or clipped & weighed sample)= 2400lbs. DM (1.2 tons)**
**Last Grazed August 17th**

Do some basic mathematics to come up with amount of dry matter available. Since it is measured from the ground surface to the top of the grass canopy, allow for at least a 3-inch stubble height left after grazing. 1500 pounds per acre of forage is actually available to feed the livestock (5/8 X 2400). Use a realistic daily intake in DM per head for the size and class of livestock to be grazing it to see how many head this paddock can support for one day before being moved to a fresh paddock. Is the paddock big enough for the herd size to be on it one day, or do they have to be moved sooner, or later? This involves the thinking part of the equation.

Troy begins stockpiling forage at by mid-August. At mid-October, he begins rationing out the stockpiled forage. Here is his technique for figuring how many days he can have his cattle grazing stockpiled forage:

EXAMPLE So here is his figuring . . .

53 Dairy Heifers, 4 bulls and 2 cow/calf pairs start grazing stockpile on October 15th.

53 head @ 850lbs, 4 bulls @ 1200lbs, 2 pairs @ 3400lbs. Eating 3.5% DM of their Bodyweight

53 x 30lbs/day = 1590lbs. 4 x 42lbs./day = 168lbs 2 x 60lbs./day = 120lbs.

TOTAL Dry Matter (Dry feed) needed per day = 1878 pounds for the herd or 2 ½ round bales/day

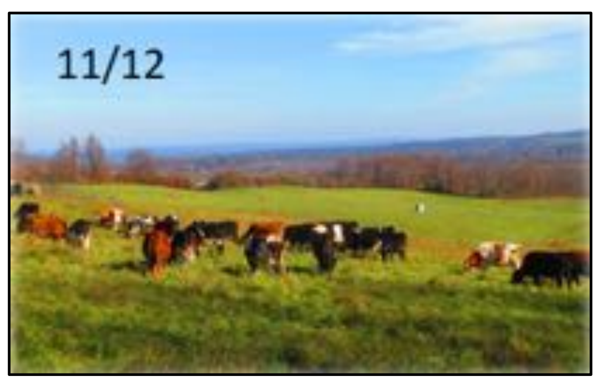
What does he have in pasture inventory??

20 fields conservatively yielded 267,800 pounds of Dry Matter (133.9 tons) *(if you grazed it at 100% leaving nothing)
267,800 pounds Divided by 1878 pounds needed per day = 142 days of feed hypothetically

@ 80% efficiency - 214,240lbs.DM ÷ 1878/day = 114 days of feed
@ 60% efficiency - 160,680lbs. DM ÷ 1878/day = 85 days of feed
@ 50% efficiency - 133,900lbs.DM ÷ 1878/day = 71 days of feed

Actual: 75 days of feed.

In this example, the stockpiled forage is gone by the end of December unless lucky enough to get some warm weather to get enough growth for a second grazing on some of the first grazed paddocks. Or, the estimate on intake is a bit high, or there was more forage than first estimated. The estimate of 50% grazing efficiency estimate is really close to the actual. The bottom of the forage sward always weighs more than the grass stand higher up, but then it is the stem bases that hold most of the carbohydrate reserves for grasses such as orchardgrass and fescue, not the roots. The reason for not going below a 3-inch stubble height with those two grasses whether it is grazed or mowed.


Troy documented the 2014 season of grazing stockpiled forage to illustrate how it goes: the good, the bad, and the ugly. Very good weather held from mid-October until mid-November before light snow occurred on November 14th. The left picture below shows the herd grazing grass on November 14th in freshly fallen snow. Clear skies and cold on November 15th, but herd contentedly grazing grass through the snow. Then, two more snow storms occurred on November 17th-18th and November 21st.






By November 23rd, the snow was almost totally melted. It was good open grazing until November 27th before another snow storm came in. By November 30th, most of the snow was gone and completely gone by December 1st. Stockpiled pastures enjoyed a week of being snow-free before a 3-day snow storm hit on December 9, 10, and 11. This was a heavy snow. Some hay was hauled in to supplement stockpiled forage that had become harder to get to. Note picture to the left, front-end loader of tractor bringing in the hay.

This snow lingered for several days, not melting away until December 24th. The weather held well the rest of December. Hay continued to be fed to supplement stockpile pasture until January 2nd, when full hay feeding commenced after a 257-day grazing season in paddocks 7 & 8.


Stockpiled pasture without a coating of snow after 10 days

Hay being rolled out on pasture on January 2nd.

Relative feed value (RFV) was focused on in some forage samples taken at different times during the stockpile grazing period. The earliest test shown was on November 1st. Another forage sample was taken on November 30. Both of these test results were accompanied with a picture of the grass in the paddock the forage samples were taken from. The two are pictured immediately below:

FORAGE TESTING LABORATORY
DAIRY ONE, INC.
730 WARREN ROAD
ITHACA, NEW YORK 14850

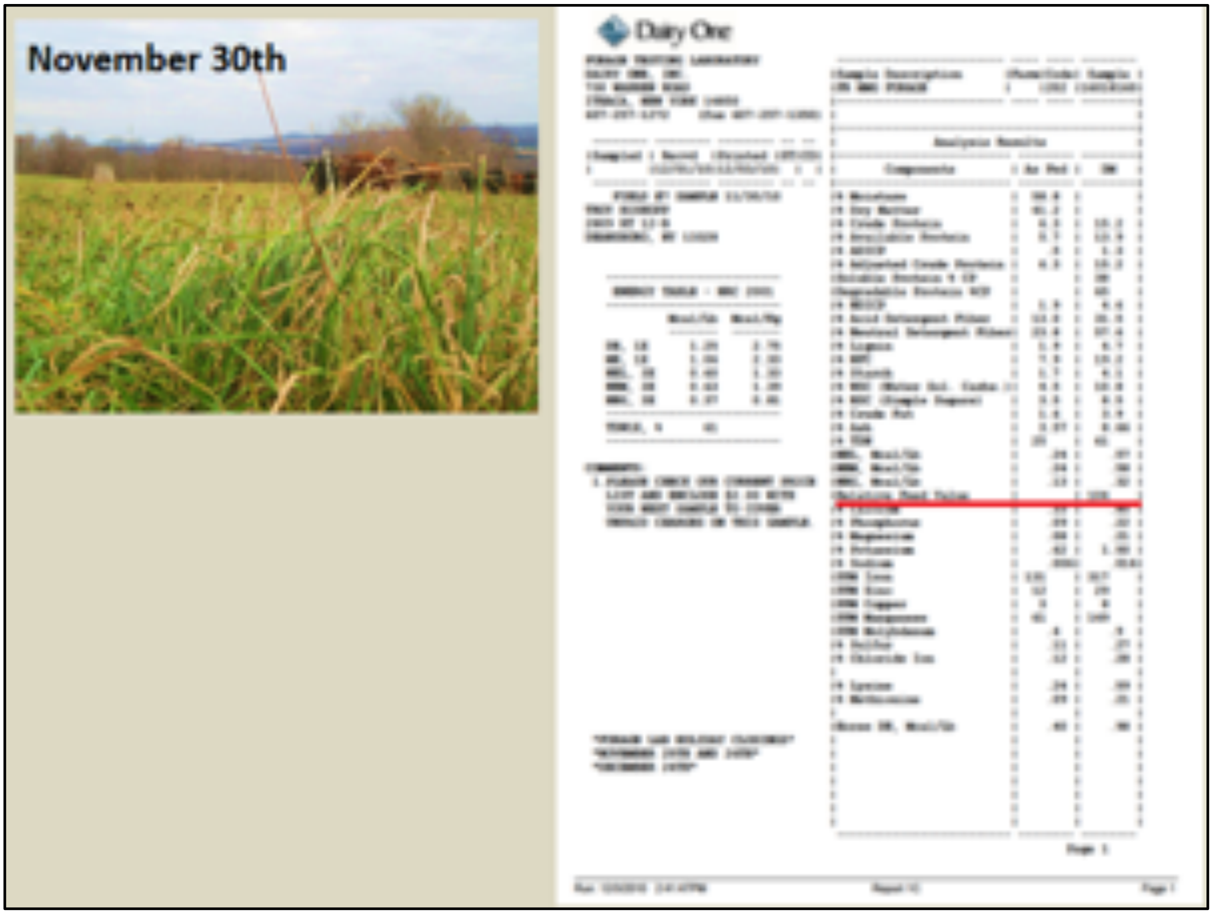
Sample Description: PRO PASTURE — STOCK PILED PASTURE PADDOCK 12 11/1/14

| Components | As Fed | DM |
|---|---|---|
| % Moisture | 68.9 | |
| % Dry Matter | 31.1 | |
| % Crude Protein | 4.3 | 14.0 |
| % Adjusted Crude Protein | 4.3 | 14.0 |
| % Acid Detergent Fiber | 11.1 | 35.7 |
| % Neutral Detergent Fiber | 17.1 | 56.0 |
| % NFC | 6.4 | 20.5 |
| % TDN | 19 | 62 |
| NEL, Mcal/Lb | .18 | .59 |
| NEM, Mcal/Lb | .18 | .59 |
| NEG, Mcal/Lb | .10 | .33 |
| Relative Feed Value | | 106 |
| Horse DE, Mcal/Lb | .32 | 1.02 |

ENERGY TABLE - NRC 2001

| | Mcal/Lb | Mcal/Kg |
|---|---|---|
| DE, 1X | 1.26 | 2.77 |
| ME, 1X | 1.06 | 2.33 |
| NEL, 3X | 0.61 | 1.34 |
| NEM, 3X | 0.64 | 1.40 |
| NEG, 3X | 0.37 | 0.82 |
| TDN1X, % | 62 | |

Relative Feed Value underlined in red in Nov. 1st forage analysis results for paddock 12




*Relative Feed Value underlined in red in Nov. 30th forage analysis results for paddock 7*

RFV for both of these paddocks composed of orchardgrass and ladino clover was 104. (Editor's Notes: Full bloom alfalfa (41% ADF and 53% NDF) is estimated to have an RFV of 100. Full bloom alfalfa is past its prime. If a forage has an RFV value greater than 100, it should result in greater intake of digestible dry matter by the cow than full bloom alfalfa [Ward & de Ondarza, 2008]. RFV is intended to reflect how well an animal will eat and digest a particular forage if it is fed as the only source of energy. Relative Feed Value is calculated from ADF and NDF content of a forage. Dry matter intake (DMI) as a percentage of animal body weight is predicted based on the analyzed NDF content of the forage. Digestible dry matter (DDM) (%DM) is predicted from the analyzed ADF content of the forage. These two estimates are multiplied together and divided by the constant, 1.29, to come up with RFV [Ward & de Ondarza, 2008].)

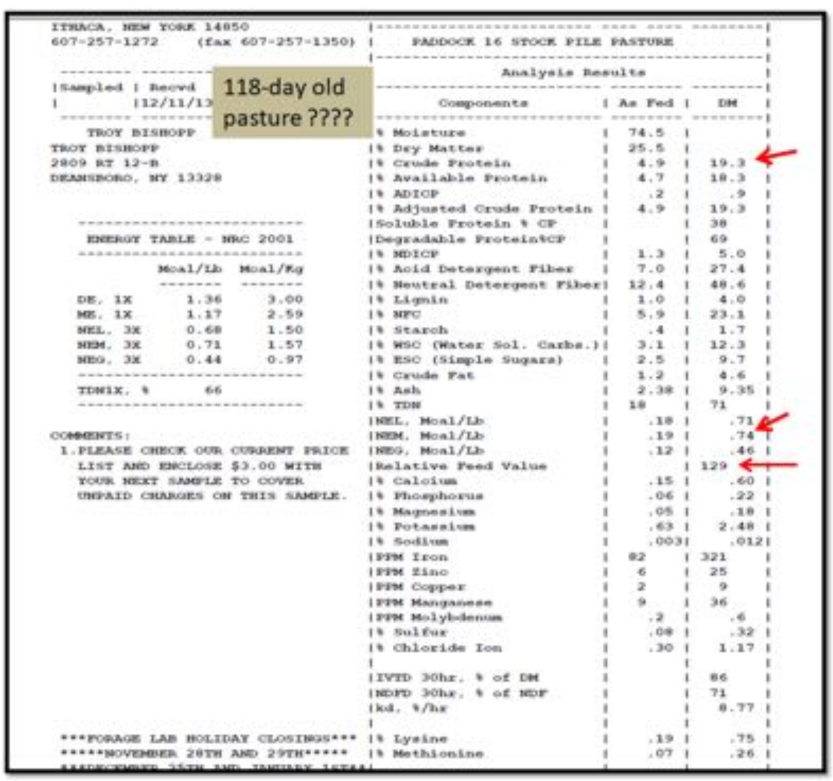
RFV is calculated as follows:
RFV = (DMI, % of body weight) * (DDM, % of DM) / 1.29
Where: DMI = dry matter intake (% of body weight) = 120 / (NDF, %DM)
**Example from Nov. 1st forage analysis results DMI = 120/54.8 = 2.19%**
DDM = digestible dry matter = 88.9 – (0.779 x ADF, %DM)

(Editor's Notes: RFV does not consider fiber digestibility. It therefore discriminates against forages with highly digestible fiber. Haycrop forage containing grass is underrated by the RFV system because grass contains more NDF but that NDF is more digestible than it is in alfalfa [Ward & de Ondarza, 2008]. The DMI calculated for the November 1st forage sample was 2.19. This is considerably lower than the target DMI set by Troy of 3.5. True intake is somewhere in between. See RFQ in second paragraph below.

RFV of these two samples shown above is rather low due to the presence of yellow leaf in the standing forage. (See the photos of the forage above.) These leaves are senescing (dying) and as a result are more fibrous elevating the ADF and NDF values higher than an all-green forage would test. This is why in mid-summer it is better to graze grass within 42 days, or end up with reduced forage quality as older leaves turn yellow. Paddock sizes need to expand to meet demand.

Relative forage quality (RFQ) is a better measure of forage quality for grasses. RFQ is an estimate of how much available energy a non-lactating animal will obtain daily from a particular forage if it is all that is fed. Relative Forage Quality (RFQ) attempts to improve on RFV by using TDN (Total Digestible Nutrients) instead of DDM and calculating TDN and intake using in vitro fiber digestibility estimates. RFQ should therefore do a better job than RFV of describing the production potential of a forage [Ward & de Ondarza, 2008]. It consistently gives grass a higher forage quality value than does RFV. Lab analysis and calculating RFQ is more involved, but worth it.)

In a forage sample taken in December 2013 from paddock 16, the RFV value is higher (129). See analysis results below.




ITHACA, NEW YORK 14850
607-257-1272 (fax 607-257-1350)

| Sampled | Recvd |
|---|---|
| | 12/11/13 |

TROY BISHOPP
TROY BISHOPP
2809 RT 12-B
DEANSBORO, NY 13328

ENERGY TABLE - NRC 2001

| | Mcal/Lb | Mcal/Kg |
|---|---|---|
| DE, 1X | 1.36 | 3.00 |
| ME, 1X | 1.17 | 2.59 |
| NEL, 3X | 0.68 | 1.50 |
| NEM, 3X | 0.71 | 1.57 |
| NEG, 3X | 0.44 | 0.97 |
| TDN1X, % | 66 | |

COMMENTS:
1. PLEASE CHECK OUR CURRENT PRICE LIST AND ENCLOSE $3.00 WITH YOUR NEXT SAMPLE TO COVER UNPAID CHARGES ON THIS SAMPLE.

***FORAGE LAB HOLIDAY CLOSINGS***
*****NOVEMBER 28TH AND 29TH*****

PADDOCK 16 STOCK PILE PASTURE

Analysis Results

| Components | As Fed | DM |
|---|---|---|
| % Moisture | 74.5 | |
| % Dry Matter | 25.5 | |
| % Crude Protein | 4.9 | 19.3 |
| % Available Protein | 4.7 | 18.3 |
| % ADICP | .2 | .9 |
| % Adjusted Crude Protein | 4.9 | 19.3 |
| Soluble Protein % CP | | 38 |
| Degradable Protein%CP | | 69 |
| % NDICP | 1.3 | 5.0 |
| % Acid Detergent Fiber | 7.0 | 27.4 |
| % Neutral Detergent Fiber | 12.4 | 48.6 |
| % Lignin | 1.0 | 4.0 |
| % NFC | 5.9 | 23.1 |
| % Starch | .4 | 1.7 |
| % WSC (Water Sol. Carbs.) | 3.1 | 12.3 |
| % ESC (Simple Sugars) | 2.5 | 9.7 |
| % Crude Fat | 1.2 | 4.6 |
| % Ash | 2.38 | 9.35 |
| % TDN | 18 | 71 |
| NEL, Mcal/Lb | .18 | .71 |
| NEM, Mcal/Lb | .19 | .74 |
| NEG, Mcal/Lb | .12 | .46 |
| Relative Feed Value | | 129 |
| % Calcium | .15 | .60 |
| % Phosphorus | .06 | .22 |
| % Magnesium | .05 | .18 |
| % Potassium | .63 | 2.48 |
| % Sodium | .003 | .012 |
| PPM Iron | 82 | 321 |
| PPM Zinc | 6 | 25 |
| PPM Copper | 2 | 9 |
| PPM Manganese | 9 | 36 |
| PPM Molybdenum | .2 | .6 |
| % Sulfur | .08 | .32 |
| % Chloride Ion | .30 | 1.17 |
| IVTD 30hr, % of DM | | 86 |
| NDFD 30hr, % of NDF | | 71 |
| kd, %/hr | | 8.77 |
| % Lysine | .19 | .75 |
| % Methionine | .07 | .26 |

This is an outstanding forage test result for stockpiled forage. Protein content is 19.3 percent of forage DM and net energy of maintenance (NEM) is 0.74 Mcal per pound. Both ADF and NDF are below 30 & 50 percent of DM, respectively. Consequently, the RFV is higher than any of the stockpile forage samples taken earlier in 2014, including one taken during a pasture walk on December 6th that had RFV of 110. Troy asked the audience why the higher RFV test in December. Tom Griggs, WVU forage agronomist, offered that RFV was staying up because of new grass growth boosting the quality of stockpiled forage in previously grazed stockpiled paddocks. Looking back at the photo of the person taking a grab sample of the forage in that paddock, there actually was more green leaf edible forage in the paddock albeit the presence of many dead weed stalks amid the grass. Amount of yellowed grass leaves was less than in the November photos. Tom's observation made good sense.

*4-inch stubble height left after grazing a stockpiled pasture helps winter survival of stand and faster green-up in the spring. Soil is insulated some and traps snow for moisture.*

Stockpiling will require advanced planning of grazing the paddocks next spring. By amassing forage growth in the fall for stockpiling, it will reduce tiller formation because of competition for light. This may also cause poor winter survival under hard winter conditions, and slow recovery next spring on heavily grazed pastures. Avoid this by leaving a 3-4 inch residual stubble. It is better to keep one or two pastures in reserve for early spring grazing to stagger the spring flush of grass and allow extra time for those late-fall grazed pastures to recover. Those pastures grazed latest into the fall before dormancy, will be slowest to recover in the spring. Winter grazing some paddocks thus can help stage paddocks to accumulate forage at different rates in the spring (WSU Extension on-line, 2020).

Troy also incorporates other areas of his farm into his winter grazing system. The two top pictures to the right show a riparian area that is too wet to graze in warm weather. It can be grazed in winter when the area is frozen. Rushes are eaten by cattle as shown in the lower two pictures. Rushes are high in minerals so they can help the cattle nutritionally. It is also better for turtles and other aquatic animals if the area is grazed in winter, he said.

He also mentioned that windbreaks are helpful for the grazing cattle to seek shelter from the wind when necessary. It also traps snow by creating drifts in pastures that will enhance soil moisture early in the next growing season.

Troy also elaborated on the melting grass bullet that he listed earlier in his presentation. As it gets colder, grasses like orchardgrass senesce (turn yellow) and if on the soil surface will start to rot and become worm food. Then, there are mice and deer that help deplete the forage base. (Editor's Note: Orchardgrass has a place as a stockpile forage, but forage researchers recommend that it be used early-on in the fall after a hard freeze and something like tall fescue (meadow fescue?) be used later as it will hold its quality much better even under snow cover.)

January 15$^{th}$ to April 15$^{th}$ is the weak link for Troy. It is two months that do not lend themselves to be a part of the grazing season. Options are:

- Send them off to another farm
- Crop residue grazing somewhere (fencing?)
- Swath graze (where? quality?)
- Overseed annuals or Brassicas that can overwinter and perhaps provide grazing earlier than April 15$^{th}$.
- Work with crop farmers and cover crops
- Just feed hay and quit whining
- Suggestions ???????????????????????????

At the close of this session, there was a question about why cattle can sometimes bloat during early spring or late fall grazing. Jessica Williamson answered by saying she had been called out to a farm where half the herd had bloated. The veterinarian thought it was because a freeze had caused cell walls in the leaves to break releasing a lot of sugars. (Editor's Note: These sugars are easily fermented in the rumen which could cause a build-up of froth in the rumen. High quality forages such as young green cereal crops, rape, kale, turnips, and legumes such as peas that are grazable cover crops can induce frothy bloat as well. Rapid degradation of highly digestible plant matter will cause a sudden release of cell contents that are available for rumen microbes to digest. This sudden increase in nutrient availability causes microbial blooms, which in turn doubly increase rate of digestion. Soluble proteins and carbohydrates make up a large part of the cell contents, as do small particles which are actually parts of the plant cell walls these microbes attach themselves to. Any excess carbohydrates that microbes do not break down are stored as "slime" over their cellular bodies. This slime is highly viscous and very stable. Microbes also release a lot of gas with fermentation and digestion of these plant tissues. But with the additional buildup of slime, gas is trapped in these highly stable, slimy bubbles (froth). As rumen pressure increases, the more slime and gas is produced. The more pressure that builds up in the rumen, the more pressure is put on the lungs. If not treated promptly, the animal eventually dies of suffocation from not being able breathe [K. Lindquist, 2020].)

After evening dinner and before the start of the Producers Showcase, Dr. Sidney Bosworth and the Executive Committee along with former committee members presented Executive Director Jim Cropper with a plaque and a gift certificate as appreciation of his leadership as Director in sustaining the Northeast Pasture Consortium over the past 11 years. Jim had announced his desire to retire at the November Executive Committee teleconference. He said at that time he would stay on as Executive Director until the end of February 2020. He also was a charter member of the Northeast Pasture Consortium since its inception in 1995 when he was stationed with Agriculture Research Service's Pasture Systems and Watershed Management Research Unit at University Park, PA. Before that he was also a member and secretary of the Northeast Pasture Coordinating Committee, a precursor of the Northeast Pasture Consortium. He began working with that Committee when he began his duties in December 1987 as regional forage agronomist at the USDA-NRCS Northeast National Technical Center in Chester, PA.

Photo at left with Jim (tan jacket) receiving a "Grazing Champion" plaque from Dr. Sid Bosworth for "A lifetime of dedicated service to well-managed pastures and the human and ecological communities that benefit from them."

Jim was gratified for the outpouring of congratulations and kind attendance of so many former committee members and colleagues from ARS, Extension, and NRCS.

**Producer Showcase**

Kevin Jablonski, Executive Committee member, moderated the Producer Showcase session. One farmer from Vermont and one farmer from New Hampshire were featured this year.

**Randy Robar**, owner and operator of the "Kiss the Cow" dairy farm, in Barnard, VT was the first presenter. The title of his presentation was "Kiss the Cow Farm, An Unexpected Journey". Randy gave the history of starting out with just one cow at a very small farmette to a much larger dairy on part of a 500-acre Vermont Land Trust farm that is in Agricultural Land Preservation zone. He presented 5 themes along the Journey:

- This Was Not the Plan: How We Became Accidental Farmers.
- How the Farm Has Changed.
- Grazing Cows & Poultry
- Climate Change & Strain

- Realities of Small-Scale Farming

**This Was Not the Plan: How We Became Accidental Farmers.**
Originally, they had a small farmette with just one cow. She went dry so they bought a second lactating cow. He quit his corporate job and he began raising pigs, chickens, built a maple sugar hut, started tapping maple trees for sap, grew fruit trees and raspberries. He had a small store to sell his farm-raised products.

*Robar farmette, from one to two cows, using a garage as a cow barn.*

**How the Farm Has Changed.**
When the Vermont Land Trust bought a 500-acre farm, he and three other people wanted to rent the farm. They convinced the Trust to rent the farm instead of selling it as the Trust attorney had recommended. It was placed in an Agricultural Preservation Area. He moved his operation to that farm. His cows now graze 75 acres of that farm. See pictures below showing the layout of the farm and a scene of the farmstead amid the grassland and another expanse of pasture. Kiss the Cow farm now process their own milk and have a farm store. They sell farm products from 50 small Vermont farms along with 9 of their own. They sell some raw milk, but they also pasteurize their milk. Some of it is made into ice cream which they sell at their store and at farmer markets. They also produce maple syrup and process 3000 chickens, ducks, and turkeys each year that they raise. See picture of the store and processing facilities below.

**Grazing Cows & Poultry**
They practice strip grazing without a back fence. Randy finds this cuts down on goldenrod, bedstraw, and brush that was prevalent on the farm before it was rented out. The poultry have

access to pasture. They are housed in movable crates. Another picture below shows how this is done.  The grazing season usually starts on May 15 and ends in early November.


*Movable poultry crates on pasture. The left picture shows the checker board pattern where the crates were. The first grazed are greening up.*

*Kiss the cow farm store and their milk and poultry processing facilities*

**Climate Change and Strain**

Randy said, “We seem to have weather patterns or episodes that last longer whether it be rainy or dry.” This makes it harder to harvest high quality hay and at times, interferes with pasturing livestock. Although they round bale dry hay, they are also making balage that is wrapped in plastic sheeting. It can be hard to get hay dry enough to bale without spoilage later on, or if it rains enough, the dry hay might be only good for mulch or bedding. Pastures can suffer from drought or too much rain. This can raise problems when rotationally grazing as it takes some forward contingency planning on what to do when either drought or too much rain occurs.

**Realities of Small-Scale Farming**

Why do small-scale farming?

- To feed our community
- To preserve and improve the land that sustains us
- To pass on this knowledge and experience to others who want to learn about this lifestyle
- To earn a living wage

They can feed their community with locally produced, wholesome food. In the meantime, they can preserve our heritage and improve the land that sustains us locally rather than depend on food sources from far-flung regions. To pass farming knowledge and experience onto others, he likes to use apprentices to help him operate the farm. They get room and board for their efforts, and he has a labor pool to do the farm work, processing milk and meat, and retailing farm products. During the summer, he hosts musical entertainment on Thursday nights. Three to five hundred people attend. This gives a real sense of community. Small-scale farming requires entrepreneurship to earn a living wage as commodity prices are too low so it has to be value-added sales.

Our second speaker of the evening was **Lora Goss**, Stonefen Farm, Pike, NH just one mile from the Connecticut River and upriver from Fairlee, VT just a few miles. Lora started her presentation about StoneFen Farm, LLC asking three questions: Is it all about the grass? Is it the breed of cattle? Is it the people? It takes all three to get the job done well when raising pastured livestock.

*The Goss Family, Steve and Lora in the middle, surrounded by their children, daughter-in-law, and grandchild*

Lora, a seventh generation Ayrshire milk cow farmer, kept up the tradition until her legs and knees gave out. She had daily milked over 50 head of Ayrshires before semi-retiring as a beef farmer. They began in 1982 with 2 Ayrshire heifers, 5 bred Hampshire sheep, and added 2 boys and 2 girls. The family moved to Pike, NH in 1998 when they purchased Stonefen Farm. They were milking the Ayrshire herd at that time. Some of the land needed to be cleared of pole-sized trees to provide more grass for the milking herd.

In 2006, the Gosses began working with the USDA-Natural Resources Conservation Service (NRCS). They installed a six strand high tensile aluminum wire perimeter fence around the pastureland. To provide water to the pasture paddocks, they installed a frost-free hydrant and seasonal water lines to fill portable water troughs for each paddock.

In 2009, with NRCS assistance, they established 2000 feet of grass waterways previously called swales and 4000 feet of underground perforated drainage tubing to get better surface and underground drainage in the paddocks. At that time, they were contract grazing bred heifers and dry cows.

Picture on the left shows one of the grassed waterways under construction. Hay bales are placed in the bottom of the waterway to trap sediment while under construction and during grass establishment. At the bottom of the picture, a waterway crossing is being put in. The black tarp is geotextile fabric. It is laid over rock riprap to give it support when soil is saturated. A course of gravel will be placed on top of it as a pavement for livestock and equipment traffic.

Mulching grass-seeded waterway to reduce soil loss and get seeds to sprout well and off to a good start. Netting can be used in the grassed waterway channel to keep mulch and seeds in place during a runoff event that could occur before the grass is well-established. Netting is pinned down with 4-inch metal staples to keep it in place. It is left in place and will eventually decompose.

Second grassed waterway with a stone-center after seeding and mulching. Stone-centers in waterways are needed where prolonged water flows are likely. Grass vegetation tends to die-out if their roots cannot tolerate being submerged creating bare areas that are subject to water channel erosion. Water-loving plants will eventually invade, but they tend to trap sediment that will eventually fill-in the waterway. Once sediment settles in between the rocks, vegetation will begin to grow hiding the rocks. A subsurface drain outlet is to the left of the waterway.

Dugout pond beginning to fill with water after it was excavated. This pond feeds three water hydrants that are used for livestock water. One of the hydrants is shown below.

A NRCS project that Lora described as "Best thing ever:  Low Water Crossing" was a stream cattle crossing so the cattle could cross at one place safely. It is pictured below shortly after construction. Concrete pad is flanked with large stones to make sure cattle do not stray off the pad.

The Gosses last NRCS project was building a high tunnel. They cleared some more pole-sized trees to put it in. They grow vegetables in it when not using it as winter shelter for the cattle. Three pictures below show how it is used depending on the season. New Hampshire is well known for its snowy winters and that is attested to in the second picture. The lower picture of the three shows a bedded pack that the cattle lay on when they go in at night or during inclement weather.

Their first foray into beef was in 2015. In 2018 herefords and polled red Devons arrived. See picture below. A Devon is in the middle of 3 white-faced herefords.

The picture to the left shows herefords and Devons on lush summer pasture. This place can really grow grass. They have 30 acres of pasture. A little over 10 acres of it produces 2 hay cuttings each year for winter feed. The biggest challenges are bloat and fat cows. They even have enough grass to raise feeder cattle from the calves that are born on the farm.

In her closing Lora explained the derivation of the farm name, Stonefen. Since New Hampshire was glaciated and has many outcroppings of bedrock, the stone part of it is easy to imagine. Fen is a bit different. It is an English term whose meaning is lost on most Americans. A fen is a low-lying wet land with grassy vegetation; usually it is a transition zone between land and water. They are characterized by their distinct water chemistry, which is pH neutral or alkaline, with relatively high dissolved mineral levels but few other plant nutrients. This is why grass grows so good on the farm and cattle do well on it. Most areas in New England are on acidic glacial till and need agricultural limestone added to them to produce good yielding, nutritious forage crops.

The Conference adjourned for the evening. It reconvened on January 16 at 8:00 AM with session 5.

**Session 5 – Pasture Soil Compaction - Identification and Remediation**

**A. Fay Benson**, Small Dairy Support Cornell Univ. SCNY Regional Team - Education Coordinator NY Dairy Grazing Apprenticeship & Project Manager NY Organic Dairy Initiative, Cortland, NY moderated this session and was its first speaker. The title of his presentation was "Identifying and Quantifying Pasture Soil Compaction".

Fay covered four topics:

- Identify indicators of soil compaction.
- How does compaction affect soil functions?
- Review remedies for compaction, and
- Data from "Pasture Compaction Ratio".

Grazing has major impact on soil health; it can be good or bad, as seen in the two pictures below.


The good: Tall grass with deep roots provides: Adequate Feed per bite reduces walking, soil protection from drying, and decreases water runoff and soil erosion. More rainfall infiltrates into the soil instead of running off during heavy rains. This increases available soil water to grow more grass. Rotational grazing allows for wildlife diversification since small parcels are grazed at a time instead of a whole pasture being grazed and treaded on. This all helps create an active biological cycle.

The Bad: Over-grazing along with heavy use areas at single gate entry points, under shade, near stationary feed bunks and mineral feeders on extensive pasture areas leads to exposed soil which inhibits water infiltration and produces less available forage per acre. Little rainwater infiltrates into the soil due to soil compaction from continual hoof traffic. The right picture above looks more like an exercise lot than a pasture. For sure, the "pasture" is not being depended upon very much for forage intake.


The concentrated animal feeding operation (CAFO) system is degenerative not just on-site but in the supply of its feed. The feed that is grown to feed cattle in feedlots is grown on cropland that can be soil degenerating depending on field conditions, such as slope, erosivity of the soil, ease of water infiltration, climate, and farm cropland management, such as amount of tillage used to plant the grain crop, the use or nonuse of contour farming and terraces on sloping ground, use of grassed waterways or not in concentrated flow areas. Additionally, methane gas related to manure pools is increased as CAFO's create a mix of fecal material and urine and this mix is likely to be anaerobic most of the time in wetter climates or in manure storage facilities.

Finishing meat-type ruminants on pasture using intensive rotational stocking can create similar average daily gains using a lot less energy and produce a less fatty meat. It can be done on perennial pastures where tillage is infrequently occurring and where annuals are used can be done with considerably less tillage or planted without any previous tillage (no-till planting). Soil structure is greatly improved when soils are tilled infrequently or not at all. Organic matter is higher where a dense sod with a fibrous root system exists. Belched methane may be similar in both systems, but methane generation from fecal matter separate from urine deposits will be less especially if dung beetles and other decomposers are active in well-managed pastures with healthy soils.

Fay had an epiphany to pasture compaction issues when he began looking closer at conditions under fences in pastured areas. He found that the:

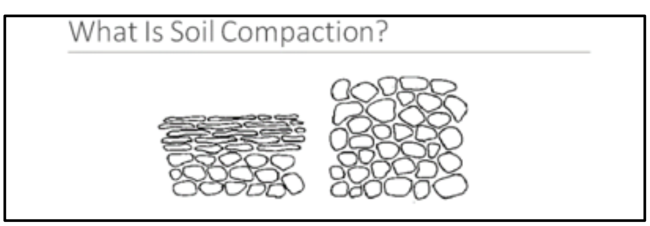
- Fence line soil level was 6-8 inches higher,
- Fence line had more pasture grasses,
- Pasture had more sedges, and the
- Farmer had not noticed the difference.

Compaction happens over decades. Most farmers do not realize that they have it. Not only the functions of the soil are impacted but also the types of plant which grow change. Sedges appear in the pasture due to the soil compaction lowering water infiltration into the soil. Water ponds on the surface creating a shallow wetland that favors the growth of sedges (a water-loving plant) over grasses with root systems that dislike growing in on-again, off-again water-saturated soils. Soil compaction makes it harder for roots to penetrate the soil and get enough nutrients, water, and oxygen to grow well so forage yields are reduced. Most noticeable difference in forage yield is to have a hayfield side-by-side with a pasture on the same soil type (especially a continuously occupied one), the grass in the hayfield will be noticeably taller in the spring at heading than the pasture where spot grazing allows some areas to grow ungrazed early in the season and sport seedheads (or a pasture not stocked immediately in the spring as the herd is elsewhere).

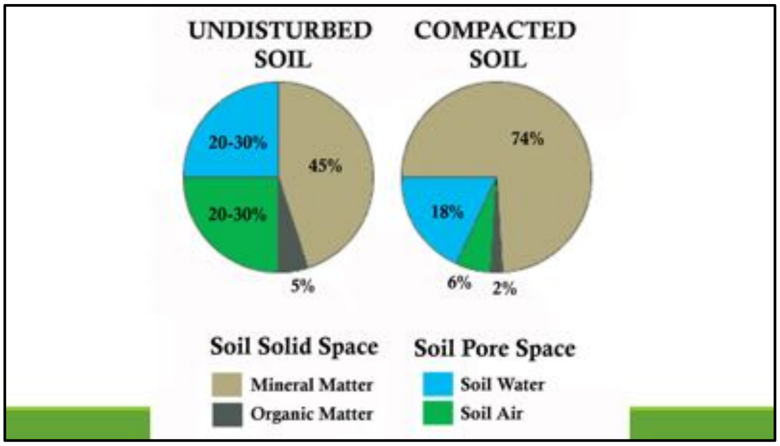
Below is a figure with a comparison of soil health between soil samples taken under-the-fence and in-pasture that Fay sent to Cornell to be tested and rated by the Cornell Soil Health Assessment. These samples were collected in April 2015. Some of the values were adjusted according to Version 3 of the Assessment that was published in 2016. In doing so, the under-the-fence soil was even more markedly different from the one in-pasture. The three worst rated soil indicators from the in-pasture sample were soil surface hardness (0-6 inches), subsurface soil hardness (6-18 inches), and soil aggregate stability. These are depicted in red on the assessment sheet for the in-pasture soil sample. The constraints column is filled out for these three indicators. These 3 factors greatly influence plant rooting depth and exploration, water infiltration into the soil and percolation through the soil, and nutrient and water access by the roots. Soil aggregation also affects soil air movement, soil surface crusting and sealing under intense rainfall, soil erosion, and water runoff. If the soil aggregates are not stable, all the things mentioned above get bad.


*Comprehensive Assessment of Soil Health – The Cornell Framework (Version 3.2). Adjusted values entered and color coded for aggregate stability, organic matter, ACE soil protein index, and respiration for the under-the-fence report on the left and organic matter only for in the pasture on the right. The under-the-fence aggregate stability value was much higher than the in-pasture value so the rating was corrected. Medium textured soil curve used for appropriate indicators.*

(Editor's Note: For people not familiar with some of the indicators, a few of them are explained as follows. The Autoclaved Citrate Extractable (ACE) Protein Index is an indicator of the fraction of the soil organic matter that is present as proteins or protein-like substances. This represents the large pool of organically bound nitrogen (N) in the soil organic matter, which microbial activity can mineralize, and make available for plant uptake. Respiration is a measure of the metabolic activity of the soil microbial community. It is measured by capturing and quantifying carbon dioxide ($CO_2$) released from a re-wetted sample of air dried soil held in an airtight jar for 4 days. Greater $CO_2$ release is indicative of a larger, more active soil microbial community. Active carbon is an indicator of the small portion of soil organic matter that can serve as a readily available food and energy source for the soil microbial community, thus helping to maintain a healthy soil food web [Moebius-Clune, B.N. et al., 2016].)




Compaction occurs when a force compresses the soil and pushes air and water out of it so that it becomes denser. Compaction is more severe when the soil is wet and less able to withstand compression.




When a soil is compacted air space is squeezed out of the soil which can be seen in the figure to the left. Root growth takes place in the air spaces around soil particles; therefore, soil compaction furthers mechanical resistance to root penetration, which limits the nutrient and water uptake. It also inhibits the emergence of seedlings and spreading of rhizomes. Clay textured soils are most easily compacted, while sandy soils are the least. Alluvial soils in bottomlands and fine textured silt loams are also easily compacted. With compacted soils, organic matter is reduced as well as overall soil health.

Measuring Soil Compaction using a penetrometer is a quick way to compare soil strength, but it has its weaknesses. It measures resistance to root penetration in soil in pounds per square inch. This resistance changes as soil moisture changes; the drier the soil, the greater the resistance. It is good for comparison on the same soil texture but different situations on the same day and time, such as under-the-fence and in-the-pasture. It is not useful as benchmarking tool as soil moisture conditions will vary considerably over time and on different soil textures. Measurements should be taken when the soil is near water-holding field capacity, but this is hard to judge without more instrumentation.

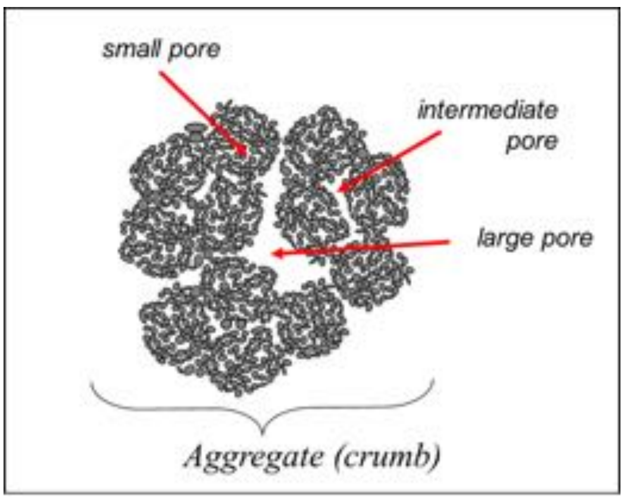
*Soil penetrometer being pushed into the ground. A dial above the handles measures soil resistance. Lower inset shows the different tips than can be put on the business end of the probe.*

Compaction and exposed surface soils

- Impede active root growth,
- Cause ponding, runoff, erosion, nutrient loss,
- Limit soil aeration and soil biology,
- Limit water infiltration: therefore, drainage and storage, raises drought frequency and severity,
- Cause stress for plants, leading to decreased yields and quality and greater input expense.

Poor nutrient management

- Limits forage growth in case of nutrient deficiencies and soil acidity, affecting the above
- Where livestock are allowed to camp near shade, permanently located water troughs, gates, and mineral feeders, soil nutrient levels can be too high at or near these spots.

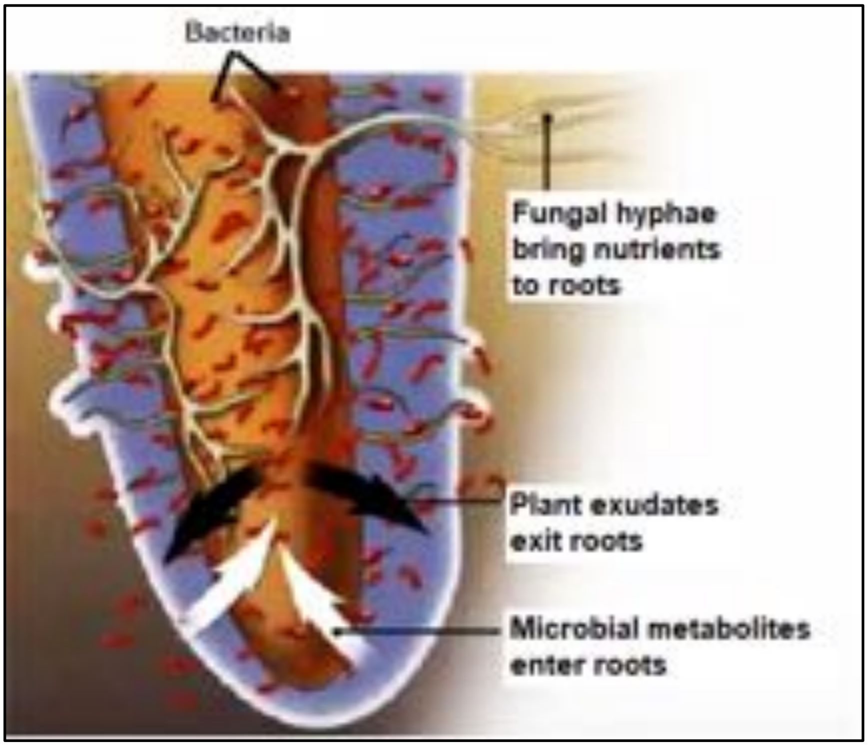



*Soil aggregate or crumb schematic, soil particles glued together by root exudates to form a granular composite soil particle similar in appearance to coffee grounds.*

*Badly pugged pasture from cattle traffic; wet, slow to dry*

Soil aggregates are key to a healthy soil. Large ones allow water and air to move freely throughout the soil. Small ones hold water for times of drought as they cut down on air space size so water can adhere to aggregate surfaces rather than move out of the root zone by gravitational forces. All aggregates keep the soil biology aerobic. When destroyed by compaction, the soil can turn anaerobic releasing methane and other undesirable gases. They aid soil porosity. Porosity is important for:

- Aeration,
- Permeability (the ability of a soil to allow gases or water to circulate through it),
- root growth,
- Water availability, and
- Biological habitat (plant roots and microorganisms).




*Root tip schematic showing its rhizosphere where the root interacts with soil bacteria and fungi. Legume roots interact with soil bacteria called Rhizobia as a mutualistic host providing food for the bacteria while they fix nitrogen, a plant food, for the host legume.*

The rhizosphere is where roots and microbes exchange nutrients. Soil compaction inhibits nutrient exchange between plants and microorganisms in the soil, harming plant growth. As seen in the schematic above, roots give off exudates which feed soil microbes and are the glue that forms soil aggregates. As the roots explore the soil and grow, they create just enough pressure to compress these aggregates into water stable ones that can resist being dissolved and suspended in water.

Pasture soil compaction remediation: Nature vs Machine. Nobel Research Institute report said five out of seven studies showed no difference from aeration. (Editor's Note: Some research papers I have seen on this were poorly designed. In one case, not done on a pasture and the soils were not compacted very much to begin with. I suggest doing this work with on-farm studies.)
https://www.noble.org/news/publications/ag-news-and-views/2000/april/some-thoughts-on-soil-aeration-of-pastureland/
The Yeoman Plow debate:
University of Georgia: "Most research has shown that aeration is, at best, a temporary solution. Studies comparing fields with aerated vs. non-aerated areas tend to only show a difference in performance for 1-2 years."
As with row crop farming, to choose mechanical means to alleviate compaction is like taking the first drug, and eventually becoming addicted to tillage. It is trying to alleviate the symptom, but not cure the problem: pasturing livestock on soils too wet to have traffic on them, machine or

animal. Perhaps it means sacrificing a paddock or two when it gets rainy, but when there is no rotational grazing system, large pastures can be affected greatly either in localized areas or all over. If the ground is subject to frost heave in winter, some of this compaction can disappear on its own. Better to have only a few acres with compaction issues than on large pasture areas.

Preventing pasture compaction is a better alternative. The old adage that an ounce of prevention is worth a pound of cure is very apropos here. Flexible Management or Adaptive Grazing can be prevention strategies, such as:

- When soils are wet, move animals from sensitive soil types if possible. (Clay, Silty)
- Increase rest period if soils are low in OM.
- Decrease animal density if soil is prone to compaction.
- Alternate pasturing with hay harvests on pastures with compacted soils where machine work can be done easily. This will allow deeper root penetration.

Infrastructural means of preventing pasture compaction are:

- Good laneways confine compaction to a specific area (dairy cows – main laneway to milking parlor).
- Drainage will decrease time soil is wet and prone to compaction (Random or system depending on soil conditions: swales versus entire field stays wet for prolonged periods.)
- Increase watering areas and move often, not same spot each time paddock is grazed.
- Look into "No-Gate" system (beef and other meat animals, perhaps dairy).

How you feed your livestock can either reduce or heighten soil compaction. Feeding large round bales either in a feeder, or not, concentrates livestock activity around a rather large feed source that invites a lot of hoof traffic in a small area. Rolling out large round bales and limit feeding them with a hot wire would spread hoof traffic over a wider area as each bale can be rolled out in a different spot and spreading hayseed around more. This is shown in the picture at left below.

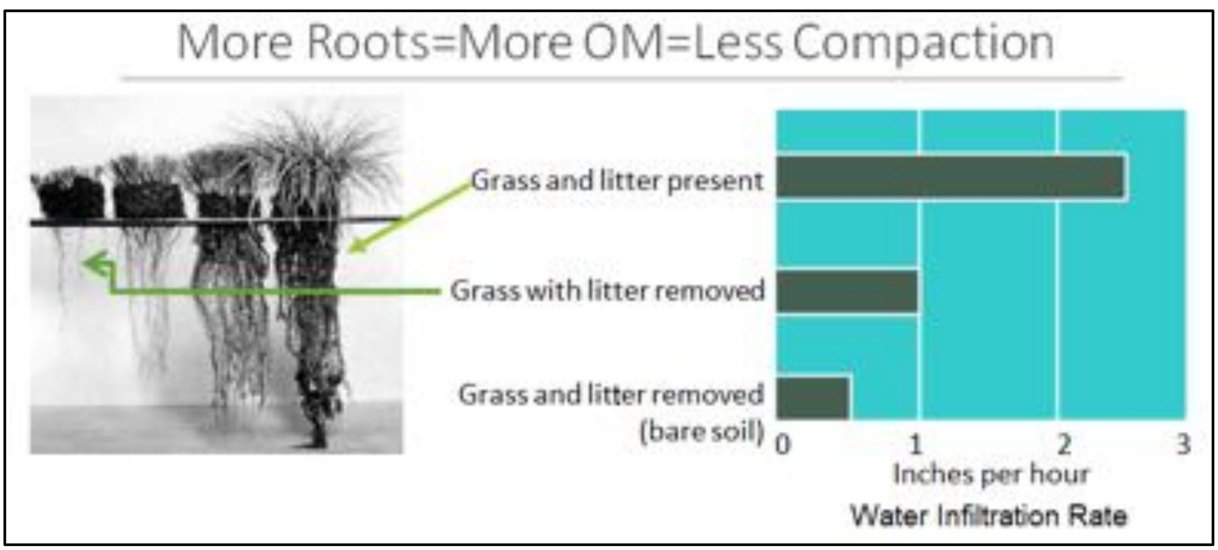
A portable oiler and mineral feeder being moved to the next paddock to be grazed. Locate at opposite side of paddock from water.

Removing leaves also affects the plant below the ground. If too many leaves (too much of each leaf) are removed, most of the stored energy to make new leaves is lost; the roots do not grow. As a rule, "taking half and leaving half" OF THE LEAF VOLUME allows some leaves to be removed

Grazing Management

| % Leaf Removed | % Root Growth Stopped |
|---|---|
| 10 | 0 |
| 20 | 0 |
| 30 | 0 |
| 40 | 0 |
| 50 | 2 to 4 |
| 60 | 50 |
| 70 | 78 |
| 80 | 100 |
| 90 | 100 |

while not stopping root growth significantly. Source: Dietz, 1999. (Editor's Note: Care must be taken on how this data is interpreted. Root stoppage alone is not a problem as long as once the grass is grazed, the grazing livestock are moved to another area with another ration of grass to consume and will not return to graze the grazed area again for 3 weeks to 6 weeks. Continually grazing the same grasses over time, will mean more than 50% of the grass is likely to be removed and root growth will be stopped for a longer period of time. Eventually this leads to the sloughing of dead roots as the plant can no longer sustain top and bottom growth simultaneously, especially for those grass species that store carbohydrate reserves to restart leaf or root growth in their leaf sheaths (orchardgrass and tall fescue). To replace carbohydrates means the grass must grow more leaf instead of roots since the leaves are needed to capture sun energy to produce carbohydrates during the growing season. Once leaf removal gets to 70%, it is likely some of the leaf sheaths are being bitten off with a loss of stored carbohydrates. Root stoppage is more complete, then. At 80 and 90 percent leaf removal, the stored carbohydrates will almost be completely consumed or the leaf sheaths damaged greatly. Rhizomatous or stoloniferous forage crops will be less damaged, this is why Kentucky bluegrass (rhizomatous) and white clover (stoloniferous) can proliferate in a closely grazed pasture while the more productive grasses and legumes will disappear over time. Their carbohydrates are stored in these underground stems (rhizomes) and on-the-ground stems (stolons). They are protected from grazing, but treading damage is a whole other matter. Soil compaction or excessive treading damage can end up hindering or ending their survival as well. Bare ground and goosegrass are at heavy use gate openings.)




More roots deeper into the soil improves soil organic matter with depth. Good ground cover improves infiltration rate. As soil permeability increases throughout the rooting depth due to the better soil structure that more organic matter and roots create, this keeps water moving downward to greater depths wicking it away from the soil surface - No backup (ponding) as if the drain pipe of the soil was plugged. With grass and litter removed, the surface soil seals shut, if it is silty or clayey, so little of the water infiltrates into the soil. Most will run off in a heavy downpour. If tilled recently, it will be loose and easily washed downslope. In a compacted pasture soil, bare soil will not erode much; it will almost be pavement, but any fecal material on it will easily be washed off downslope.

Fay cited a research paper on a 12-year sheep pasture grazing intensity study done in France entitled "Grazing triggers soil carbon loss by altering plant roots and their control on soil microbial community". It had an interesting finding concerning how soil microbe fauna changed when the intensity of grazing increased. High disturbance grazing led to a decrease of soil fungi and a proliferation of Gram(+) bacteria that accelerated decomposition of old particulate organic carbon. (Editor's notes: However looking back at a previous paper on the same study [Louault, F. et al., 2005] to get a full look at the methods and conditions underlying the study, the plant species of the pasture studied were mostly low-growing grasses and forbs due to their being grazed by sheep since the 1940's. Quackgrass (couchgrass) was a dominant species unless under high disturbance, defined in this study as 3 grazing events about 2 months apart after a June hay cutting and 1 grazing event in mid-April before a June hay harvest each year. Sheep were removed once grass height was down to about 2.5 inches, measured daily until achieved. Bent-grass, velvet-grass, perennial ryegrass, and Kentucky bluegrass made up most of the grass ground cover in the high disturbance pasture while dandelion and Dutch white clover were the dominant forbs. If relating this to US conditions, this would be similar to a long-time continuously grazed naturalized pasture made up of European grass species and forbs. Short duration grazing where livestock are moved within 3 days or less and do not return for 3-6 weeks depending on grass growth or age (beginning of senescence) would be lax grazing compared to this study due to the shortness of the residual stubble left (~2.5 inches) when the sheep were moved. Low disturbance in this study was a single spring grazing by sheep in early spring each year until getting down to the 2.5-inch stubble height. A single yearly grazing is not going to be done on a commercial farm. Research and anecdotal findings here in the eastern US comparing organic matter in pasture soils in rotationally short duration grazed pastures and typical heavily-grazed continuous pastures has shown an increase in organic matter in the rotational pastures over that of continuously grazed pastures. Put and take continuously grazed research farm pastures do not capture what goes on commercial farms where no taking of livestock takes place, just more hay is taken to the pasture, or supplemental-feed back at the dairy barn or dry lot replaces pasture forage. A 2010 research paper by Franzluebbers and Stuedemann conducted in the southeastern US concluded "Contrary to nutrient source (organic or inorganic), how forage was utilized had an enormous impact on the temporal development of soil properties. When forage was hayed continuously, surface residue was low, soil bulk density was high, and soil organic C and N remained relatively unchanged. When forage was grazed by cattle, surface residue was low to moderate, soil bulk density was low to moderate, and soil organic C and N were sequestered at high rates. We tested two grazing pressures and found that surface residue C and N contents declined, soil bulk density increased slightly, and soil organic C and N sequestration rates remained unchanged with high grazing pressure compared with low grazing pressure. When forage was unharvested (similar to a Conservation Reserve Program management scheme), surface residue was highest, soil bulk density was low (similar to low grazing pressure), and soil organic C and N sequestration rates were intermediate between haying and grazing. Soil organic C sequestration at a depth of 0 to 6 cm (linear regression across 12 years) followed the order: *haying (0.04 ± 0.04 Mg C ha$^{-1}$ yr$^{-1}$) < unharvested (0.23 ± 0.18 Mg C ha$^{-1}$ yr$^{-1}$) < low grazing pressure (0.65 ± 0.05 Mg C ha$^{-1}$ yr$^{-1}$) = high grazing pressure (0.67 ± 0.04 Mg C ha$^{-1}$ yr$^{-1}$)*. Rates were lower than reported earlier in this (12-year) study due to a drought period that caused a temporary decline in soil organic C. Although broiler litter added significant organic C throughout the course of this study (2.4 ± 0.6 Mg C ha$^{-1}$ yr$^{-1}$), its decomposition was high, resulting in statistically undetectable changes in soil organic C. Cattle grazing of mixed bermudagrass–tall fescue pastures can be considered a viable strategy to rehabilitate degraded cropland in the southeastern United States. Our data negate the perspective that only non-utilization of land will be the best strategy for rehabilitating degraded land." One could add rehabilitating long-abused pastures too.)

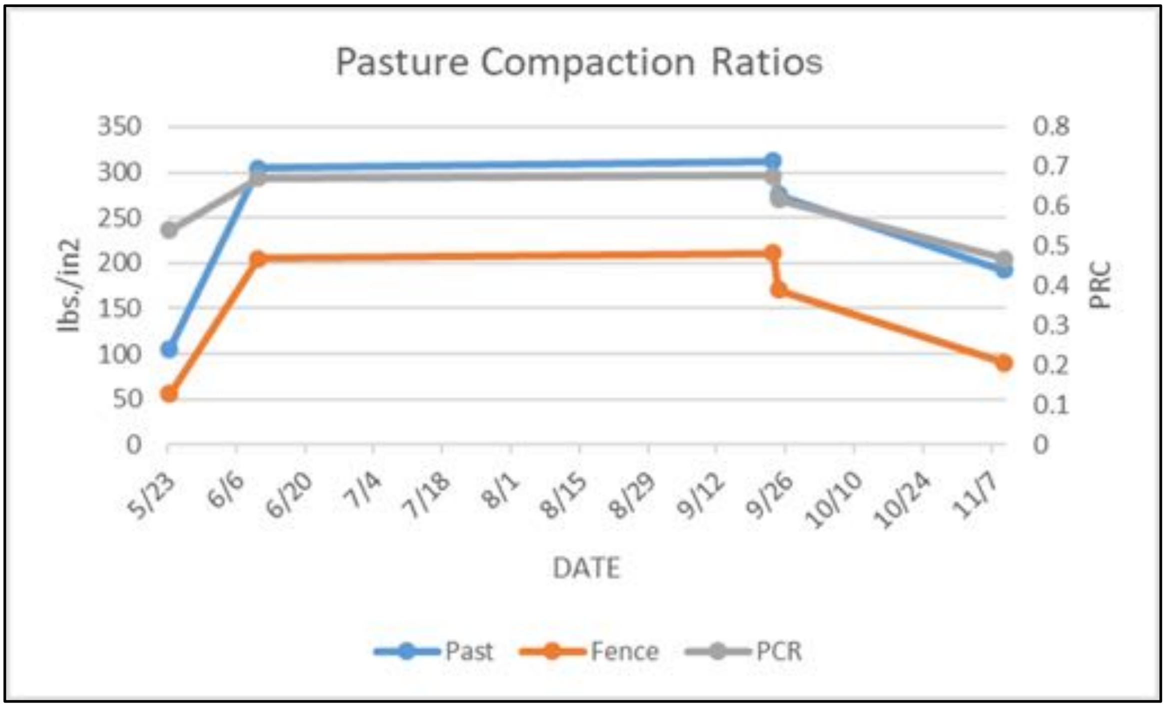
The reason for discussing soil carbon is in overgrazing or haying pastures there are effects below ground as well as the obvious stresses on forages. Negative changes in soil particle aggregation, bulk density, and soil carbon occur. As soil carbon and water stable aggregates decrease and bulk density increases, pasture soils are more prone to compaction. It worsens with more livestock traffic and allowing them access to pastures with soils wet enough to be easily squished.

A Northeast SARE grant project "Identification and Remediation of Compaction on Northeast Pasture Soils" is headed up by Fay. It seeks to accomplish these tasks:

- Convene educators from the Northeast for a Train the Trainers on soil compaction
- Provide educators with funds and equipment (Soil Health Trailer) for on farm education on soil compaction, and
- Enlist farmers and educators to collect data for Pasture Compaction Ratio (PCR).

*New York Soil Health Trailer*

Pasture compaction ratio to determine the difference in soil compaction between under-the-fence and in the pasture is being stressed as part of the train the trainers on soil compaction after they are made aware of the problem and its causes. The ratio between fence line and pasture is a definitive indicator that livestock traffic in the pasture is compressing the soils there even when invisible. The trainers are taught to retest as soil conditions change going from dry to wet and back to dry depending on the season and rainfall.

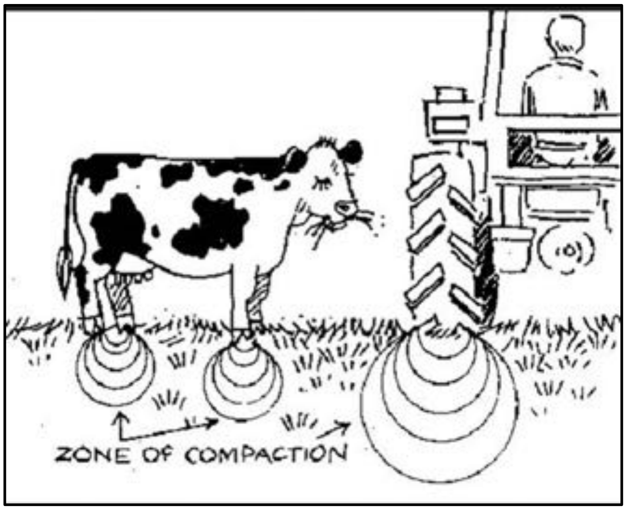



Here is an example of grazing season-long pasture compaction samples taken every two weeks. The pasture compaction ratio (PCR) shown as the gray line on the above graph is remarkably consistent even though the soil strength changes with time as soils become drier and then once summer is over and fall rains and cooler temperatures begin the soil strength decreases. For this pasture, the fenceline soil is always easier to penetrate with a soil penetrometer than the soil in the pasture. The PCR runs between 0.5 (half) to 0.7. This indicates soil compaction is occurring from hoof traffic. This may disappear overwinter with frost action if the pasture is not occupied during the winter months. The more sample times, the more precision there is in getting a true picture of how the PCR changes with time. Less frequent samplings will not give the amount of detail there is in the above graph.

What is the "Correct" Amount of Compaction? Silty and clayey soils are going to compress some if at all wet enough to be molded. When hoof prints become noticeable, serious compaction is beginning to take place. If hoof prints (pugs) hold water for more than a few hours, the soil at the bottom has sealed shut (no pore spaces) due to compression of the soil. This is serious compaction not readily solved and usually worsens. Prevention is a better solution. Soil drainage might be in order if it is a chronic problem and the field cannot be left ungrazed (deferred) due to the lack of drier pastures elsewhere to graze while the wet one dries out or forage quality at that pasture suffers too much in the meantime.

For the new year, Fay (afb3@cornell.edu) plans to engage more educators for on-farm presentations, collect more data points for PCR, and determine the repeatability of the PCR, and measure soil strength on an enclosed area to determine how time changes soil compaction.

**Lawrence D. Hepner Jr.**, Consulting Agronomist & Soil Scientist, Emeritus Professor of Agronomy & Environmental Science, Delaware Valley University, South Kortright, NY followed Fay. His presentation was on "Soil Structure Changes Resulting From Compaction and The Impact On Soil Health".




Larry covered three topics:

- What Is Soil Structure?
- How Do We Describe It?
- Impact Of Compaction.

Soil Structure is the aggregation of sand, silt, and clay particles and the fracturing of the soil along natural lines of weakness. Structure is a dynamic soil property having two kinds: Inherent properties that change little or not at all with management. They are texture, type of clay, depth to bedrock, and drainage class. And, dynamic properties that are affected by human management over the human time scale. They include organic carbon, structure, biological activity, and chemical activity. The terminology that we use to describe soil structure are type, grade, and size. One type of structure is granular. It is spheroidal in shape. Typically, it is found in the plow layer (Ap horizon) in pastures or cropland. In wooded sites, it is typically found in the surface A horizon.  See picture below showing granular soil structure in the palm of a hand.

The next soil structure type identified was blocky. Block-like in shape and denser, this type has two forms: Angular blocky found in higher clay soils has sharp edges and sub-angular blocky found in soils with less clay has rounded edges. Blocky is usually found in the subsoil (B horizons) that is directly under the topsoil. Both forms of blocky structure shown side-by-side below.


Angular Blocky

Subangular Blocky

The next type of soil structure described was platy. It is like a bunch of plates stacked on top of each other. Plate-like in shape, its horizontal axis is longer than its vertical axis which can be quite thin depending on its location in the soil. Platy structure is usually found in subsurface soils that have been subject to leaching or at the surface when compacted by animals or machinery. The plates can be separated with a little effort by prying on the horizontal layers with a pen knife. Platy structure impedes the downward movement of water and plant roots through the soil.

*Platy soil structure, on the left platy structure in the topsoil and on the right platy structure in the C horizon*

The next soil structure type discussed was prismatic with the opposite orientation of platy. Its vertical axis is longer than its horizontal axis. In the prismatic structure, the individual units are bounded by flat to rounded vertical faces. Units are distinctly longer vertically, and the faces are typically casts or molds of adjoining units. Vertices (Vertices are the corner points.) are angular or subrounded; the tops of the prisms are somewhat indistinct and normally flat. Prismatic structures are characteristic of the B horizons or subsoils. The vertical cracks result from freezing and thawing and wetting and drying as well as the downward movement of water and roots.

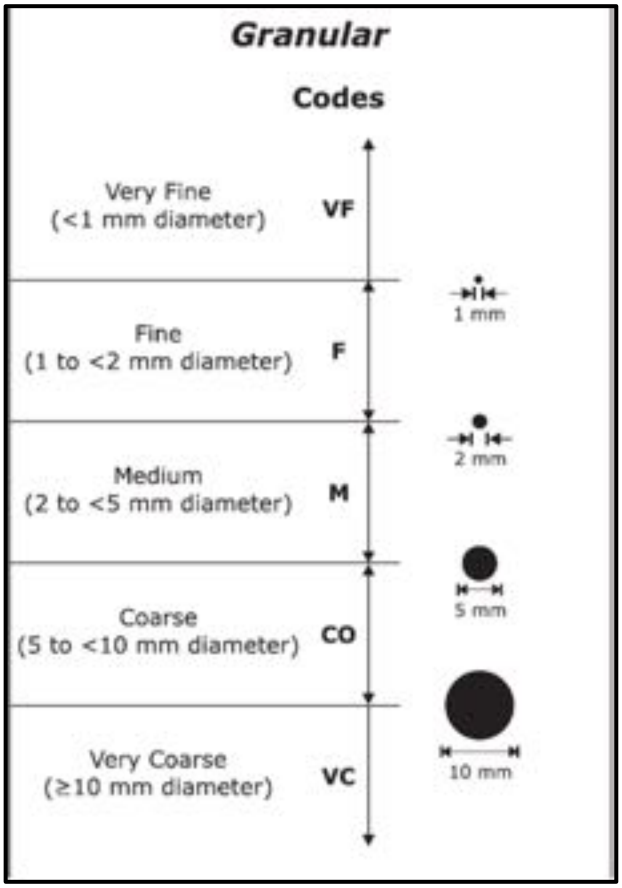
*Note 4 white vertical cracks of the prisms*

The term Grade was described next. There are 4 grades of how well the soil structure is formed. Strong structure is a sign of a healthy soil. As the grade number decreases, the soil is declining in health.

**(SOIL STRUCTURE) - GRADE—**

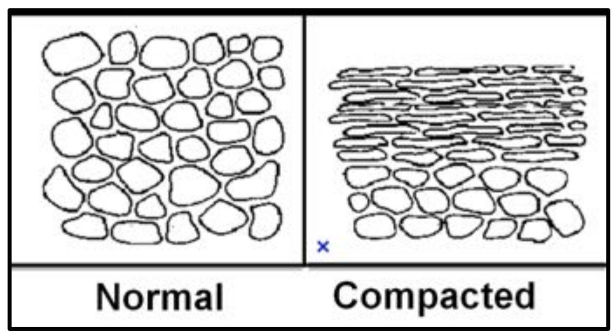
| Grade | Code | Criteria |
|---|---|---|
| Structureless | 0 | No discrete units observable in place or in hand sample. |
| Weak | 1 | Units are barely observable in place or in a hand sample. |
| Moderate | 2 | Units well formed and evident in place or in a hand sample. |
| Strong | 3 | Units are distinct in place (undisturbed soil) and separate cleanly when disturbed. |

The last terminology to describe soil structure is size. An example of size is illustrated in the figure below using granular type soil structure.




For the granular type of structure, the size ranges from very fine to very coarse as measured in millimeters. In a previous picture of a hand holding soil granules, they run in size from very fine to very coarse.

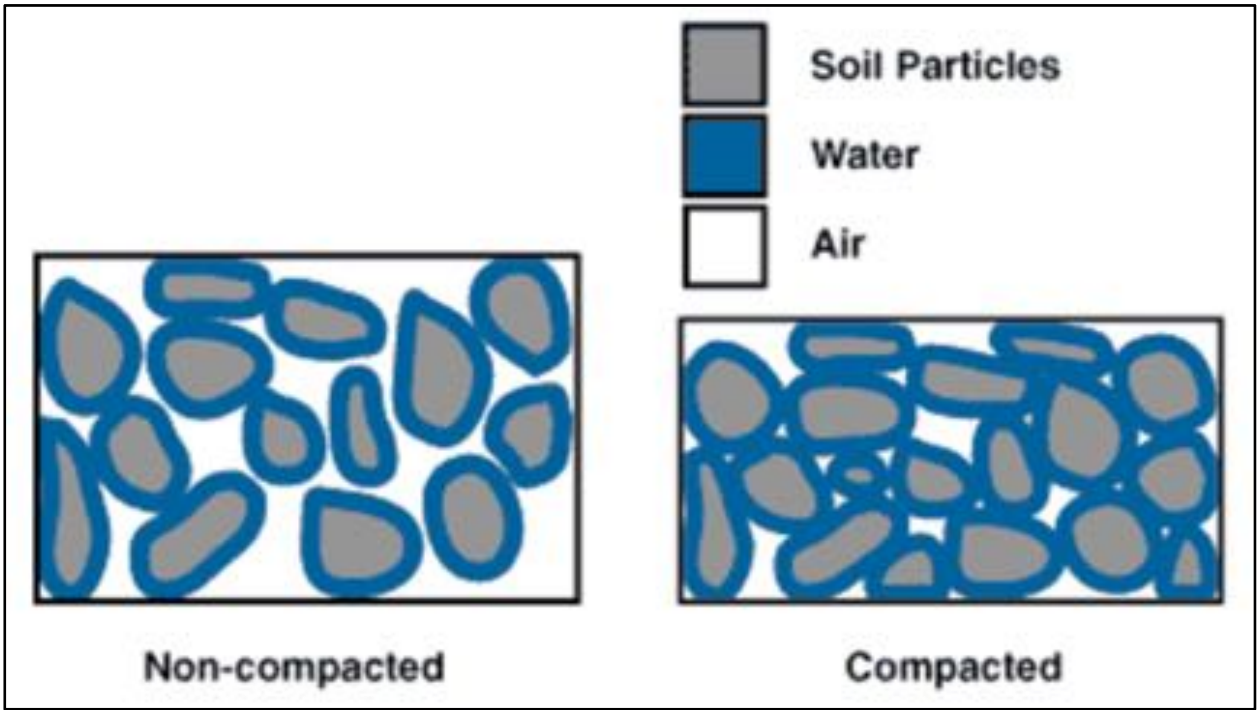
The impact of compaction on soil structure is shown in the schematic below. The compacted topsoil has a platy soil structure at its surface, as what was granular soil structure gets compressed into plates instead of being spheres like in the normal soil. There are also less air spaces between the soil aggregates.





Looking at two pasture soils, one normal and one compacted, note the normal soil has spherical granules of various sizes and is loose. The compacted soil has a platy structure and is dense.

When soil compaction occurs, soil macropores between soil aggregates are destroyed first, the normal granular structure of the topsoil is destroyed and becomes platy structurally, drainage and infiltration is slower, the soil becomes anaerobic, and it stays wet much longer.




*Compacted soil has much less macropores for air, wetter, and is becoming platy as soil particles are being pressed together.*

P. Tuohy *et al.*

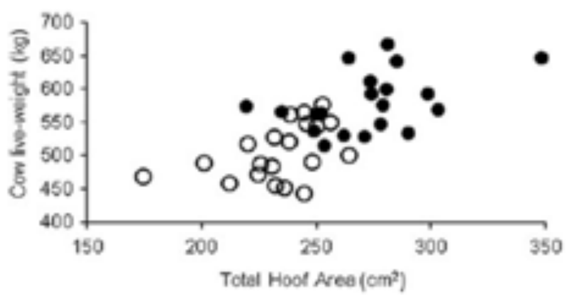



**Fig. 3.** Relationship between cow live weight and total hoof area for HF (•) and JX (○) cows. HF cows are heavier ($P < 0{\cdot}001$) and have larger hoofs ($P < 0{\cdot}001$) than their JX equivalents.

**Table 4.** *Mean weight, total hoof area and static pressure of subset of Holstein-Friesian and Jersey × Holstein-Friesian cows measured from the herd*

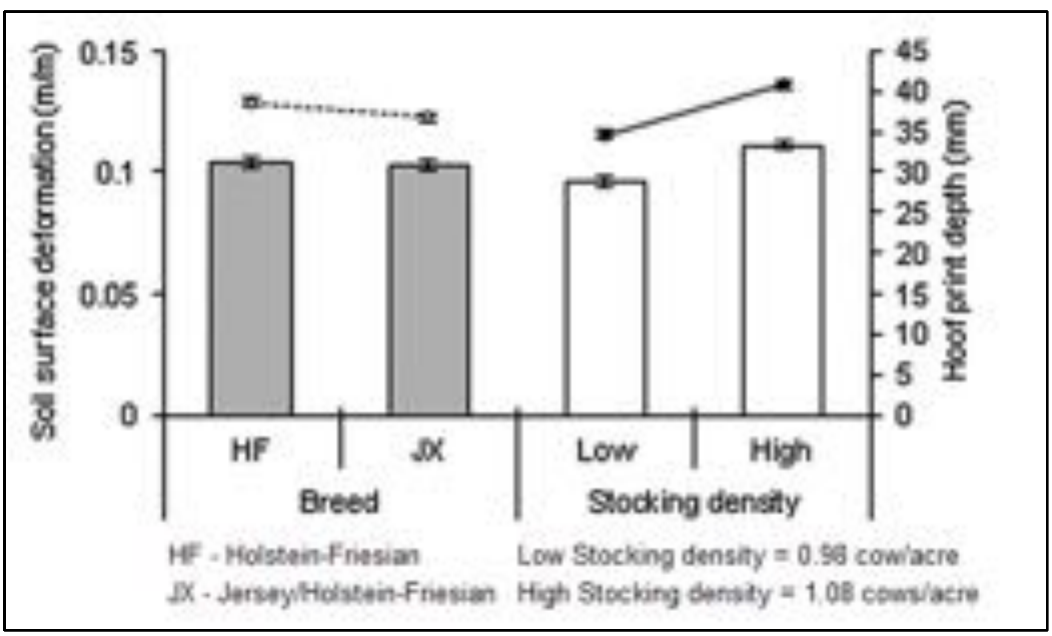
| Breed | Mass (kg) | Total hoof area ($m^2$) | Static pressure (kPa) |
|---|---|---|---|
| HF | 580 | 0·027 | 214 |
| JX | 506 | 0·023 | 218 |
| S.E. | 6·6 | 0·0005 | 4·2 |
| *P* | <0·001 | <0·001 | NS |

HF, Holstein-Friesian; JX, Jersey × Holstein-Friesian; NS, not significant

Larry presented some data from Irish dairy cow research on soil compaction that occurs on intensive rotational pastures that are wet (46% of Irish farmland is 'limited in agricultural use because of land wetness' [P. Tuohy et al., 2014]). They compared two dairy breeds, Holstein-Friesian and Jersey X Holstein-Friesian crossbreds, on their impact on soil properties when grazing pastures that are slow to dry in a climate that is cool and damp. In the second year of the study, they actually kept the cattle off the pastures when the pastures were deemed too wet to be grazed. The Holsteins have a bigger hoof than the Jerseys crosses. They were looking to see if grazing smaller cows on wet soils would cause less damage than larger cows. Although the Holsteins do leave bigger hoof prints in the soil surface and thereby leave more hoof area behind in the pastures (graph on left above), there is no significant difference in the static pressure created in the hoof print area of the soil (table on right above).

(Editor's notes: This piqued my curiosity. I used the citation information that Larry gave and did a search to get the whole research paper. I like Irish dairy cow pasture research as it fits very well with what our Northeast dairy graziers have to deal with, except our graziers are not as enamored with perennial ryegrass as they are (our winters are too cold and summers too dry/hot). Ireland has mild winters and rather cool summers. So, here is the rest of the story.

Although soil compaction was not affected much, poaching (pugging) of pastures was significant as seen in the figure below. What was interesting about this figure is the impact stocking density has on hoof print depth (HPD), hoof prints are deeper in paddocks stocked at a higher density. However, the annual stocking density is not that much higher, 1.08 cows per acre versus 0.98 cow/acre. HPD is quite different even though the stocking density is not. It actually is misleading to say low and high stock density based on the annual stock density. They also determined stock density based on the number of cows per hectare at 4 different times during the grazing season. These stock density numbers are much higher (2-4 times higher) in the spring and mid-summer of 2011 and 2 times higher in the spring of 2012 (a very wet year that caused cows to be pulled-off the pasture altogether at times). 2011 was a truer picture of day-to-day stocking density when cows were not pulled-off due to soils being too wet. It better reflects the true stocking density that the occupied paddocks received at those times.




*Effect of breed, on SSD (grey columns, no significant difference) and HPD (dashed line, P < 0·01), and effect of stocking density on SSD (white columns, P < 0·001) and HPD (solid line, P < 0·001), error bars show the treatment S.E.M.*

Soil surface deformation (SSD) was not significantly different between breeds, but the slight difference in stocking density did significantly deform the soil more at the higher stocking rate than the "low" one. SSD coupled with compaction at depth results in increased soil resistance and reduced pore space, which affects both shoot and root growth. Plant growth may also be reduced by direct effects of poaching (pugging) including plant injury, fragmentation, and burial. The resistance of soil to deformation is dependent on soil moisture; however, intensively grazed grassland is often situated in regions with high rainfall. The extent of soil damage in poorly drained soils is dependent on factors that are fixed (soil type and climate) and non-fixed (animal live weight, stocking density and grazing duration). The non-fixed elements may be managed to overcome soil and pasture damage [Tuohy et al., 2014]. In this experiment, Tuohy et al. found SSD was greater at the higher stocking density (P < 0·001, 0·11 v. 0·10 m/m, S.E. 0·0020 m/m) and was affected (P < 0·05) by an interaction between year and stocking density: Stocking density affected SSD in both years, but more so in 2012 (Table 3). SSD was significantly correlated with HPD (y=2·46x+ 12·29, R2= 0·75, P < 0·001). Mean SSD was lower (P<0·001) in 2011 (mean± S.D.), (0·07 ± 0·042 m/m) compared with 2012 (0·14 ± 0·056 m/m). Mean HPD was lower (P < 0·001) in 2011 (28 ± 11·9 mm) than 2012 (48 ± 17·1 mm). Soil surface deformation was not affected by breed but was affected (P < 0·05) by the interaction between year, breed, and stocking density.

Table3. The effect of dairy cow breed (Holstein-Friesian and Jersey × Holstein-Friesian), at two stocking densities (low; 2·42 cows/ha and high; 2·66cows/ha) and year on HPD (mm) and SSD (m/m)

| | Dairy cow breed | | | | Stocking density | | | | s.e.m. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 | | 2012 | | 2011 | | 2012 | | | | | | | | |
| | HF | JX | HF | JX | L | H | L | H | Year | Breed | Stocking density | Year×breed | Year×stocking density | Breed×stocking density | Year×breed×stockingdensity |
| Hoof-print Depth (mm) | 29 | 27 | 49 | 46 | 26 | 30 | 43 | 52 | 0·5 (P <0·001) | 0·5 (P <0·01) | 0·5 (P <0·001) | 0·7 NS | 0·7 (P <0·01) | 0·7 NS | 1·1 (P <0·001) |
| Soil surface deformation m/m | 0·07 | 0·07 | 0·14 | 0·14 | 0·06 | 0·07 | 0·13 | 0·15 | 0·002 (P <0·001) | 0·002 NS | 0·002 (P <0·001) | 0·003 NS | 0·003 (P <0·05) | 0·003 NS | 0·004 (P <0·01) |

HF, Holstein-Friesian; JX, Jersey×Holstein-Friesian; L, low stocking density; H, high stocking density; NS, not significant

Poaching damage in this experiment was described by Tuohy et al. as follows. "HPD as shown in the figure on the previous page was greater under the HF cows (P < 0·01, 39 v. 37 mm, S.E. 0·5 mm) and was affected significantly (P < 0·001) by the interaction between year, breed, and stocking density in table 3 above. HPD was deeper (P < 0·001) at the higher stocking density (41 v. 35 mm, S.E. 0·5 mm) and was affected (P < 0·01) by an interaction between year and stocking density. Stocking density had an effect on HPD in both years, but this was more pronounced in 2012." This is shown in table 3 above, difference in HPD values under stocking density by year.

Tuohy et al. described the effect of treading on poaching damage in this 2-year experiment. "While there was no effect of breed on SSD and only a slightly higher HPD imposed by HF cows, there was a clear difference in poaching damage between the stocking density treatments, particularly in 2012 when it was rainy. This difference is due to the effect repeated loading had on soil strength. A higher stocking density resulted in a greater frequency of hoof-soil interactions and a higher amount of surface damage, which was further made worse by the wet conditions.

The repeated treading of wet soil increases the depth to which the soil is weakened (Mullins & Fraser 1980). Thus, partly poached soil is more susceptible to subsequent poaching as it is softer and wetter (Gradwell 1968). This process may also account for some of the difference in HPD recorded between breeds during the experiment. Since an HF hoof is 1.17 times larger than a JX hoof, HF treaded on 0.17 more of the pasture area than JX at each grazing. While the loading pressure is the same (see table below), the intensity of loading is increased, in much the same way as the intensity of hoof-soil interactions is increased with higher stocking rate. The higher poaching damage in 2012 was due to the soil being above its plastic limit throughout the grazing season. The plastic limit of a soil is the gravimetric water content (GWC) at which a soil changes from being friable to being plastic, and represents the lowest water content at which pugging and poaching may occur (Drewry et al. 2008). Analysis of the soil at 0·00–0·10 m. depth, found the plastic limit was 0·43 g/g GWC. In 2011 this threshold was not breached until November when mean GWC was 0·51 g/g. Soil samples taken in 2012 show soil GWC was continually well above the plastic limit, ranging from 0·56 (August) to 0·68 (November) g/g. In this scenario, soil deformation was the dominant effect of treading during grazing."

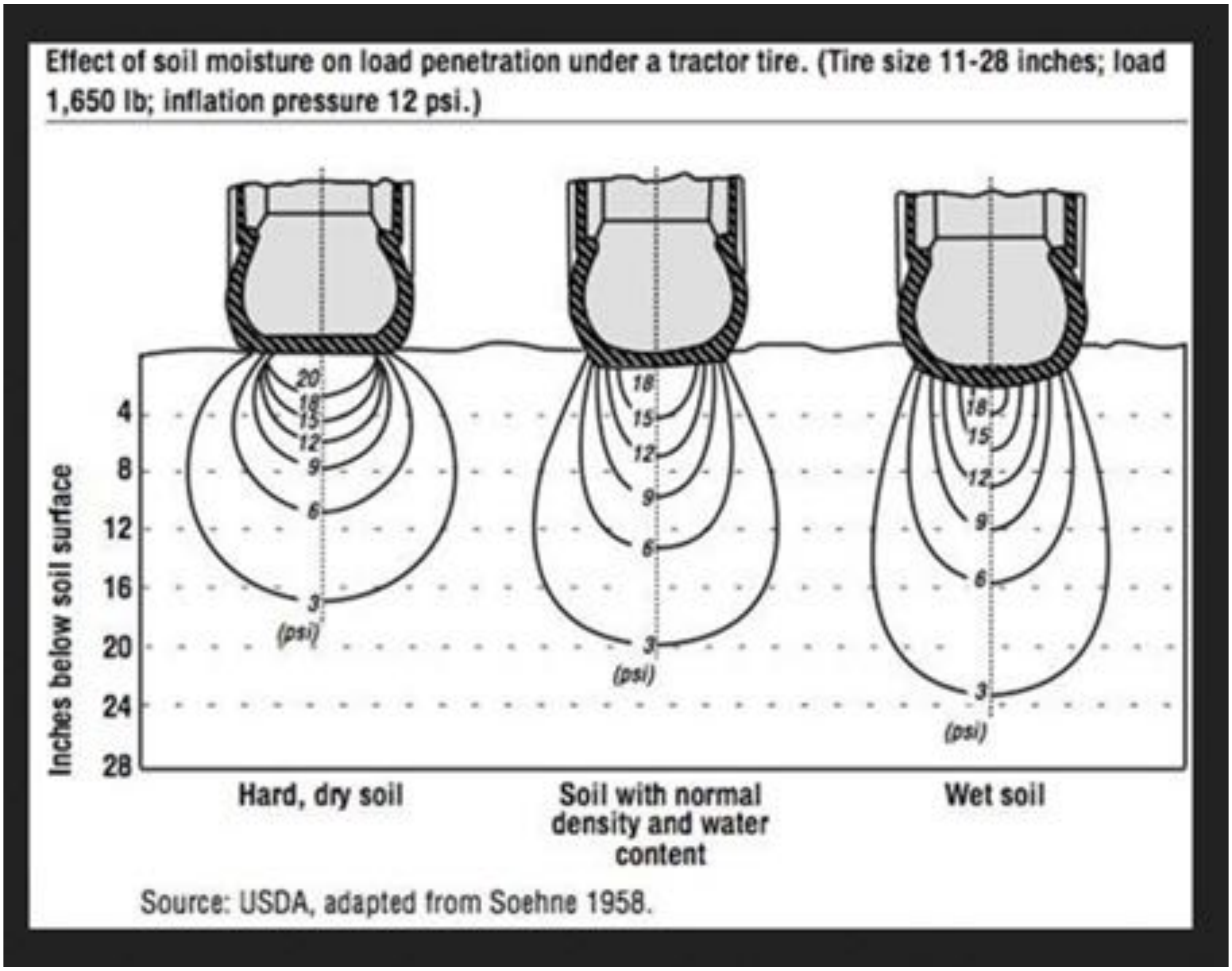
Cow weight 1,115 to 1,278 pounds

| Total (kPa) | Total psi | psi per hoof Standing | psi per hoof Walking |
|---|---|---|---|
| 214 | 31.0 | 7.75 | 15.5 |
| 218 | 31.6 | 7.9 | 15.8 |

From Tuohy et al., 2014

Note in the table above that an increase in cow weight of 163 pounds does not give the same commensurate increase in soil loading. However, there is a doubling of the pounds per square inch (PSI) exerted by a cow when walking instead of standing still. The more the cows have to walk around in search of forage to eat, the more pugging of the pasture soil surface. In larger pastures, this pugging can become more concentrated as a cattle trail when going back and forth to shade, water, feed bunk, or gate opening. The cattle trail becomes a smoother surface to walk on as it gets established and is then preferred over a tussocky pasture produced by pugging.)

The figure below shows three different load penetrations of a tractor tire as the soil moisture goes from dry to wet. The temptation is to harvest dry hay or haylage off pastures that are past their prime for grazing. This often happens after wet weather has stopped or slowed down cycling livestock through every paddock, especially during the spring flush of forage growth. Due to the time of year when there usually is excess pasture forage in relation to livestock demand, the better-laying pastures many be set-aside for mechanical harvest. They could very well be the ones that are the wettest. It is bad enough to have to harvest stored forage at that time with the risk of putting up poor quality forage, but deep soil compaction and rutting can occur as well when driving harvest machinery across the field if the soil is wet enough to be compressible.




*Note that as going left to right in the figure, tire sinks deeper into the soil and soil compaction extends deeper into the soil.*

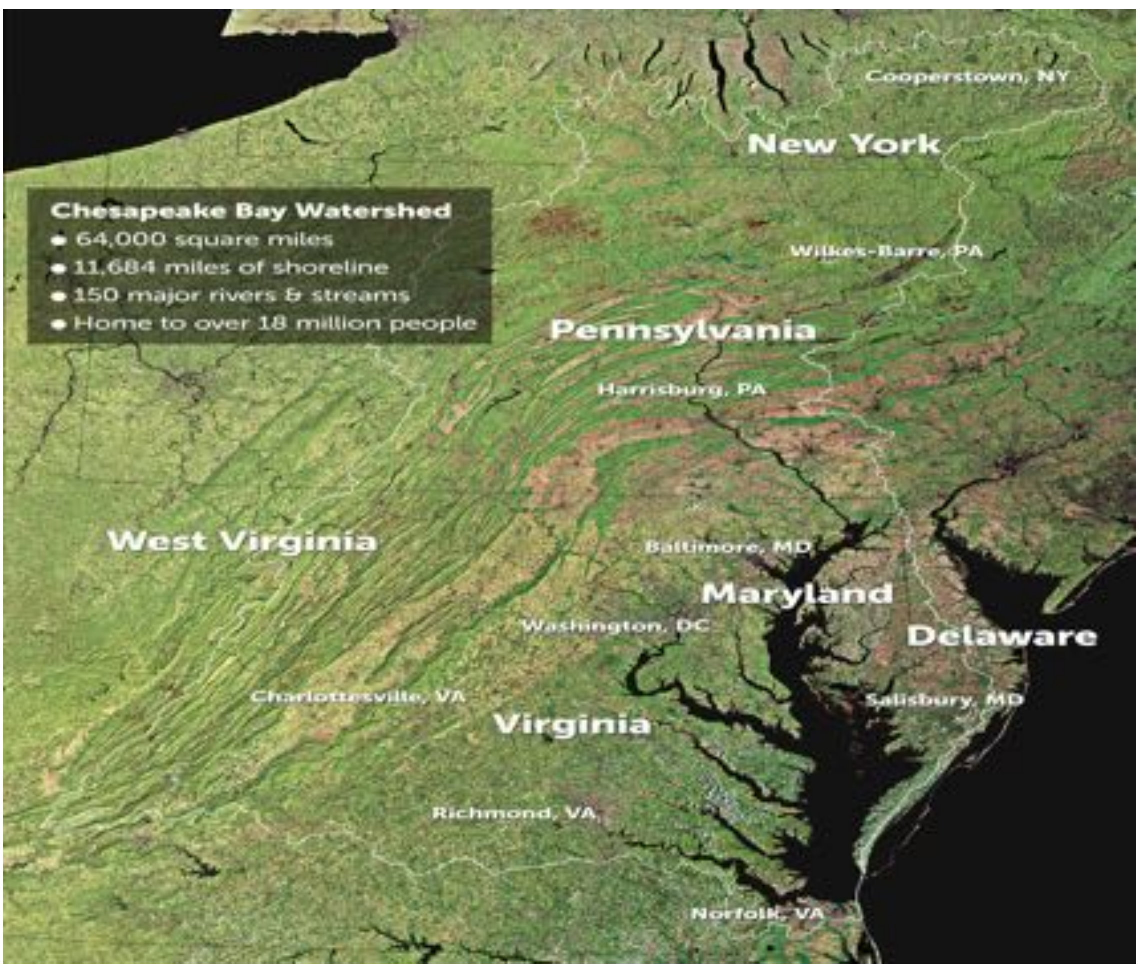
Larry, in closing, summarized the impact of soil compaction on soil Health:

- Converts granular structure to platy structure in the topsoil,
- Loss of pore space – Macro pores destroyed first,
- Water infiltration reduced,
- Water movement through the soil profile reduced by deep compaction,
- Soil oxygen content is reduced,
- Soil microorganism activity is reduced,
- Carbon dioxide ($CO_2$) content rises,
- Gas exchange rate with atmosphere reduced, and
- Soil remains anaerobic much longer.

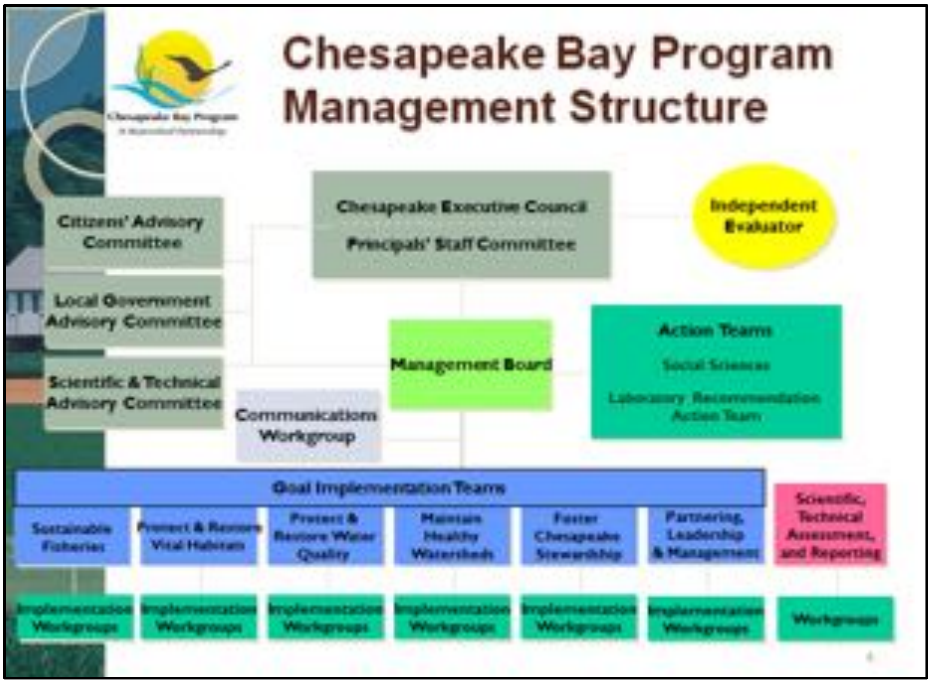
## Session 6 – Pasture Management Practices for Achieving the Chesapeake Bay Watershed's TMDL Goals

**Mark Dubin**, Chesapeake Bay Program Senior Agricultural Advisor, University of Maryland Extension, Department of Environmental Science & Technology at Annapolis, MD requested to have the opportunity to bring the Northeast Pasture Consortium up-to-date on the Chesapeake Bay Program use of pasture management practices to meet the 2025 total maximum daily load allowed of nitrogen (N), phosphorus (P), and sediment entering Bay streams and waters. We made time for him in the Conference program. James Cropper, Executive Director, has been a member of the Agricultural Work Group since 2009 and also was a member of the Nutrient Management subcommittee of that group. He provided them guidance on N, P, and soil loss from pastures for version 6.0 of the Chesapeake Bay Watershed computer model.

Mark started his presentation by giving some facts about the Chesapeake Bay Watershed and how the Chesapeake Bay Program is structured managerial.




*Chesapeake Bay Watershed is large. The Susquehanna River is a major tributary entering the Bay from the north. It begins in the southern tier of counties in NY. The Potomac River is the main western tributary with headwaters in WV. The James River is the major southern tributary that runs through VA. Bay Watershed boundary is marked by a white line, somewhat indistinct at times.*





*The Northeast Pasture Consortium is represented in the Agricultural Work Group that is under the Goal Implementation Team, Protect & Restore Water Quality*

The Agriculture Workgroup (AgWG) is tasked with:

- Agricultural forum for federal, state, and local agencies, conservation districts, universities, agri-business, and the corporate sector,
- Recommend prioritization of federal and state technical and financial resources on specific practices,
- Technical leadership to support the development and implementation of agricultural elements of the Chesapeake Bay TMDL, and
- Identify, define, quantify, and incorporate agricultural conservation practices into the Chesapeake Bay Program modeling tools.

Phase 3 Watershed Implementation Plans (WIPs) for TMDL Goals by 2025 is a work in progress. The Chesapeake Bay Watershed N gap has been reduced from 6.8 million pounds to 1.8 million pounds. However, it is unlikely the TMDL Targets will be greatly exceeded by a jurisdiction or major tributary by 2025. The P gap has also been reduced but is projected to still exceed the TMDL Targets by 2025. Some states' progress on N TMDL's is very good. Virginia's plan exceeds (goes beyond) their N target by 6.2 million pounds, Maryland by 1.8 million pounds, West Virginia by 0.73 million pounds, and the District of Columbia by 0.12 million pounds.

With that overview, Mark then went into agriculture and pasture management goals by state beginning with Delaware. The rate of N load reduction called for in DE's WIP is 5 times greater than the reduction rate since the TMDL, which averaged 66,000 pounds/year. Since the TMDL, 97% of DE's N load reduction came from agriculture. DE's plan calls for 5 times the level of effort from agriculture than what has been achieved by this sector since the TMDL and 17 times what has been achieved by agriculture over the long term (1985-2018), for N. The rate of P load reduction called for in DE's WIP is 2.4 times greater than the reduction rate since the TMDL, which averaged 2,300 pounds/year. Since the TMDL, 74% of DE's P load reduction came from agriculture and 26% from forests, wetlands, and stream restoration. DE's plan calls for twice the level of effort from agriculture than what has been achieved by this sector since the TMDL, for P.

Delaware's pasture management practice implementation goals are:

- ❖ Pasture Alternative Watering
  - 2018 Progress – 600 Acres (A)
  - Implementation – 12.2 %
  - 2025 Goals – 1,400 A
  - Implementation – 35.2 %
- ❖ Prescribed Grazing
  - 2018 Progress – 100 A
  - Implementation – 1.4 %
  - 2025 Goals – 100 A
  - Implementation – 3.4 %
- ❖ Horse Pasture Management
  - 2018 Progress – 0 A
  - Implementation – 0.0 %
  - 2025 Goals – 0 A
  - Implementation – 0.0 %
- ❖ Fenced Forest Stream Buffers
  - 2018 Progress – 0 A
  - Implementation – 0.0 %
  - 2025 Goals –0 A
  - Implementation – 0.0 %

- Fenced Grass Stream Buffers
  - 2018 Progress – 20 A
  - Implementation – 0.4 %
  - 2025 Goals – 30 A
  - Implementation – 0.7 %
- Pasture Management Composite
  - 2018 Progress – 700 A
  - Implementation – 13.6 %
  - 2025 Goals – 1,600 A
  - Implementation – 35.6 %

In Maryland, the rate of N load reduction called for in its WIP is 2.2 times greater than about twice the reduction rate since the TMDL, which averaged 530,000 pounds/year. Since the TMDL, 84% of MD's N load reduction came from wastewater and 16% from agriculture. MD's WIP calls for 42% of the reduction to come from wastewater and 52% from agriculture. The plan calls for 6 times the level of effort from agriculture than what has been achieved by this sector since the TMDL. The rate of P load reduction called for in MD's WIP is about the same as the reduction rate since the TMDL, which averaged 49,000 pounds/year. Since the TMDL, 70% of MD's P load reduction came from wastewater and 17% from agriculture. MD's WIP calls for 23% of the reduction to come from wastewater and 40% from agriculture, with the remainder from forests, wetlands, and stream restoration. The plan calls for 3 times the level of effort from agriculture than what has been achieved by this sector since the TMDL.

Maryland's pasture management practice implementation goals are:

- Pasture Alternative Watering
  - 2018 Progress – 35,500 A
  - Implementation – 23.3 %
  - 2025 Goals – 12,700 A
  - Implementation – 10.0 %
- Prescribed Grazing
  - 2018 Progress – 9,800 A
  - Implementation – 6.4 %
  - 2025 Goals – 19,500 A
  - Implementation – 15.3 %
- Horse Pasture Management
  - 2018 Progress – 1,600 A
  - Implementation – 1.0 %
  - 2025 Goals – 2,700 A
  - Implementation – 2.2 %
- Fenced Forest Stream Buffers
  - 2018 Progress – 200 A
  - Implementation – 0.1 %
  - 2025 Goals – 700 A
  - Implementation – 0.6 %
- Fenced Grass Stream Buffers
  - 2018 Progress – 1,200 A
  - Implementation – 0.8 %
  - 2025 Goals – 1,200 A
  - Implementation – 0.9 %
- Pasture Management Composite
  - 2018 Progress – 48,200 A
  - Implementation – 31.5 %
  - 2025 Goals – 36,800 A
  - Implementation – 29.6 %

In New York, the rate of N load reduction called for in its WIP is 10 times greater than the reduction rate since the TMDL, which averaged 26,000 pounds/year. Since the TMDL, 99% of NY's N load reduction came from agriculture. NY's WIP calls for 28% of the reduction to come from agriculture, 34% from developed and 28% from wastewater. The rate of P load reduction called for in NY's WIP is about the same as the reduction rate since the TMDL, which averaged 12,000 pounds/year. Since the TMDL, 65% of NY's P load reduction came from wastewater and 19% from agriculture. NY's WIP calls for 35% of the reduction to come from wastewater, 30% from developed and 20% from forests, wetlands, and stream restoration. The plan calls for 69 times the level of effort from the developed sector than what has been achieved by this sector since the TMDL.

New York's pasture management practice implementation goals are:

- Pasture Alternative Watering
  - 2018 Progress – 0 A
  - Implementation – 0 %
  - 2025 Goals – 0 A
  - Implementation – 0 %
- Prescribed Grazing
  - 2018 Progress – 31,800 A
  - Implementation – 17.8 %
  - 2025 Goals – 46,900 A
  - Implementation – 39.8 %
- Horse Pasture Management
  - 2018 Progress – 500 A
  - Implementation – 0.3 %
  - 2025 Goals – 750 A
  - Implementation – 0.6 %
- Fenced Forest Stream Buffers
  - 2018 Progress – 1,700 A
  - Implementation – 1.0 %
  - 2025 Goals – 3,500 A
  - Implementation – 2.9 %
- Fenced Grass Stream Buffers
  - 2018 Progress – 900 A
  - Implementation – 0.5 %
  - 2025 Goals – 1,800 A
  - Implementation – 1.5%
- Pasture Management Composite
  - 2018 Progress – 34,900 A
  - Implementation – 19.4 %
  - 2025 Goals – 53,000 A
  - Implementation - 43.5 %

In Pennsylvania, The rate of N load reduction called for in PA's WIP is 6 times greater than the reduction rate since the TMDL, which averaged 590,000 pounds/year. Since the TMDL, 90% of PA's N load reduction came from wastewater and 7% from agriculture. PA's WIP calls for 92% of the reduction to come from agriculture. The plan calls for 67 times the level of effort from agriculture than what has been achieved by this sector since the TMDL, for N. The rate of P load reduction called for in PA's WIP is twice the reduction rate since the TMDL, which averaged 69,000 pounds per year. Since the TMDL, 63% of PA's P load reduction came from wastewater and 24% from agriculture. PA's WIP calls for 72% of the reduction to come from agriculture. The plan calls for 6 times the level of effort from agriculture than what has been achieved by this sector since the TMDL, for P.

Pennsylvania's pasture management practice implementation goals are:

Pasture Alternative Watering

2018 Progress – 53,00 A
Implementation – 12.2 %

2025 Goals – 100,000 A
Implementation – 29.2 %

Prescribed Grazing

2018 Progress – 30,500 A
Implementation – 7.0 %

2025 Goals – 168,500 A
Implementation – 29.3 %

Horse Pasture Management

2018 Progress – 0 A
Implementation – 0.0 %

2025 Goals – 0 A
Implementation – 0.0 %

Fenced Forest Stream Buffers

2018 Progress – 7 A
Implementation – 0.0 %

2025 Goals – 21,000 A
Implementation – 5.6 %

Fenced Grass Stream Buffers

2018 Progress – 400 A
Implementation – 0.1 %

2025 Goals – 10,000 A
Implementation – 2.7 %

Pasture Management Composite

2018 Progress – 84,000 A
Implementation – 19.4 %

2025 Goals – 299,500 A
Implementation – 80.4 %

In Virginia, The rate of N load reduction called for in VA's WIP is about the same as the reduction rate since the TMDL, which averaged 1,100,000 pounds/year. Since the TMDL, 92% of VA's N load reduction came from wastewater and 6% from agriculture. VA's WIP calls for 76% from agriculture and 13% from developed. The plan calls for 14 times the level of effort from agriculture than what has been achieved by this sector since the TMDL. The rate of P load reduction called for in VA's WIP is 1.4 times greater than the reduction rate since the TMDL, which averaged 93,000 pounds/year. Since the TMDL, 85% of VA's P load reduction came from waste-water and 8% from agriculture. VA's WIP calls for 56% of the reduction to come from agriculture, 16% from developed and 24% from forests, wetlands, and stream restoration. The plan calls for 9 times the level of effort from agriculture than what has been achieved by this sector since the TMDL.

Virginia's pasture management practice implementation goals are:

- Pasture Alternative Watering
  - 2018 Progress – 153,700 A
  - Implementation – 15.9 %

  - 2025 Goals – 176,200 A
  - Implementation – 21.2 %
- Fenced Forest Stream Buffers
  - 2018 Progress – 0 A
  - Implementation – 0 %

  - 2025 Goals – 26,400 A
  - Implementation – 2.9 %

- Prescribed Grazing
  - 2018 Progress – 209,200 A
  - Implementation – 21.7 %

  - 2025 Goals – 347,400 A
  - Implementation - 41.8 %

- Horse Pasture Management
  - 2018 Progress – 60 A
  - Implementation – 0 %

  - 2025 Goals – 19,900 A
  - Implementation – 2.1 %

- Fenced Grass Stream Buffers
  - 2018 Progress – 9,500 A
  - Implementation – 1.0 %

  - 2025 Goals – 45,800 A
  - Implementation –5.0 %

- Pasture Management Composite
  - 2018 Progress – 372,500 A
  - Implementation – 38.4 %

  - 2025 Goals – 615,600 A
  - Implementation – 66.7 %

In West Virginia, the rate of N load reduction called for in WV's WIP is 9/10 (slightly less than) the reduction rate since the TMDL, which averaged 38,000 pounds/year. WV's planned N goal remains under the state's 2025 target as it is currently. Since the TMDL, 48% of WV's N load reduction came from wastewater and 42% from agriculture. WV's WIP calls for 90% of the reduction to come from agriculture and 9% from developed. The plan calls for 3 times the level of effort from agriculture than what has been achieved by this sector since the TMDL. The rate of P load reduction called for in WV's WIP is 1/3 the reduction rate since the TMDL, which averaged 21,600 pounds/year. WV's planned P goal remains under the state's 2025 target as it is currently. Since the TMDL, 70% of WV's Phosphorus load reduction came from wastewater and 10% from agriculture. WV's WIP calls for 58% of the reduction to come from agriculture, 14% from developed and the remainder from forests, wetlands, and stream restoration. The plan calls for twice the level of effort from agriculture than what has been achieved by this sector since the TMDL.

West Virginia's pasture management practice implementation goals are:

- Pasture Alternative Watering
  - 2018 Progress – 19,600 A
  - Implementation – 8.9 %

  - 2025 Goals – 25,600 A
  - Implementation – 12.2 %

- Prescribed Grazing
  - 2018 Progress – 27,800 A
  - Implementation – 12.6 %

  - 2025 Goals – 65,900 A
  - Implementation – 12.3 %

- Horse Pasture Management
  - 2018 Progress – 0 A
  - Implementation – 0.0 %

  - 2025 Goals – 5 A
  - Implementation – 0.0 %

- Fenced Forest Stream Buffers
  - 2018 Progress – 3,400 A
  - Implementation – 1.5 %

  - 2025 Goals – 5,700 A
  - Implementation – 2.7 %

- Fenced Grass Stream Buffers
  - 2018 Progress – 70 A
  - Implementation – 0.0 %

  - 2025 Goals – 50 A
  - Implementation – 0.0 %
- Pasture Management Composite
  - 2018 Progress – 50,900 A
  - Implementation – 23.1 %

  - 2025 Goals – 87,400 A
  - Implementation - 45.8 %

This is an ambitious plan set forth by these states in an effort to clean up the Bay. A review of the 5 practices listed is needed for readers to understand why these were chosen. Alternative watering facilities are needed where the sole source of water for pastured livestock currently comes from live streams, unprotected springs, and still bodies of water, such as ponds. Ideally, these water facilities should be more than one in number in large pastures whether they are rotationally grazed by moving livestock around them in paddocks or undivided into paddocks. Prescribed grazing is the USDA-NRCS conservation practice standard name for adaptive grazing management which varies significantly around the Nation. In the Bay Watershed, this is essentially short duration stocking (grazing) with the use of small areas of pasture called paddocks that provide enough available forage for the livestock to meet their daily demand of dry matter based on the amount of time that they are on the paddock. They are then moved to a similarly sized paddock of fresh grass while the paddock they left is allowed to regrow ungrazed for several days until it is tall/mature enough to be grazed again. There are other rotational schemes that would meet the standard that could be employed in the Watershed, hence the newer term, adaptative grazing. This is particularly true, if a farmer chose to graze riparian areas rather than fencing them off from grazing entirely as two of the other practices require. These areas might be deferred from grazing seasonally or not grazed as frequently as other paddocks that are situated away from water. This allows streambanks to heal since occupancy by livestock would be measured in days of less than a week total per year. It would help keep the stream area in herbaceous vegetation rather than reverting to brushy or tree species eventually. These could interfere with flood flows on larger streams and eventually shade pasture beyond the exclusion fence making it attractive for livestock to seek shade and lounge for hours there creating a nutrient hotspot near the "protected" waterbody. Fenced Grass Stream Buffers and Fenced Forest Stream Buffers are livestock exclusion practices to keep livestock off streambanks and entering streams to drink or cross them wherever the livestock want. Forested buffers generally are planted with nursery trees to get quick establishment. Grassed buffers, if not actively kept free of invading native brush and trees, will revert to a forested buffer within ten years. Shading of pastureland near the exclusion fence will be an issue with either practice sooner or later depending on stream orientation and where the pasture is in relation to it. North-south stream with trees will produce shade in the morning on the west side and shade on the east side in late afternoon. East-west stream will vary with the seasons, but is capable of casting tree shadows on either side, just not as far in and not much (tree branch overhang beyond the fence) at all on the south side in late fall through late winter. Horse pasture management is a low acreage practice, but needed where horse numbers are higher than the "pasture" acreage and forage production allow. This can lead to nutrient and soil loss to surface waters. Pasture management composite equals the 5 aforementioned practices acreage extent. The composite gives an idea of the overall progress being made.

Mark said at the end of his presentation that the Maryland Governor has just directed the State Attorney General to sue Pennsylvania and the U.S. Environmental Protection Agency in an effort to protect Chesapeake Bay restoration efforts. The Governor has repeatedly called upon up-stream states, including Pennsylvania, to step up and take responsibility for sediment and debris that pours into the Chesapeake Bay by way of the Susquehanna River. The Susquehanna River supplies 50% of the fresh water entering the Bay.

**Public and Private Sectors Research, Education, and Technical Assistance Priorities Deliberation Breakout sessions and Report**

The breakout sessions were shortened to a half hour so that the Conference could hear the two reports, private and public, before lunch on revisions and additions to the priorities for research, education, and technical assistance going forward. A slow moving snowstorm was entering the western part of the Northeast Region; therefore, the Conference needed to end by midafternoon so those not staying overnight could get home safely. The body of stakeholders, private and public, continues to foster future work in quantifying economics for ecosystem services, soil health, climate resiliency of pastures, and the viability of grazing enterprises. Here are the 2020 research, education, and technical assistance priorities:

1. Explore new methods to transfer knowledge and information to increase adoption of research findings within the agriculture community; incorporate social science research into increased adoption and technology transfer:
    - Including farm organizations and advocacy groups to additionally influence regulations and legislations.
    - USDA-ARS—keep working with and building partnerships and communicate with ARS headquarters about upcoming events.
    - Seek new contact with USDA-NRCS Chief, seek a commitment to encourage reps from every state (electronic options for joining?) and invite NRCS Chief to the 2021 NEPC Conference.
    - Strengthen Extension and university research connections, work listservs and across communication methods; —use Organic Research & Education Initiative (OREI) funding opportunity.
        1) Utilizing connections within Pasture Consortium; grazingguide.net
        2) Expand distribution list to a set list within each state for advertising date of upcoming NEPC (even if it is only a Save the Date w/o a set agenda)
        3) Advertise NEPC on already-existing websites and social media accounts owned by Consortium members (ex: Facebook pages, Instagram, websites)
        4) Invite farmers from all NEPC states (Cedar Tree grant—NE states, could apply to USDA OTT, USDA-NIFA Scott Angle) by reaching out to existing grazing networks within each state to reengage farmer participation. (Cedar Tree Foundation and NE Grazing Network as source of funding??)

- More efficient outreach of objectives:
  1) Industry (ex: Organic Valley)
  2) Review newsletter distribution (one-click unsubscribe? Which email list to use? Sarah Goslee discussion; outreach to admin within universities and agencies)
  3) Educating new farmers; reaching the next generation.

2. Ecosystems Services and Disservices from Pasture Systems and Grazing Management:
   - Impacts to riparian areas,
   - Impacts to water quality and availability (citizen involvement),
   - Wildlife benefits to adaptive grazing management,
   - Impacts of permanent stream and streambank exclusion from livestock grazing riparian area pastures in the Northeast and economic impacts on producers,
   - Economic models for ecosystem service payments (measurement, payment, structure).
3. Silvopasture contributions to carbon sequestration; adaptive strategy in changing climate conditions.
4. Research adjustments in forage management needs in a changing climate:
   - Regional management approaches (understanding variability),
   - Species adaptation and evaluation (meadow fescue, use of annuals, increase in invasive plants),
   - Impacts of grazing on greenhouse gas emissions and environmental resiliency,
   - Management practices to reduce invasion of undesirable plant species due to increased precipitation and lack of water infiltration in pastures,
   - Research on nutritional value of weeds while considering their antiquality issues , and
   - Does climate change affect native/invasive species? Does it change pasture management? Change animal intake or increased lignification of plants?
5. Soil biology and management impacts on animal health and human health
   - Small ruminant parasite research at WVU, Rhode Island, and Cornell,
   - Red and white clover functions in animal and soil health, pollinators, forage and animal production,
   - Tanniferous forages to reduce worm load and increase bypass protein in animal diets,
   - and Grazing management as it affects soil health (e.g., compaction, worms).
6. Further research in meat and dairy products regarding human nutrition and health:
   - Fatty acid updates, value of side chains on long chain FAs (Jana Kraft), & short chain FAs,
   - Artificial gut for milk digestibility located at the Wyndmoor, PA ARS Laboratory,
   - Whole milk/fats; A2A2 milk – effects on human health and getting information out to a larger audience,
   - Milk probiotics/prebiotics identified and their function in human health discovered,
   - C3, C4 grasses, forbs, and effects on Omega-3 content in milk and meat,
   - Impacts of plant-based products marketed as “meats” and “milks” to farmers and environment,
   - Dairy cow plant fiber digestibility impact on milk quality, and
   - Continue to quantify research in nutrient-dense foods; how does cooking affect beef/food nutrition values?

7. Addressing the Heavy Use Area/Pasture interface (vegetation management)
    - Comparison of options (deep-bed packs, composted packs, wood chips) and economic impact on handling facilities, heavy use areas, and cost-effective options,
    - Biological composition of bedded packs and livestock health (mastitis—John Barlow & Deb Neher),
    - Bale grazing and in-field winter management/calving,
    - Species evaluation for vegetated heavy use areas,
    - Using summer annuals to restore winter sacrifice areas, and
    - Research fact sheet updates?
8. Farm profitability and upcoming cultural/societal changes
    - Compare different philosophies, results, benchmarks,
    - Development of artificial and plant-based "meat" and "milk" (and other animal products) and how they will that affect our work, stakeholders, audience, and research. Three papers of interest listed below:
        1) Paper in Global Change Biology, Proceedings for Natl Academy of Sciences "Soil carbon sequestration is an elusive climate mitigation tool." (2018 Nov 13; 115(46): 11652–11656),
        2) EAT-Lancet Commission Summary Report – "Our Food in the Anthropocene: Healthy Diets From Sustainable Food Systems", Jan 16, 2019, and
        3) American Farmland Trust - Testimony of Dr. Jennifer Moore–Kucera, Climate Initiative Director of American Farmland Trust, before the US House Select Committee on the Climate Crisis, October 30, 2019.
    - Ecological/carbon footprint of animal production compared to ecological footprints of alternative products,
    - Quality assurance program requirements; impacts on profitability
9. **New:** Research on planting mixes of 6-12 species together to see what mix works well and remains diverse under well-documented grazing conditions, which species complement one another, and the economics involved in trying to maintain a diverse, as-planted mixture (cost versus value-added with increased meat and milk production and food quality).

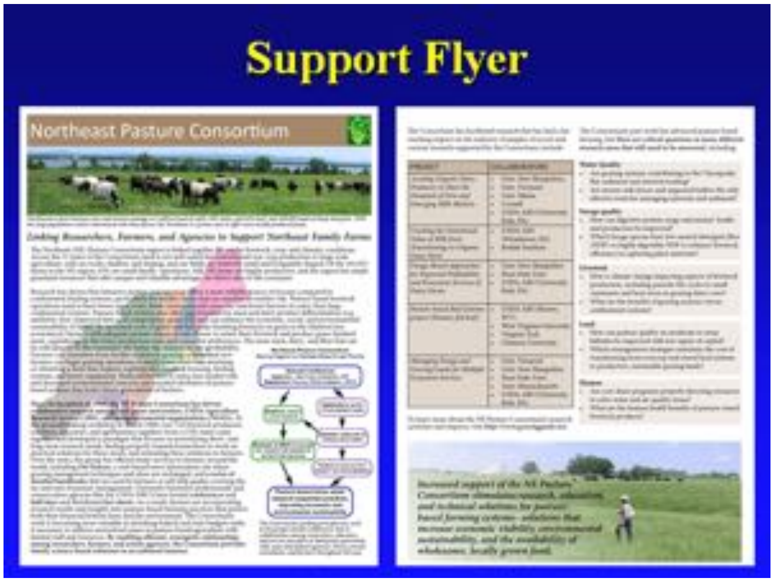
**Business Meeting**

After the public and private sector reports on revised and new research, education, and technical assistance priorities were presented and discussed, the business meeting followed. Fay Benson, Public Sector Co-Chair and Don Wild, Private Sector Co-Chair, presided. The first order of business was to nominate and elect a public sector member-at-large and a private sector member-at-large to the Executive Committee. Jim Cropper nominated Dr. Tom Griggs, West Virginia University forage agronomist, for the public sector member-at-large. Jessica Williamson nominated Dr. Ben Goff, West Virginia University Extension ANR Agent - Mason & Putnam Counties. Once she nominated Dr. Goff, Dr. Griggs withdrew his nomination citing that he will be retiring before the 4-year term was up most likely and moving to Vermont. Thereupon, Jim Cropper seconded Jessica motion to nominate Dr. Goff. Nominations were closed by those present at the meeting. Dr. Ben Goff was unanimously elected to the Executive Committee. Don Wild announced that the Private

Sector had several people interested in being a member-at-large, but when Aimee Braxmeier was proposed as a candidate, the other people rallied around her candidacy. Mrs. Lora Goss made a motion to nominate Ms. Braxmeier as the private sector member-at-large. Mr. Rob DeClue seconded the motion. Nominations were closed by those present at the meeting. Ms. Aimee Braxmeier was unanimously elected to the Executive Committee. Jim Cropper said he would send out their duties in a welcoming email along with background information about the Northeast Pasture Consortium since they were first year attendees.

**Margaret Smith**, NEPC Administrative Advisor, Cornell University Agricultural Experiment Station, Ithaca, NY presented a PowerPoint "NEPC is a Project of the Northeast Regional Association of Ag. Experiment Station Directors, NEERA 1603". She provided a brief history of the origin of the Northeast Pasture Consortium that began as a concept and was approved by the Northeast Ag. Experiment Station Directors in 1995. The first Multistate Project was established for the Consortium as NEERA1000 in 2001. It brought together a diverse, integrated group: University research and extension, USDA-ARS, NRCS, and farmers and industry.


Two impact statement leaflets were produced for the Northeast Pasture Consortium about the last two 5-year projects, with editorial support from the National Association of Ag. Experiment Station Directors. A support flyer was also produced to inform state and national agricultural agencies that the role of the Northeast Pasture Consortium is to bring this integrated group together to promote pasture-based livestock production and marketing. Already it is nearly time to submit a Project proposal - we need to re-new! The current 2016-2021 project is almost over. After a question and answer period, Margaret asked the membership if they thought it worthwhile to renew for another 5 years. There was a general consensus that the partnership of private and public sector people are advancing the research, education, and technical assistance needed to create productive pastures all over the Northeast in a




manner that is cost-effective, environmentally responsive, and produces wholesome food. It is more important than ever to combine the ever-shrinking resources of university and agency people and funding to continue advancing the science and art of pasture-based farming.

Jenn Colby and Sid Bosworth reminded the attendees to submit any filled-in *Future of the NEPC* questionnaires that were still outstanding. They explained that these would be helpful to guide an ad hoc committee on how to proceed with the Consortium with Jim Cropper retiring as Executive Director in February and Sid Bosworth, the Principal Investigator, retiring later this year.

Jim Cropper wrapped up the business meeting by thanking Jessica Williamson and Cliff Hawbaker for their many contributions while being on the Executive Committee. Both had served out their 4-year terms with distinction. He welcomed Ben Goff and Aimee Braxmeier to the Executive Committee. The two new co-chairs were announced, Kevin Jablonski-Private Sector and Daimon Meeh-Public Sector. The 2020 business meeting was then adjourned earlier than originally planned so those residing in the western part of the Northeast could head home before the snowstorm got there.