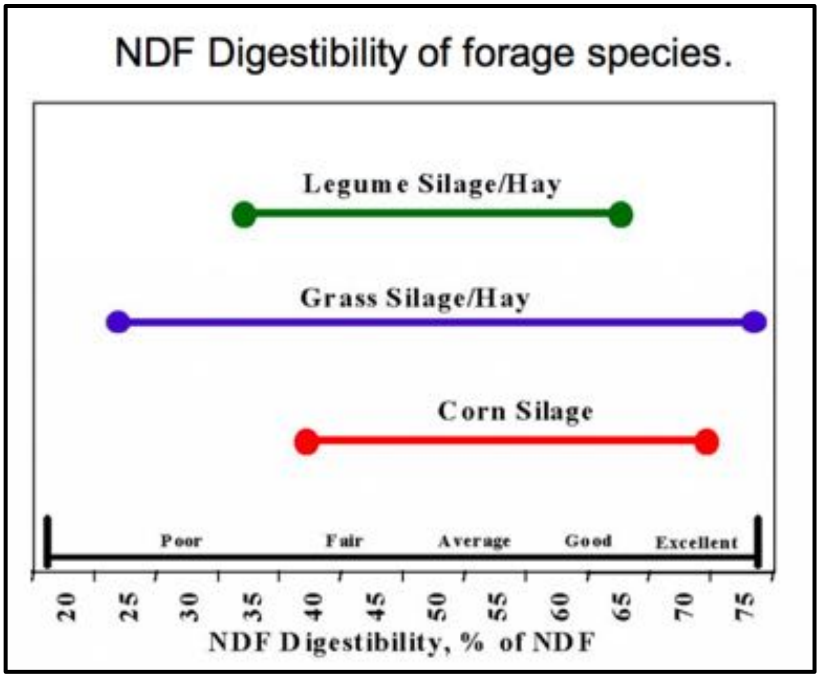
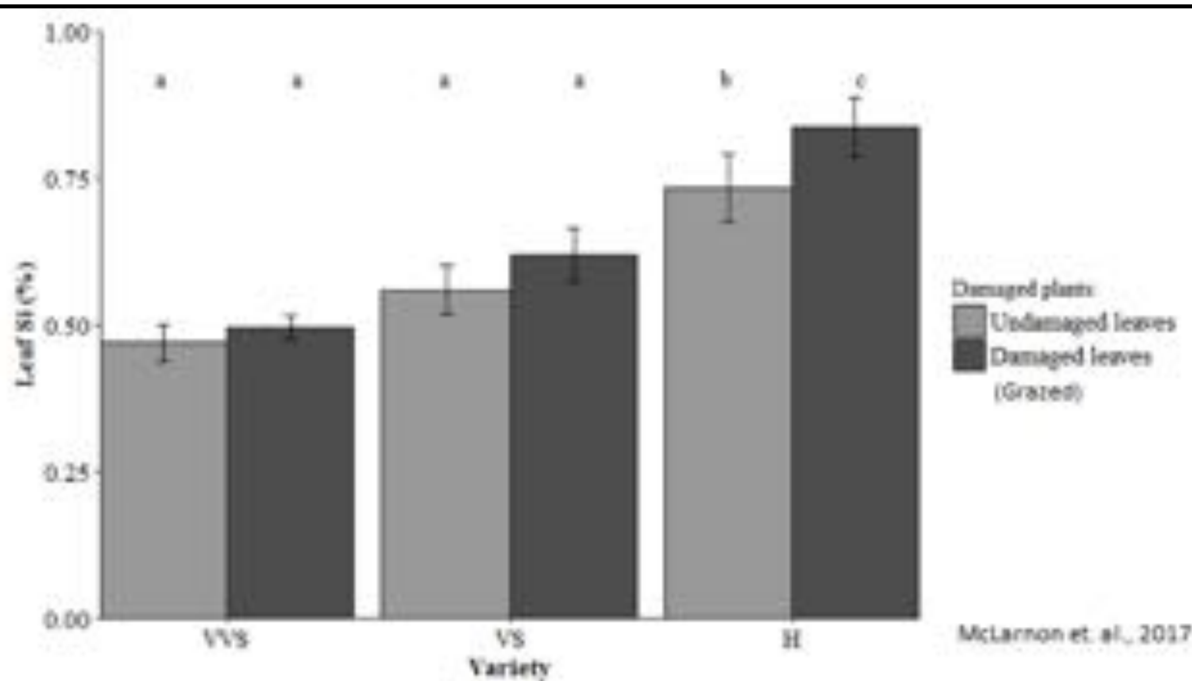
primarily two fundamental reasons: First, research has demonstrated that lactating dairy cows will eat more dry matter (DM) and produce more milk when fed forages that have higher NDF digestibility. Second, while lignin and acid detergent fiber (ADF) have been used in the past to estimate the potential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



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

Silicates in tall fescue appear to be a herbivory defense mechanism (Hartley & DeGabriel, 2016). Van Soest et. al. back in 1968 found an increase in silicates led to a decrease in digestibility. In 2016, Cougnon et. al. found that soft genotypes had fewer trichomes (2.74 mm−1) on the leaf margins than coarse genotypes (9.03 mm−1), but there was no relation between leaf softness or trichome number and digestibility (R^2 = 0.05), nor between silica content and softness or digestibility (R^2 = 0.09). In advanced breeding programs, it becomes difficult to discriminate the leaf softness between genotypes (A plant within a species assigned to a specific intraspecific group based on its genetic makeup). Moreover, there is evidence that the digestibility of the softest varieties is not necessarily higher compared to varieties with coarser leaves. (Editor's Note: However, the authors do not address palatability in their study. They only mention it as a concern in their opening sentence of the abstract.) They are not aware of any silicate testing in variety development. (Editor's Note: I expand upon silicate content in tall fescue as it is increasingly being found to be a deterrent to grazers. It should be tested for in variety development. Tall fescue has been classified as both a Si accumulator and a nonaccumulator indicating its Si uptake in the natural environment is not uniform. It has the ability to take up and deposit Si upon the leaf epidermis, and that the levels of Si within the leaf tissues and the structures it enriches differ among breeding varieties within the species [very, very soft 0.43%–0.69% Si, harsh 0.46%–0.80% Si] [McLarnon et al., 2017]. Note there is overlap among leaf texture groups. This is due at least in part to the impreciseness of the feel test. It would also explain why a very soft leaf variety may not be any better in palatability that one thought to be harsh. Plants take up Si in the form of monosilicic acid [$Si(OH)_4$] via the roots. It is transported through the xylem and deposited in the leaves to form phytoliths. Phytoliths are solid bodies of silica (SiO_2) found in epidermal layers, both within and between the plant cells [McLarnon et al., 2017]. However, in the McLarnon et al. [2017] research paper, the chart below compares simulated herbivory [damaged] versus undamaged plants of 3 tall fescue varieties selected for their leaf texture characteristics showed a steady increase in silicate from very, very soft to harsh leaf texture in both undamaged leaves and damaged (grazed) leaves. The defense mechanism of silicate build-up after tall fescue is damaged by grazing or some other disturbance is also more muted in the soft leaf varieties than in the harsh leaf variety used in this study.)



Leaf Si concentration of damaged plants in unbagged conditions. VVS = very very soft, VS = very soft and H = harsh.

(Editor's Notes: In the McLarnon et al. chart above the very, very soft variety has the lowest leaf Si concentration, but is not significantly lower than the very soft leaf variety. The harsh leaf variety has a significantly higher leaf Si concentration when undamaged [ungrazed] state than the two soft leaf varieties. When damaged [grazed] the leaf Si content rises to an even higher level that is significantly higher than the ungrazed harsh variety and both soft leaf varieties. This would argue that the very, very soft and very soft leaf varieties when grazed would respond very little to increase Si in their leaves whereas the harsh leaf would become even less palatable than it already was before being grazed.

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

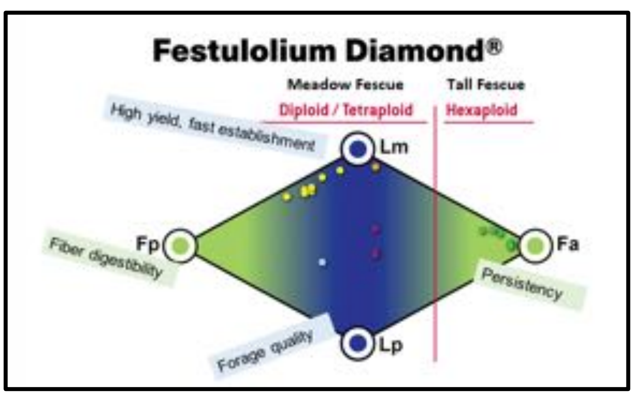
Jerome listed the range of tall fescue types:

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

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

Role of tall fescue in forage production:

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



Festulolium is a cross between perennial ryegrass or Italian ryegrass and either meadow fescue or tall fescue (See adjacent figure). It combines the best features of the fescues and the ryegrasses. Perennial ryegrass (Lp in the figure) is well noted to be a high quality forage, but its persistence in much of the US is not very good. Its drought tolerance is low. It winter kills in the northern states (tends to break dormancy easily during a winter warm spell and gets hammered when it turns cold again). If protected by snow cover, it sometimes gets snow mold and dies. In the South, it can suffer from the summer heat and is susceptible to leaf diseases. *Lolium multiflorum* (Lm in the above figure) is often referred to as Italian ryegrass. It is an annual or biennial depending on where it grows. Obviously, it is short-lived, so not at all desirable in a permanent pasture unless overseeding into a bermudagrass pasture for winter grazing utilization. The two fescues improve upon ryegrass's weak points especially the tendency not to stick around very long. They also maintain forage quality rather than detract from it. Italian ryegrass is fast to germinate, so a festulolium crossbred containing it will produce grazable forage quickly, ideal for emergency pasture or hay use.

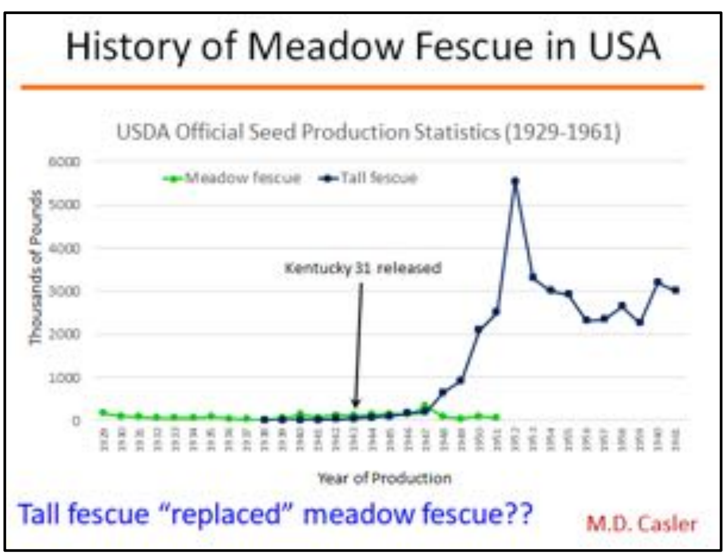
Jerome's concluding remarks were:

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

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

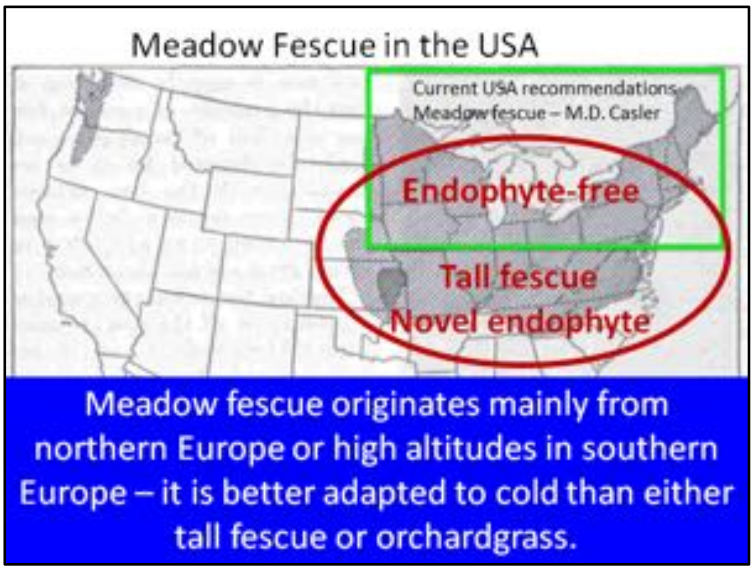
The third and last speaker of The Fescues – Soft-leaved and Meadow session was **Jerome Cherney**, E.V. Baker Professor of Agriculture, Soil & Crop Sciences Section, School of Integrative Plant Science, Cornell University, Ithaca, NY. The title of his presentation was "Meadow fescue: A perennial grass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

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



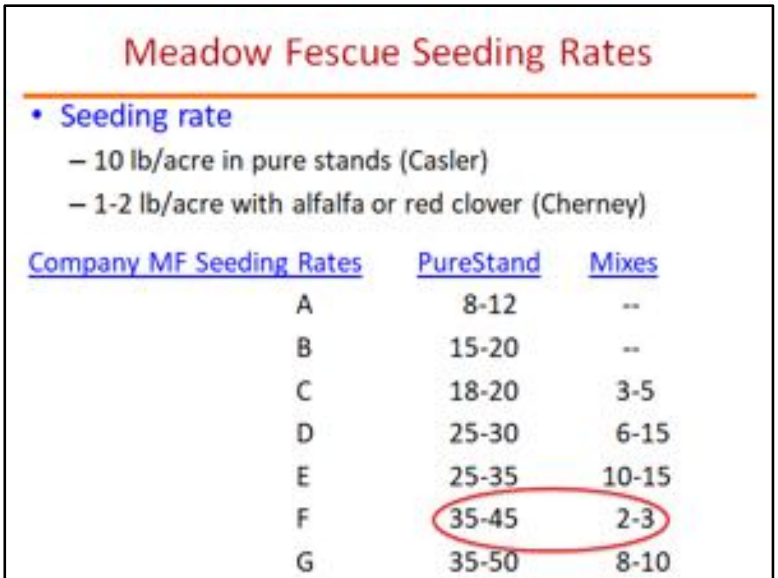
Jerry has been growing meadow fescue at Cornell for 7-8 years. Mike Casler, USDA, ARS, who rediscovered meadow fescue growing in western Wisconsin, has been selecting it for reintroducing it into US agriculture for 10-11 years. It had naturalized in pastures there and Charles Opitz, dairy farmer, in southwestern Wisconsin found it in a remnant oak savanna pasture in 1990 as an isolated occurrence of an unfamiliar grass. It had the leaf and stem morphology of ryegrass but had the panicle morphology of meadow fescue. He asked Mike Casler to identify this unknown grass. This spurred Mike on to collect over 4000 samples from over 100 farms. Three different types of DNA analysis were done. Unequivocal identification as meadow fescue (*Schedonorus pratensis*) was the outcome. Meadow fescue was later identified on over 300 WI farms in naturalized pastures.

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

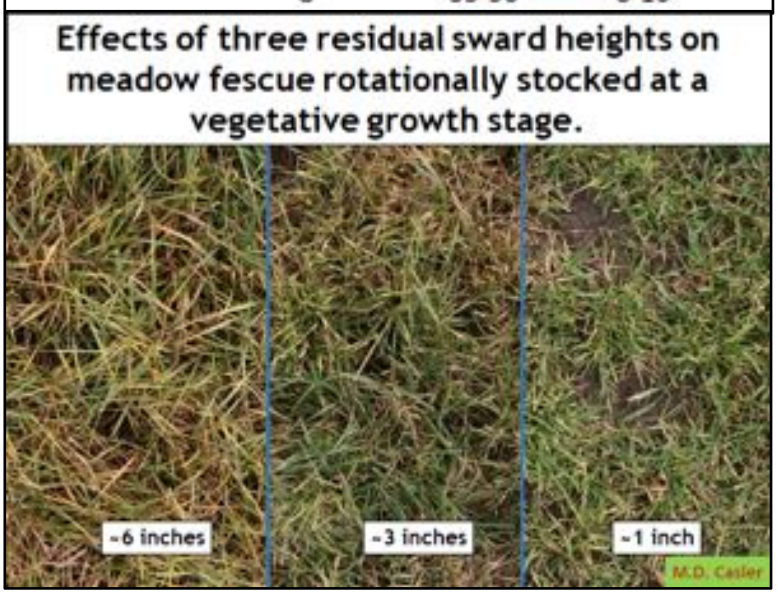


The figure to the left shows the 1909 climatic range of adaptation of meadow fescue (shaded areas). It grows and persists better than tall fescue or orchardgrass in the extreme northern range of adaptation. It is not adapted to southeast US except in the Blue Ridge and Appalachian mountains and Shenandoah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

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



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

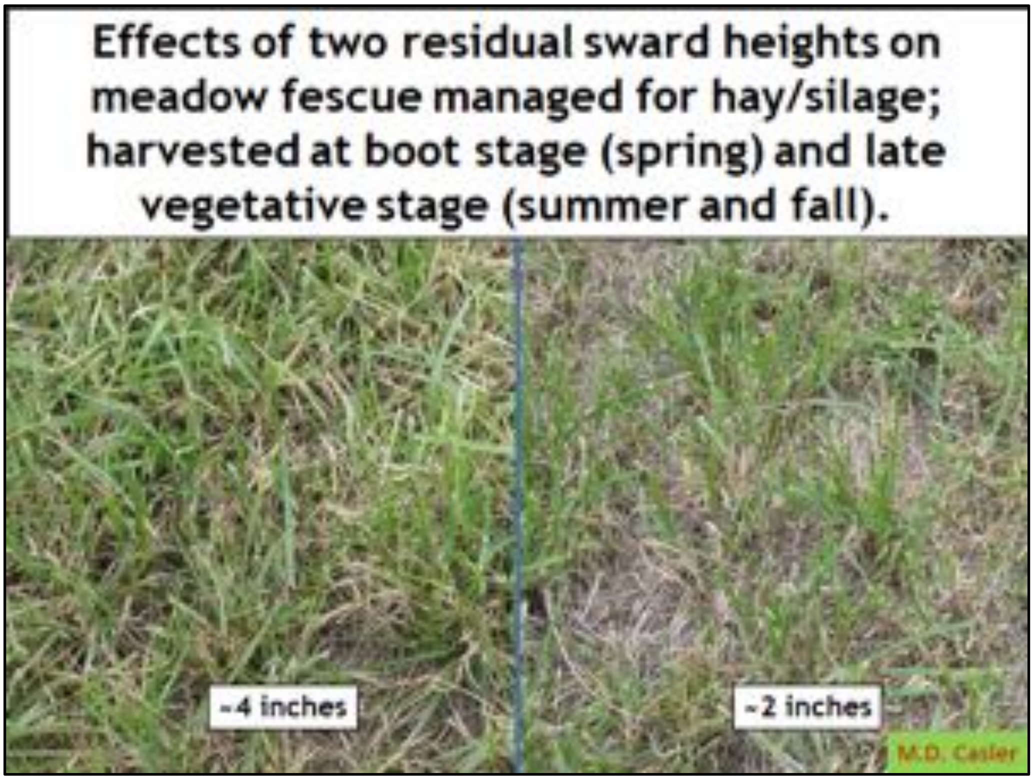


Seeding rates for meadow fescue are all over the place depending on the source. Mike Casler recommends 10 pounds per acre for a pure stand. Jerry recommended 1-2 pounds per acre if seeding it with alfalfa or red clover so as not to compete to much with the legumes. (Editor's notes: One pound of meadow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

Harvest management options:

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

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

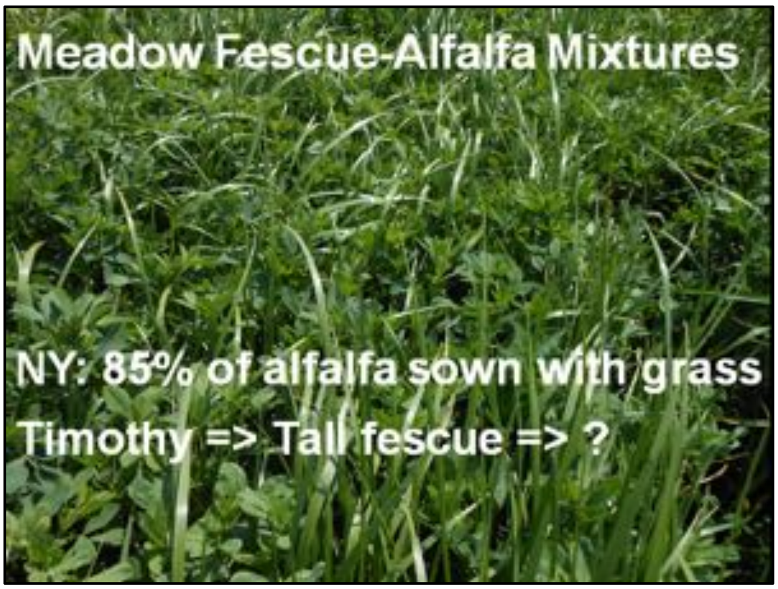


Potential Milk Production

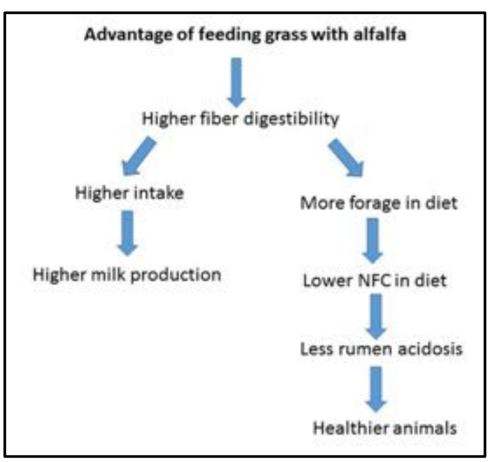
	NDFD	NDF	DM intake	NE_L intake	Milk
	----- g/kg -----		kg/day	Mcal/day	kg/day
Meadow fescue	**765**	**460**	**15.4**	**26.0**	**24.5**
Tall fescue	709	492	14.1	23.1	20.4
Orchardgrass	714	485	14.5	23.6	20.9

M.D. Casler

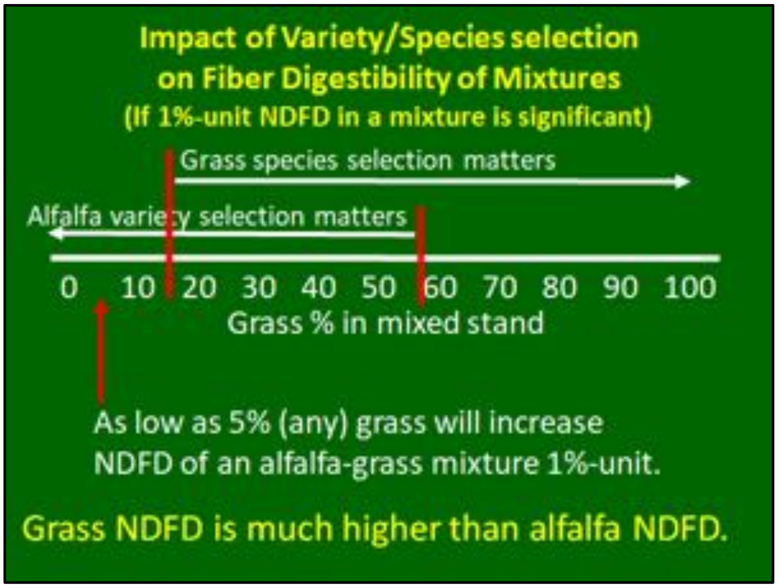
Comparing meadow fescue to tall fescue and orchardgrass, its NDF digestibility is considerably higher than the other two grasses. This increases dry matter and net energy lactation intake allowing milk production to increase over 4 kilograms/day (8.8 pounds/day) over tall fescue and 3.6 kilograms/day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



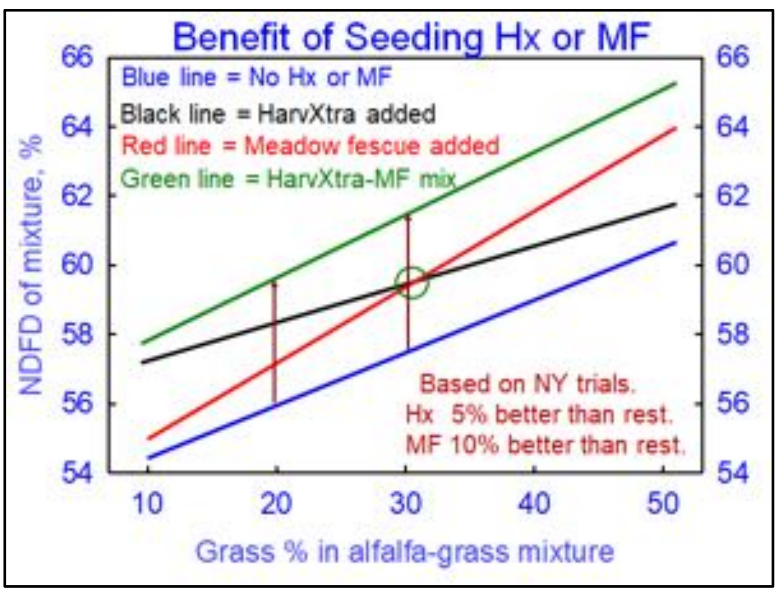
Jerry went on to talk about meadow fescue being seeded with alfalfa for hay production. In NY, most alfalfa stands are seeded with a grass. This is done for a number of good reasons. Most soils in NY are prone to frost heaving. This severs the alfalfa tap root wherever the freeze line in the soil causes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



As shown in the diagram to the left, an alfalfa-grass mix has higher fiber digestibility that allows higher forage intake by the dairy cow that creates the condition for higher milk production. Grass NDFD is much higher than alfalfa NDFD. With more forage in the diet, dairy cows fed a grain supplement will have a lesser amount of non-fiber concentrate (NFC) in the diet. This will lessen the chance for rumen acidosis to occur leading to a healthier dairy cow fed in confinement. For dairy, 20-30% grass is the goal. This is why Jerry recommends only a 1-2 lbs./acre seeding rate. In his trials where seeding rates ranged from a 0.5 pound to 4 pounds/acre, a 1-2 pound seeding rate easily reached the goal of 20-30% of forage dry matter (DM) as grass. He has found the Textrax meadow fescue variety to be ideal companion grass with alfalfa among the 19 different meadow fescue varieties he has observed. It is less aggressive than other meadow fescue varieties while being among the highest in NDFD.

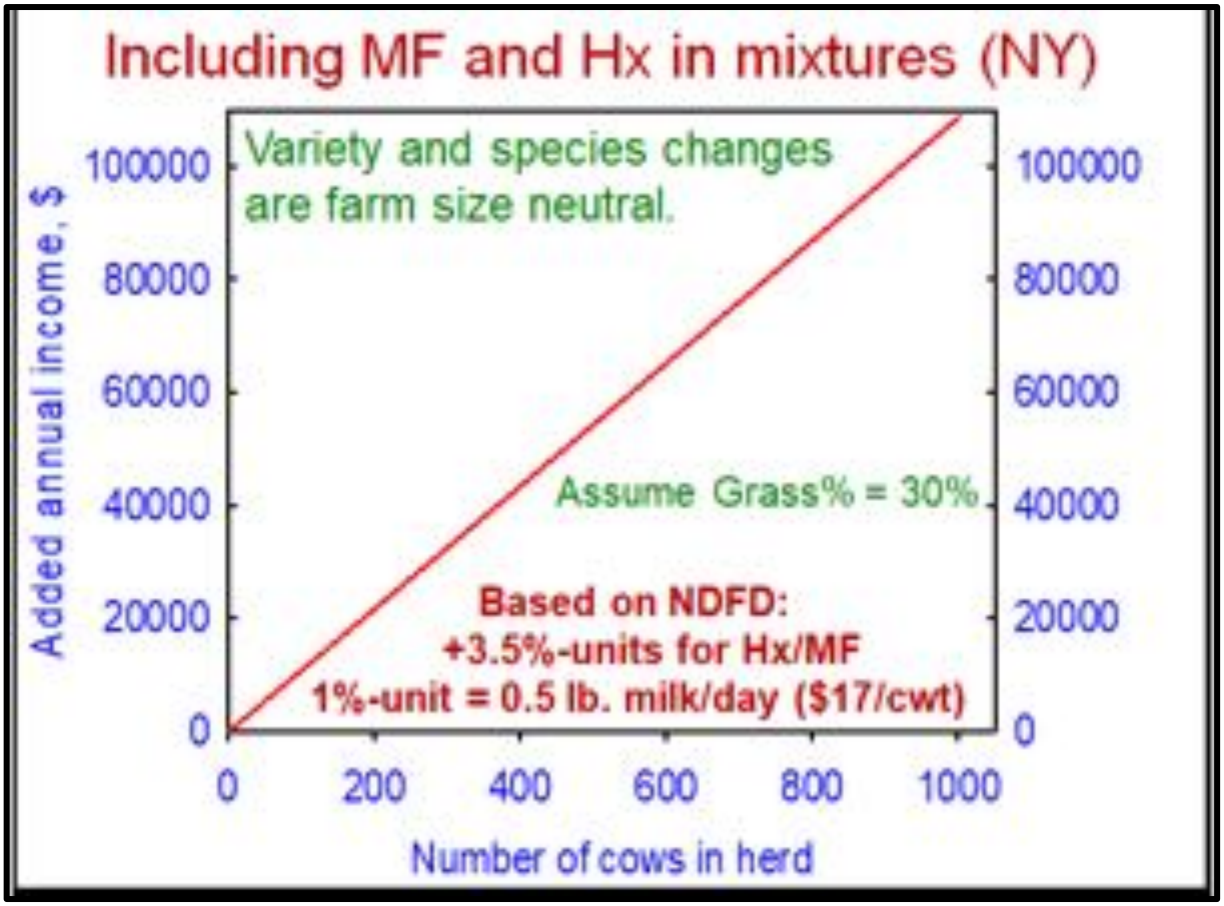


Alfalfa variety selection and grass species selection matters in getting the proper % DM production as grass. Alfalfa has to be aggressive enough not to let the grass take-over while grass species selection has to be done so as not to over-whelm the alfalfa stand regardless of variety selected. If 5%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



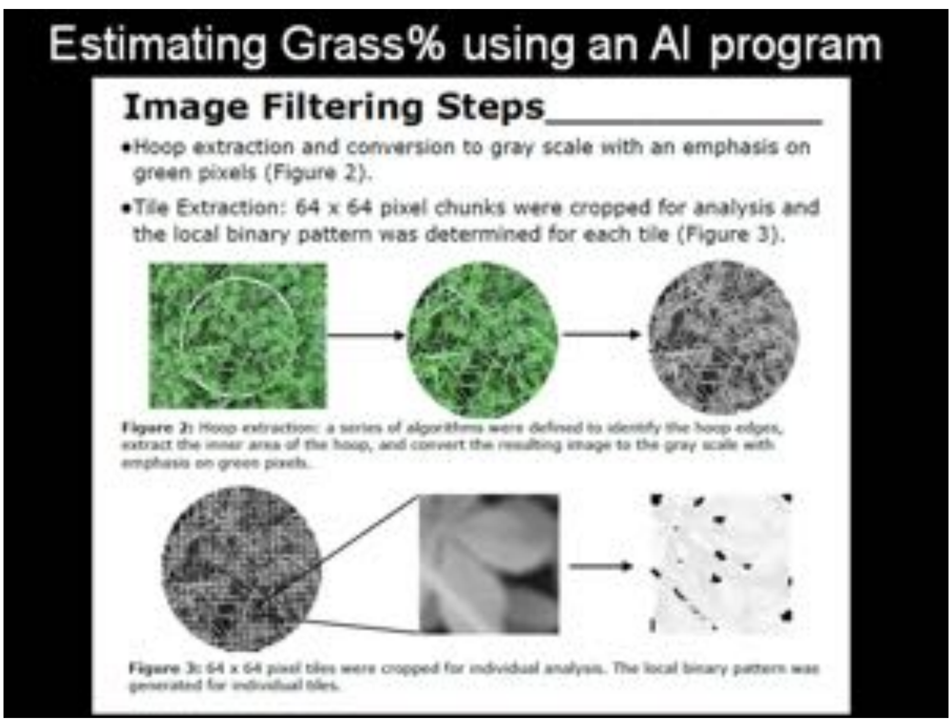
To get the best NDFD in an alfalfa-grass mixture, a combination of a new alfalfa low lignin variety called HarvXtra and a meadow fescue like Textrax is ideal. As shown in the figure to the left, the green line de-picts the HarvXtra and meadow fescue mixture that yields the high-est level of NDFD achieved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

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

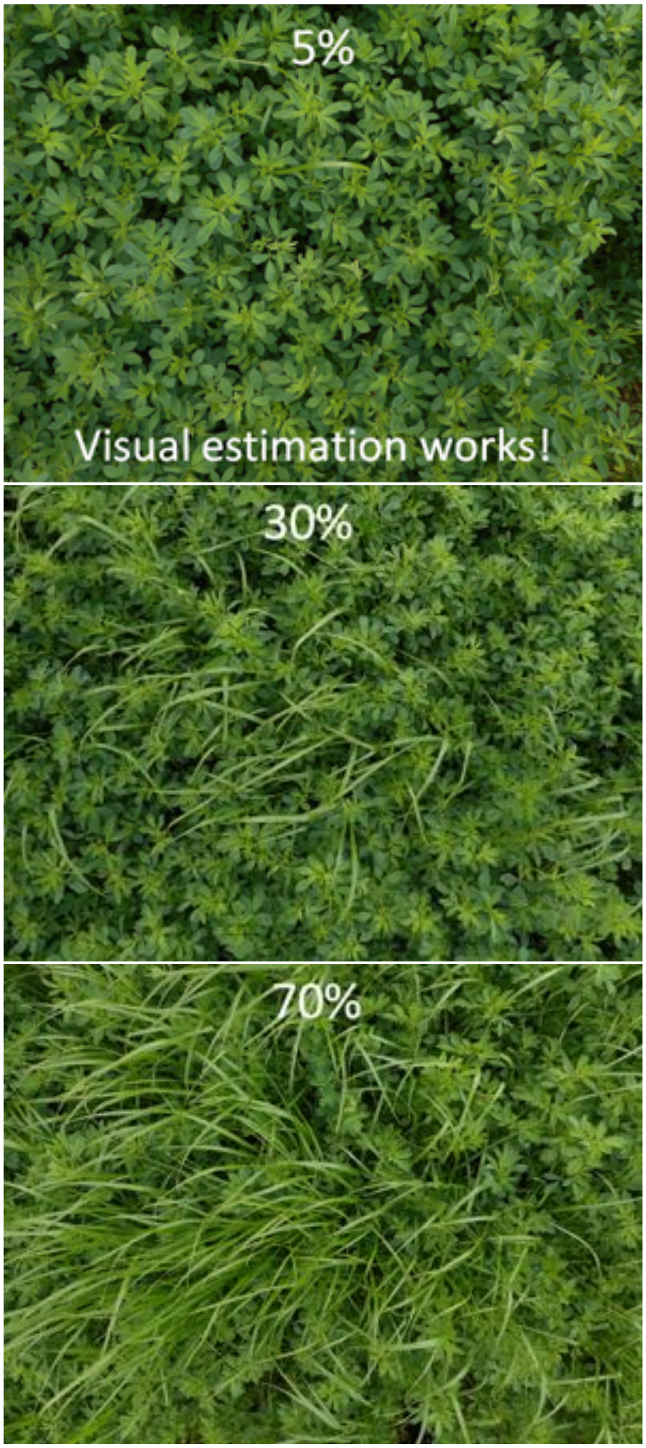


The pros far outweigh the cons of growing an alfalfa-grass mixture for hay or haylage. Many of the pros were covered earlier. Winterkill of the alfalfa is primarily from frost heave damage. The more fibrous root system of the grass tends to make the soil less prone to frost heave and rutting up with machinery traffic as easily as it would in a pure alfalfa stand. Alfalfa pests and diseases are less prevalent when a grass is grown with it. Soil health is improved by the greater root mass in the top 8 inches of soil when grasses are present. Organic matter will increase over time and soil structure is likely to improve since stand life is longer so less tillage is involved to reseed. Less erosion on steep hillside fields is likely to occur than it would if it were pure alfalfa, especially as the alfalfa stand thins out but is still an economic stand. On the con side, forage quality is variable from cutting to cutting as grass and alfalfa content will vary with the weather and time of year. As the stand ages, grass will become a greater part of the DM yield. Weed control is limited as most herbicides to control weeds in alfalfa are likely to kill the grass. Roundup-ready alfalfa varieties could not have Round-up applied to them if grown in association with grasses.

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



During this presentation, Jerry talked about a new method of determining percent of grass by weight in an alfalfa-grass mixture using artificial intelligence (AI). This methodology would be useful to other forage researchers, and agencies, such as NRCS, with their pasture inventory in determining plant species composition of pastures by weight.



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