2016 Northeast Pasture Consortium Annual Conference & Meeting Proceedings held at the Harraseeket Inn in Freeport, Maine, March 16-17

Forage Breeding

After lunch, the **What's New in Forage Plant Breeding** session began at 1:00 PM, moderated by Dr. Sid Bosworth and Mr. Tim Fritz, King's AgriSeeds. Dr. Bosworth introduced Dr. Yousef Papadopoulos, Research Scientist, Kentville Research and Development Centre, Forage Breeding, Science and Technology Branch/Agriculture and Agri-Food Canada / / Government of Canada, Truro, Nova Scotia. Dr. Papadopoulos' presentation was *Genetic Improvements in Pasture Species – What's New and What's Needed*. After introducing his staff at the Centre by way of PowerPoint, he started his presentation by showing a chart about forage species recommended for maximum productivity at different times of the growing season. This was done to show how different forages can compliment one another in a pasture forage mixture to maintain a more constant amount of forage production throughout the growing season. The more complex the mixture is; the better the annual yield is. Winter grazing can be feasible provided snow cover is not too deep and there is ample forage for stockpiling to provide grazable forage after the growing season ends. He suggested bluegrass, meadow and tall fescue, and possibly reed canarygrass for grasses while holding out the possibility that other cool season grasses might be suitable as well. Legumes for winter grazing use, he suggested red clover, birdsfoot trefoil, and alfalfa.

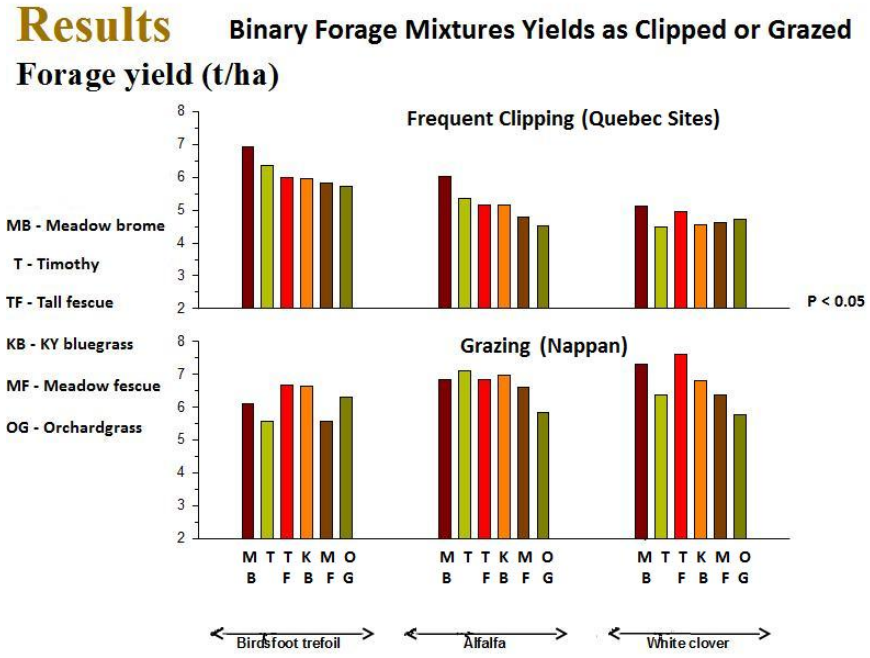
Early Spring	**Late Spring**
-Meadow bromegrass -Orchardgrass -Kentucky bluegrass -Red fescue -White clover	-Meadow bromegrass -Orchardgrass -Kentucky bluegrass -Reed Canarygrass -Perennial ryegrass -Red fescue -White clover
Early Summer	**Mid-Late Summer**
-Meadow bromegrass -Orchardgrass -Timothy -Meadow/tall fescue -Reed canarygrass -Perennial ryegrass -White/red clover -Birdsfood trefoil	-Meadow bromegrass -Orchardgrass -Meadow/tall fescue -Reed canarygrass -Alfalfa, -Red clover -Birdsfood trefoil
Early Fall	**Late Fall**
-Kentucky bluegrass -Tall fescue -Reed canarygrass -Red clover	-Kentucky bluegrass -Tall/meadow fescue -Reed canarygrass -Red clover

Five years of research by Dr. Papadopoulos and his team, published in 2011, found that diverse forage mixtures yield better than simple mixtures. Increasing complexity of mixtures (more grass types) increased yield of forage. A seven-year study (April 2010 to March 2017) by the Canadian Cattlemen's Association Beef Cattle Research Council has as its objective: Assess The Role Of Cultivars In The Performance Of Forage Species In Diverse Forage Mixtures Under Various Management Systems. It is finding that selection of species/cultivar components of pasture mixtures requires these qualities:

- Grow and regrow at the right time
- Forage stand is in suitable quantity and quality *for specific class of livestock*

- Persist long enough, and
- Companionable enough with other species.

Their first experiment's objective was to develop simple and complex forage mixtures for long term and low cost beef grazing management systems in different environments. The plots were seeded in 2010 and grazing began in 2011. Trials were conducted at Nappan, Nova Scotia and two sites in Quebec. The grass species selected were Kentucky bluegrass, meadow fescue, orchardgrass, tall fescue, timothy, and meadow bromegrass. Alfalfa, white clover, and birdsfoot trefoil, were the legumes selected. At Nappan, NS, three commercially available cultivars were selected for planting from each grass species. Grass and legume species were seeded in all possible legume-grass-grass cultivar combinations to create 54 binary mixtures planted for evaluation at Nappan. At Nappan, the plots were grazed, while at the two Quebec sites the plots were clipped. This led to an interesting result with the binary mixtures of a grass and a legume as seen in the chart below. The binary mixtures performed differently under frequent clipping and cattle grazing. This indicates that if one is interested in forage response to grazing - use grazing animals, not simulated grazing by means of mechanical clipping.



Under grazing, Kentucky bluegrass yields are higher than if it is clipped. Part of the reason for this is probably that it was not clipped as low as it was grazed. It would also depend on the interval of the clipping frequency in relation to the grazing interval. If they are not the same number of days between harvest events, clipped bluegrass may suffer as a result, especially if the clipping interval is quicker than the grazing interval, or alternatively if it is longer, bluegrass growth may grow out of its quick growth stage. Once clipping harvests are less frequent than under grazing, bluegrass annual yields will also suffer. Looking at the grazed yields for the six grasses studied, bluegrass is among equals, not a low producer as is often thought and often verified by clipping heights set higher than the grazed height

would actually be. Bluegrass is highly palatable to the ground or as close as it can be grazed.

Birdsfoot trefoil, when frequently clipped, out-performed alfalfa with the 6 different grasses. Alfalfa needs a minimum of 30 days between harvest events so if the frequency was sooner than that, this would explain why trefoil out-performed alfalfa. Alfalfa grows back by crown buds, not by axillary buds along the stem as does trefoil. Crown buds need more time to trigger stem elongation than do axillary buds as they are dormant until currently growing stems begin to flower. Alfalfa out-performed trefoil in the grazing trial with the 6 different grasses except when growing with orchardgrass. White clover and alfalfa grown with the 6 different grasses were similar in yield overall. Tall fescue and meadow bromegrass yielded better with white clover than with alfalfa.

In this study, two of the three legumes did not persist very well by four years out. They were seeded with the grasses in 2010. In the second year, 2012, all the legumes were competing well with the grasses having 33 to 44 plants per square meter. The grasses had 32 (timothy & tall fescue) to 37 plants per square meter (meadow bromegrass). By 2013, all three legumes had declined significantly in plant counts with the more competitive grasses - bluegrass, tall fescue, and orchardgrass. White clover persistence was the best among the legumes. Its plant count remained between 30 and 40 plants per square meter with timothy, meadow fescue, and meadow bromegrass. Grass counts increased slightly to 36 (orchardgrass) to 44 plants per square meter (bluegrass & meadow fescue), except for meadow brome which declined slightly from 37 plants per square meter to 34. By 2014, birdsfoot trefoil was nearly absent from bluegrass, tall fescue, orchardgrass, meadow fescue, and meadow brome. It was a minor component in timothy. Alfalfa was also largely gone by then being totally absent in orchardgrass, and nearly absent in meadow fescue and meadow brome. It was a minor component in timothy, bluegrass, and tall fescue. White clover remained an important component in timothy, orchardgrass, and meadow fescue with 29 to 40 plants per square meter. It was a minor component in the other grasses except meadow brome. Meadow brome continued to decline slowly in plant numbers probably due to its ever expanding crown (short rhizomes) as compared to the other grasses in the experiment. Weaker meadow brome plants die-out; edged out by thriftier plants with expanding crowns. The other five grasses continued to slowly thicken in stand density. Reseeding legumes every three years was recommended. Frost crack seeding works well in Canada. The persistence problem with birdsfoot trefoil may be caused by cattle selecting for it while they graze. This weakens the plant especially if grazed too close to the ground. It needs to have a 4-inch stubble to allow enough axillary buds to grow new stems or allowed to mature at some point annually to throw new seed from its pods.

Forage species and varieties that perform well under grazing was covered next. Average seasonal dry matter yield for years 2012 – 2014 for grass-legume mixtures rotationally grazed by steers was highest for tall fescue 7.1 tons per hectare average for 3 cultivars, followed by Kentucky bluegrass at 6.9 tons/hectare average for 3 cultivars, and then meadow bromegrass at 6.7 tons/hectare in one chart. The other 3 grass species averaged a little over 6 tons/hectare. However, only five of the 54 grass/cultivar-legume binary mixtures consistently demonstrated superior long-term agronomic performance. They are shown below in the next chart.

Ranking	Legume	Grass	Grass Cultivar
1	White Clover	Tall Fescue	Courtney
2	Trefoil	Tall Fescue	Kokanee
3	Alfalfa	Tall Fescue	Kokanee
4	Alfalfa	Timothy	Express
5	Trefoil	Orchardgrass	Artic

The next chart displays their first harvest forage quality attributes.

Legume	Grass	Grass Cultivar	ADF	NDF	CP
White Clover	Tall Fescue	Courtney	304	513	151
Trefoil	Tall Fescue	Kokanne	300	505	162
Alfalfa	Tall Fescue	Kokanne	292	495	170
Alfalfa	Timothy	Express	308	490	156
Trefoil	Orchardgrass	Artic	302	521	133

Above average for grass species Average for species

irst Harvest Pasture Quality

Legume	Grass	Grass Cultivar	ADF	NDF	CP
White Clover	Tall Fescue	Courtney	342	562	132
Trefoil	Tall Fescue	Kokanne	351	555	144
Alfalfa	Tall Fescue	Kokanne	327	507	160
Alfalfa	Timothy	Express	316	495	183
Trefoil	Orchardgrass	Artic	349	555	143

Above average for grass species Average for species

egrowth Pasture Quality

The above chart shows how good the forage quality is when regrowth is grazed later on during the pasture season.

In the second experiment they conducted, four grass mixtures were seeded with either alfalfa or birdsfoot trefoil (Complex mixtures). It was conducted in this manner:

- Grazing research trial in Nappan, NS; and simulated grazing trials, 2 sites in Quebec.
- Seeded in 2010, grazing started in 2011.
- Forage yield, seasonality, persistence and forage quality
- Animal weight gain, grazing days, animal gain per acre, and
- 4 core animals per treatment group for data collection.

Legume effect on animal gain from 2011 to 2015 was to add from 1.4 pounds per day to 2.4 pounds per day. Trefoil began at 2.4 pounds per day but by 2015 it declined to 1.75 pounds per day as stand declined. Alfalfa on the other hand started out at 1.4 pounds per day and oscillated between that and 1.75 pounds per day. Both legumes met at the 1.75 pounds per day level in 2015.

This experiment is still on-going and other results were not presented.

Dr. Papadopoulos began the next segment of his presentation entitled: *Genetic Improvements in Pasture Species – What's New and What's Needed.* He presented a new alfalfa cultivar CRS 1001 that is being bred to tolerate flooding better than other alfalfa cultivars. Its attributes are:

- Characterized by unique rhizomatous growth habit
- Long-term persistence under effective rotational grazing.
- Late-flowering, winter hardy, and high yielding.
- Tolerant to: mid-summer drought, spring and fall water-logging, and grazing.

When tested for tolerance to fall and spring flooding, CRS 1001 had better than 50% survival while two other cultivars, AC Caribou and Apica, survival rates were below 10% and 30% respectively.

Commercialization of CRS1000 was initiated 2015. Seeds for on-farm trials are available at Perennia, Extension and Food Safety Services, 199 Dr. Bernie MacDonald Drive, Bible Hill, NS Canada B6L 2H5 (contact Bill Thomas, Director of Extension/Field Crops Specialist, Office: (902) 896-0277, EXT 225, Cell: (902) 890-4555, > bthomas@perennia.ca).

He also told us of two birdsfoot trefoil cultivars that show much promise, NB95-118 and NB95-106. Both cultivars showed superior yield over a 3-year trial from 2011-2013 with NB95-118 yielding 7.0 tons/hectare on average and NB96-106 yielding 7.2 tons/hectare. The other trefoil cultivars averaged a little over or under 6 tons/hectare. They are developing birdsfoot trefoil cultivars for productivity under intensive grazing and improved condensed tannins profiles. As we learned last year, higher condensed tannins content in trefoil provided more bypass protein which is digested in the lower intestinal tract of the animal rather than in the rumen so animal performance is enhanced.

He closed his presentation by saying that the following attributes need to be considered when choosing appropriate legume cultivars in the northeast US and southeast Canada:

1. Winter Hardiness
2. Grazing Tolerance
3. High Root Mass
4. Deep Rooting system
5. High Yield
6. High Regrowth Yield
7. water-logging Tolerance
8. Drought Tolerance
9. Acid Soil Tolerance
10. High Seedling Vigor

Dr. Bosworth introduced the second presenter for the session, Dr. Heathcliffe Riday, ARS Research Geneticist at the US Dairy Forage Center, Madison, WI. Dr. Riday's presentation title was *New Traits and Improvements in Old Traits in Forage Legumes*. He began his presentation by talking about red clover genetic improvement. It is a short-lived perennial. In fact, when used extensively in crop rotations, it was often used as a biennial. It was seeded with a small grain crop of oats or barley and then maintained one year afterwards for hay before being plowed under for a row crop the following

year. It provides a good nitrogen source for following crops, such as corn or potatoes (Maine). Its advantages are - easy to establish, shade tolerant, does well on acid soils, and high yielding. Its big disadvantage is, that even with newer cultivars, it only persists for 3 to 4 years. Red clover seed demand showed heavy usage (35 million kilograms sold per year) until about 1960, then a very steep 30-year decline until 1990, since then seed sales stabilized at approximately 5 million kilograms per year. Nearly all (75-90%) the red clover seed is now produced in Oregon. Even though seed production has declined to a much lower level than it did from 1940 to 1960, it is still economically important. Oregon wholesale average annual seed value for years 2010 to 2014 was $14.7 million. Estimated retail seed value at $200 per 50 pound bag (35 lbs seed + 15 lbs coating) = $28.6 million. Dr. Riday had to estimate red clover acreage using its seed sales in comparison with alfalfa to arrive at a Drought estimate of 4.5 million acres in the US. Assuming 4.5 million acres of red clover producing 3 tons per acre forage:

- Estimated forage value $100/Ton = $1.3 billion
- Estimated nitrogen fertilizer value @ $0.40/lbs N @ 120 lbs/Ac N credit = $215 million
- Estimated milk value @ 3 Tons/Ac = 171 grazing days @ 50 lbs milk/day @ $18/cwt = $6.9 billion
- Estimated beef value @ 15:1 feed conversion rate and 62% usable beef @ $4/lbs meat = $4.4 billion.

A long time goal of red clover forage breeders has been to increase its persistence. The chart below shows the progress achieved during the last half of the twentieth century.

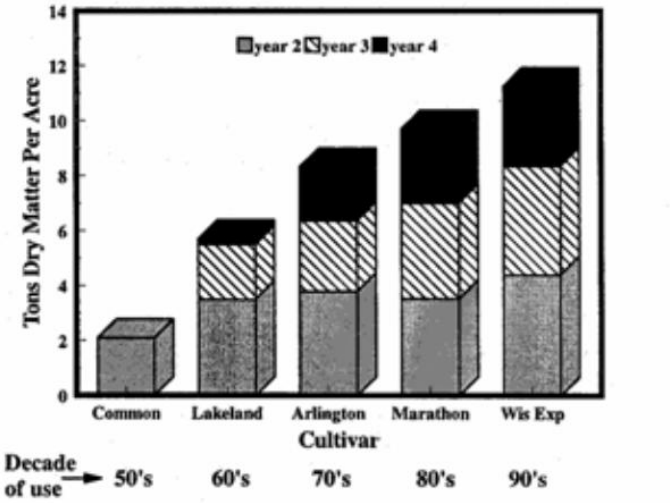


Figure 2. Forage production of red clover resulting from five decades of breeding for persistence and disease resistance.

(Smith, 2000)

Newer red clover cultivars tend to be more persistent, but not all new red clover varieties are equally persistent so care has to be taken in selecting one if persistence is desired.

Presently only three active red clover forage breeders are left to carry on in North America, they are at Nova Scotia, Madison, WI, and Florida. At any one time 30,000-40,000 red clover transplants under evaluation at the Dairy Forage Research Center. There has been a 4.0% performance (persistence and yield) gain per year in spaced-plant cultivar trials using Marathon red clover as the standard. This equates to a 1% gain in sward performance when predicting sward performance from visual spaced-plant evaluations. With 100% market penetration Dr. Riday's program would be adding approximately $50 million dollars of value per year to the US economy. Two new cultivars developed by Dr. Riday that show superior persistence are FF 9615 and DFRC3. Third year stands in late summer looked much better than the other cultivar plots where clover was nearly absent.

Historically, Wisconsin red clover breeding focus has been on improving persistence as elsewhere. In the chart below, genetic gain in percent per year is shown for yield and survival from their work.

Table 2 Estimates of genetic gain in red clover breeding. † Woodfield and Brummer (2001), ‡ Data from Six trials planted 1986 to 1991 in Wisconsin, USA. (Smith *et al*. 1987-1994; Riday and Krohn 2010a), § Data from 1 Rotational Grazed red clover – tall fescue mixture trial established 2004 in Wisconsin, USA (Riday *et al*. 2007), ¶ Unpublished results from (Riday *et al*. 2007), a – released 1953 (Hollowell 1961); b – released 1973 (Smith *et al*. 1973); c – released 1987 (Smith *et al*. 1994); and d – unreleased experimental first tested in 1992 (Smith 2000).

Trait	Benchmark variety	Improved varieties	Genetic gain (% yr^{-1})
DM yield†	G. Turoa	G. Hamua, Pawera	0.43
DM yield†	G. Hamua	G. Colenso	0.21
DM yield†	G. Pawera (4x)	G27 (4x)	1.39
1st post-seeding year DM yield‡	Lakeland[a]	Arlington[b], Marathon[c]	0.41
2nd post-seeding year DM yield‡	Lakeland	Arlington, Marathon	0.55
3rd post-seeding year DM yield‡	Lakeland	Arlington, Marathon	0.95
Trial DM yield‡	Lakeland	Arlington, Marathon	0.60
Establishment survival§	Lakeland	Arlington, Marathon, C328[d]	0.94
12-month survival§	Lakeland	Arlington, Marathon, C328	1.94
24-month survival§	Lakeland	Arlington, Marathon, C328	1.43
36-month survival¶	Lakeland	Arlington, Marathon, C328	2.78
48-month survival¶	Lakeland	Arlington, Marathon, C328	1.32

(Riday, 2010)

New traits being worked on now are: more fall growth, "creeping" rooted or "stoloniferous", and 2,4D tolerant red clover. Australia released a creeping rooted red clover called Astred in 1995. Texas A&M has one cultivar designated as TX-Creep. One "okay" red clover was recovered in Wisconsin. It has okay biomass and okay persistence and is spreading - slowly. 2,4D tolerance was first worked on at the University of Florida in the 1980's. This red clover is very early flowering. It was backcrossed to Wisconsin elite germplasm. An additional 5 cycles of selection for 2,4D tolerance were conducted. Field test on cycle 3 material started in 2013 using 1.5 pounds of 2,4D active ingredient per acre. The 2,4D tolerant red clover showed very good tolerance to that rate of application compared to a standard red clover cultivar. This is important in pastures where broadleaf weed control with 2,4D is desired, but red clover exists and would be killed as well if not tolerant to the herbicide.

Other legumes being worked on include yellow flowered alfalfa, "*falcata*". Falcata or yellow flowered alfalfa is a subspecies of alfalfa. It has spreading crowns and is more decumbent and winter hardy than *sativa*. It is native to Eastern Europe, Eurasian Steppes, and Siberia. It is less improved than regular alfalfa "sativa". Falcata can be found as a naturalized alfalfa in western US. Breeding targets are:

- Improved yield
- More upright growth habit

- Maintain Spreading, and
- Reduce fall dormancy.

One original objective was to use *falcata* in a hybrid system with regular alfalfa, *sativa*. Crosses of falcata and sativa were successful in improving yield. However, there is interest in pure falcata alfalfa varieties as the yellow flower is a recessive gene and is a visual marker for GMO-free alfalfa.

US Dairy Forage Research Center collaborated with the Noble Foundation and Forage Genetics from 2005 to 2010 to examine all aspects of lignin modified alfalfa. Various lignin modifications were examined to improve the digestibility of the neutral detergent fiber (NDF) of alfalfa. Caffeoyl-CoA O-methyltransferase (CCOMT) downregulated alfalfa was chosen for commercialization and became available starting in 2015 as HarvXtra. Percent NDF digestibility was 5 points higher on average in HarvXtra than in normal alfalfa. Young growing lambs fed 100% alfalfa diets using HarvXtra and normal alfalfa had higher dry matter intake (DMI) with HarvXtra compared to the normal alfalfa. On average, the increase in DMI was 0.2 percent of body weight (3.63 versus 3.43). This would translate into faster average daily weight gain.

US Dairy Forage Research Center is also working on kura clover breeding. Its advantage is that it is very persistent due to its rhizomatous nature. However, it is difficult to establish (seed germination is bad) and yields less seed than other clovers. A small breeding program began in 2007. Selection work is being done to get better establishment, spreading, and flowering. Current phase focused on developing varieties. 'Everlast' seed production phase is underway. Multiple other experimental varieties are in initial seed production phase.

US Dairy Forage Research Center released 'WITT' trefoil variety in 2007 with increased persistence. It was more persistent than Norcen or Viking in 16 trials conducted in MN and WI into the fourth year of production. Unfortunately, seed production is poor. It is a bigger trefoil plant so it yields more than other trefoil varieties. This concluded Dr. Riday's presentation.

The last speaker for this session was Mr. Joe Schmidlen, Northeast Territory Manager, Barenbrug USA. The title of his presentation was *What's new from Barenbrug in plant breeding? Products-Programs-Performance*. Mr. Schmidlen's territory includes three other states adjoining our Northeast Region - Ohio, Kentucky, and Virginia. He explained that the mission of Barenbrug is to "Increase animal productivity to help feed the world and enhance the enjoyment of green spaces". He said Barenbrug was distinctly unique as a seed producer as they do all aspects of seed production - plant breeding, research, production, and marketing. The parent company is based in the Netherlands and began in 1904. In 1979, Barenbrug USA was established. In 2012, a strategic alliance was formed between them and Dow Agricultural Sciences. Barenbrug has a Global Position in marketing seeds and conducts Broad Based Global Research in several countries - the Netherlands, Northern Ireland, France, Italy, Finland, Poland, Romania, USA, Mexico, Argentina, Brazil, Chile, New Zealand, Australia, China, and South Africa.

Common cool season grasses grown in the US are not native to the North American continent. Centers of origin for commonly US grown cool season grasses are:

Orchardgrass - Ubiquitous from Europe and Canary Islands.

Tall Fescue - Endemic to Europe and North Africa.

Bromegrass - Smooth and Meadow - Origin in Eastern Europe.

Italian Ryegrass - thought to be from Northern Italy.

Perennial Ryegrasses - many from New Zealand.

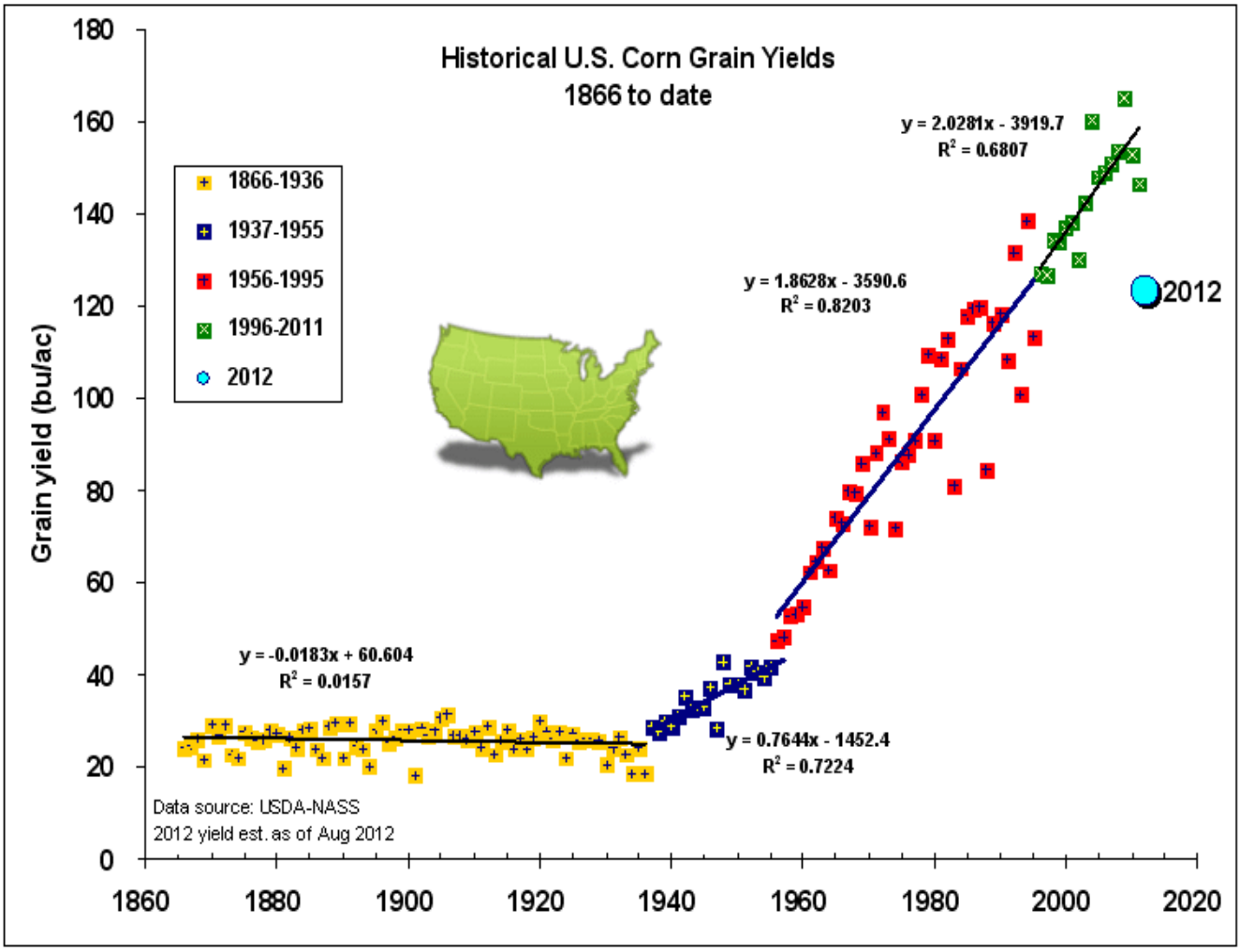
Therefore, genetic selection of them is made from Europe, Asia, Africa, and South America, Australia, and New Zealand. Barenbrug is picking up the slack in public forage breeding. Their West Coast Research Center is in Corvallis, Oregon. They cooperate with land grant universities with forage breeding and trials. In this way Barenbrug can do regional observations, evaluations, and screenings of their many cultivars with forage trials. Specifically in the Northeast, they have trials in NY and PA. Also in the Northeast, they cooperate with Cornell (germ plasm screening) and Penn State (perennial ryegrass & others) on forage breeding. They also work with US Dairy Forage Research Center in Madison, WI on legume breeding. Their US seed production is based in the Willamette Valley of Oregon. Devesh Singh is Research Director. Dr. Peter Ballerstedt is Forage Product Manager. Steve Wallace is Senior Forage Agronomist and Justin Burns is National Forage Sales Manager. Joe is the next in line for the Northeast territory.

11 Main Groups of cool season grasses

- Tall Fescue
- Orchardgrass
- Bromegrasses
- Wheatgrasses
- Phalaris
- Ryegrasses
- Timothy
- Bluegrasses
- Wildrye
- Creeping and meadow Foxtails
- Other (50 species)

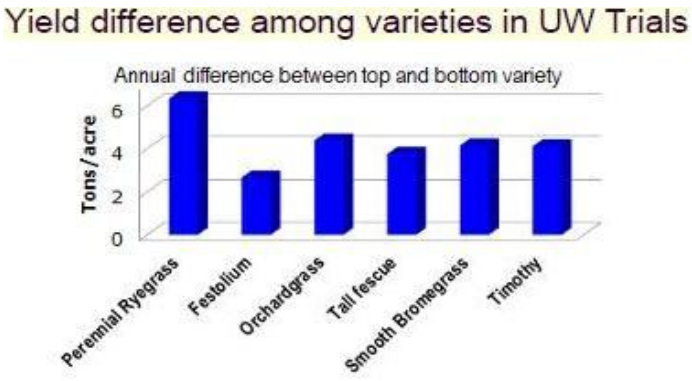
Since forage grasses and legumes have not been hybridized within species (intraspecific hybridization), yield gains through selection has been slow as compared to intraspecific hybridized corn and GMO corn. There has been a tremendous leap in corn grain yield since 1956 with the use of ever-improving hybrid corn, better fertilization, weed control with herbicides, and now GMO corn with its built-in insect protection and tolerance to the herbicide Roundup among other beneficial traits. Nationally, yields went from under 50 bushels per acre in 1956 to over 160 bushels per acre in 2008. The extreme widespread national drought of 2012 still had an average yield over 120 bushels per acre of corn grain

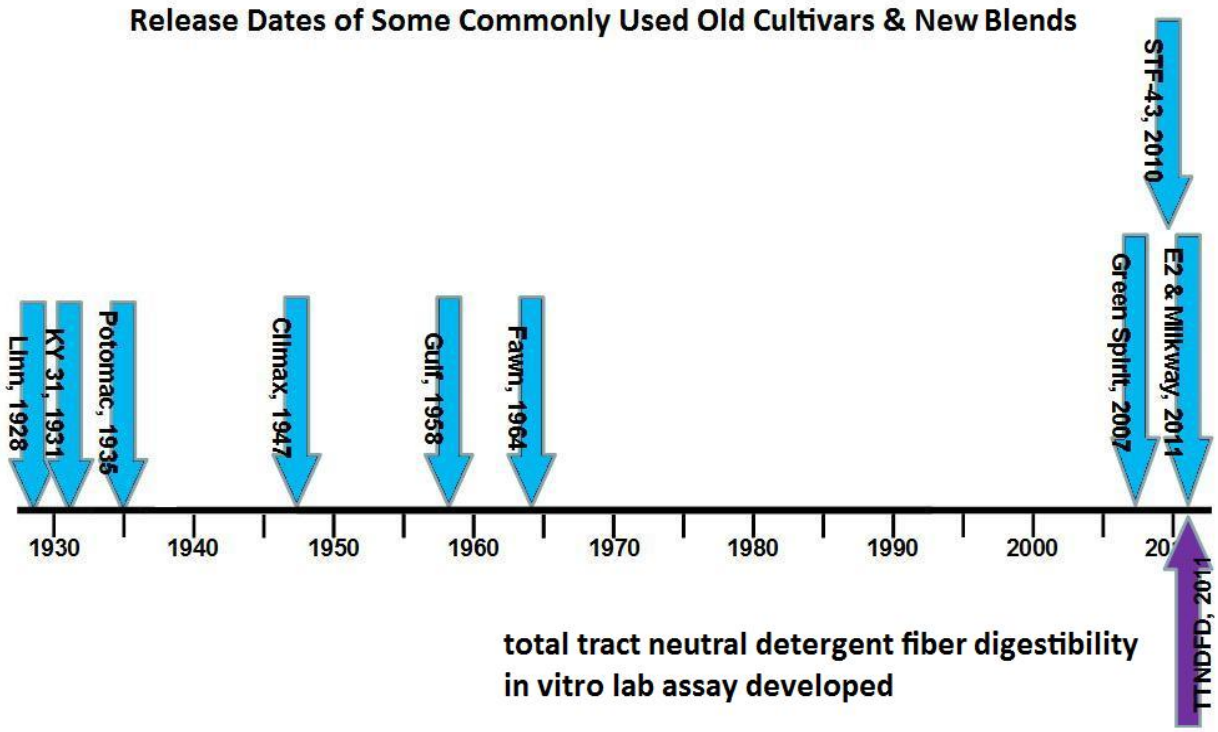
production. GMO corn became widely used starting in 1996 and is shown as green squares.



It can take seventeen years to produce a new *Lolium perenne* (perennial ryegrass) grass variety through a careful selection process and cross breeding to produce superior half siblings and then cloning them to produce a desirable synthesized grass plant and then produce enough of that plant to see if it produces sufficient seed and retains the desired qualities to make it worthwhile to multiply it and produce enough seed to list it as a new variety. This leads to much slower progress in increasing grass forage yields and resistance to disease and insects and tolerance to soil and climatic conditions unfavorable to the current varieties. Mr. Schmidlen quoted Dr. Dan Undersander from the University of Wisconsin, "Greater differences exist among grass varieties than among corn hybrids and soybean varieties." This quote is captured in the chart below. Perennial ryegrass difference in yield from the bottom yielding variety to the top yielding variety is six tons per acre. There is approximately a four tons per acre difference between the bottom variety and the top variety for orchardgrass, smooth bromegrass, and timothy. Festolium, a hybrid from tall or meadow fescue and perennial or Italian ryegrass, has a lesser yield difference between top and bottom yielding varieties, but is still over two

tons per acre. Yield difference between top and bottom varieties is due in large part to winterkill of some varieties in Wisconsin resulting in zero yield for them.





The above chart shows only a few varieties (cultivars) that have been developed over the years since 1928, but it is useful in stressing that old varieties never die nor fade away very quickly. K-31 or Kentucky 31 tall fescue was released in 1931. It virtually covers nearly all of the tall fescue dominated pastures in the eastern humid US even though it has an endophyte fungus in it that produces a toxic alkaloid harmful to herbivores. It was selected for its vigor (conferred by the endophyte fungus) and livestock producers have lived with the problem ever since, as endophyte infected tall fescue prospers

in the Mid-South from Missouri and Arkansas to Virginia, Maryland, and North Carolina. Other cool season grasses are much less productive and persistent than it in that region. Fawn tall fescue released in 1964 was the first of the low endophyte varieties to emerge to solve the toxicity problem of tall fescue. This solution has been adopted little as totally eradicating K-31 has not been successful in any large way. It will return from the soil seed bank or from field edges not purged of K-31 and eventually will out-compete the other tall fescues. Linn perennial ryegrass, Potomac orchardgrass, Climax timothy, and Gulf annual ryegrass are still sold and grown commercially and in university forage plot trials. Of the new Barenbrug blends shown, Green Spirit is an Italian ryegrass blend of tetraploid and diploid Italian ryegrasses. Milkway or Milky Way is a mixture of 60% soft-leaved tall fescue and 40% meadow fescue from Barenbrug. E2-640 is a mixture of premium soft-leaved tall fescue for increased digestibility and hybrid alfalfa. E2-631is a mixture of premium tall fescue, orchardgrass, and hybrid alfalfa. It has latest heading orchardgrass variety for an ideal companion to alfalfa. STF-43 is a soft-leaf tall fescue blend. Varieties in it are late-maturing with yields equal to or greater than alfalfa. They have high amounts of digestible fiber and are highly palatable and persistent.

The purple arrow at the right corner of the chart is total-tract neutral detergent fiber digestibility (TTNDFD). The in vitro total-tract NDF digestibility (TTNDFD) test predicts NDF digestion for alfalfa, corn silage, grass forages and byproduct feeds. The digestibility of NDF profoundly affects feed intake and milk production in dairy cattle. This is a significant breakthrough in estimating forage digestibility in ruminants.

Relative Forage Quality of Grasses

Common Name	Variety	Heading Date	PROTEIN (%)	NDF (%)	NDFd (%)	IVTD (%)
Perennial Ryegrass	BAR 1M	16-May	16.9	55.5	83.5	90.9
Perennial Ryegrass	Remington	25-May	14.0	57.0	81.0	89.2
Meadow Fescue	Pradel	16-May	16.8	55.5	83.7	90.9
Meadow Fescue	Barvital	14-May	17.7	51.9	89.0	94.3
Tall Fescue	Retu	21-May	15.5	57.2	75.4	85.9
Tall Fescue	Barcel	18-May	16.8	54.7	79.3	88.7
Orchard grass	Potomac	14-May	16.7	64.2	75.4	84.2
Orchard grass	Baridana	14-May	17.6	62.6	79.7	87.3
Timothy	Barpenta	17-Jun	8.1	67.7	66.8	77.5
Timothy	Climax	27-May	12.9	63.2	74.6	83.9

Grass Trial in Ithaca, NY, Forage quality predictions by NIRS;
NDF: neutral detergent fiber
NDFd: NDF digestibility (48 hour digestion)

The above chart compares older varieties of grasses with newer Barenbrug varieties. Especially note the higher NDF digestibility of these newer forage varieties over the older ones for tall fescue and orchardgrass. Then, compare meadow fescue with tall fescue and perennial ryegrass. Note meadow

fescue has a much higher NDF digestibility than the tall fescue varieties. Meadow fescue is slightly better in NDF digestibility than perennial ryegrass often considered the grass with the highest digestibility. Meadow fescue is adapted to colder climates whereas perennial ryegrass is not yet.

Breeding improved forage grasses requires basic selection criteria:

- Yield Superiority
- Disease Resistance
- Winter Hardiness
- Stand Persistency
- Heat and Drought Tolerance

If they are to be used for hay/silage, then these criteria are important:

- Late Maturing Selections that offer wider harvest windows
- High Forage Quality
- Plant Recover Response for selected cutting intervals
- Mechanical Traffic Tolerance

If they are used for pasture, then these criteria are used:

- Palatability
- Plant Recovery - frequent defoliation - intensive rotational grazing (species specific on length of duration and whether or not this duration can be varied appreciably)
- Yield - under intensive rotational grazing conditions
- Grazing species - some species are better adapted than others for intensive rotational grazing.

(Editor's note: Very few forage grass species hold up well under continuous grazing for an entire season. A few survive, but none thrive to live up to their yield potential. Replanting continuously grazed pastures to better performing varieties will largely be disappointing and a waste of time and money.)

Improved grass varieties can have remarkable resistance to disease (such as rust), persistence, and salt tolerance even if yield differences are slight over older varieties. However, potential yield of the older variety may never be realized if a disease can wipe it out or its persistence or salt tolerance is low and it disappears prematurely. This is especially critical in pastures where frequent renovation is undesirable as it interferes with having enough pasture to meet livestock demand/production goal that was counting on no lost acres during the year. It is less of a problem if it is a grass crop in rotation with other crops. Persistence past 3 or 4 years may actually be undesirable if it is hard to kill off before growing the next crop in the rotation.

On the next chart, some Cornell University forage trials are featured to show potential differences in yield and differences of maturity dates of first harvest among cool season grass species. These should not be construed to be absolutes as other trials, for instance, have shown little difference in yield between orchardgrass and tall fescue. Varietal selection is very critical and the number of varieties represented in such trials to arrive at an average yield for the grass species represented in those trials.

Relative Yield and Maturity of Grass Forages

	Yield tons/acre	Heading Date
Orchardgrass	5.98	May 17
Tall Fescue	**7.28**	May 18
Meadow fescue	6.07	May 26
Perennial Ryegrass	5.19	May 29
Timothy	6.24	May 30

Grass trials, Cornell University, sown in 2005

The heading dates as shown in the chart above are fairly representative for the five grass species. However, there have been many varieties produced that either have later heading dates (later maturing) for a species, such as orchardgrass, or earlier heading dates, for a species like timothy. Meadow fescue usually does yield less than tall fescue, but it is more digestible and palatable than tall fescue, so it may actually produce more milk per acre when fed to or grazed by dairy cows.

Mr. Schmidlen then concentrated on the most common cool season grasses used in the Northeast. He began with orchardgrass and the challenges it presents to growers. Challenges are:

- Early heading (compatibility issues with alfalfa in hay stands; heads out too fast in pastures in the Spring causing rejection and low utilization by livestock if not cut for stored forage.)
- Lower yielding (Editor's Note: depends on location; not too cold, not too hot or dry)
- Quality declines rapidly once it begins to head-out
- Winter survivability where snow cover is often absent during lowest temperatures
- Stands decline prematurely (in Mid-Atlantic and Mid-South)
- Susceptible to "diseases", such as brown stripe
- Susceptible to "rust"

Breeding improved orchardgrasses, such as Intensiv and Barlegro, for these attributes:

- High Yielding
- Late maturing

- Leafy (HLR - high leaf ratio)
- Selected for "disease and rust" resistance
- Winter hardy

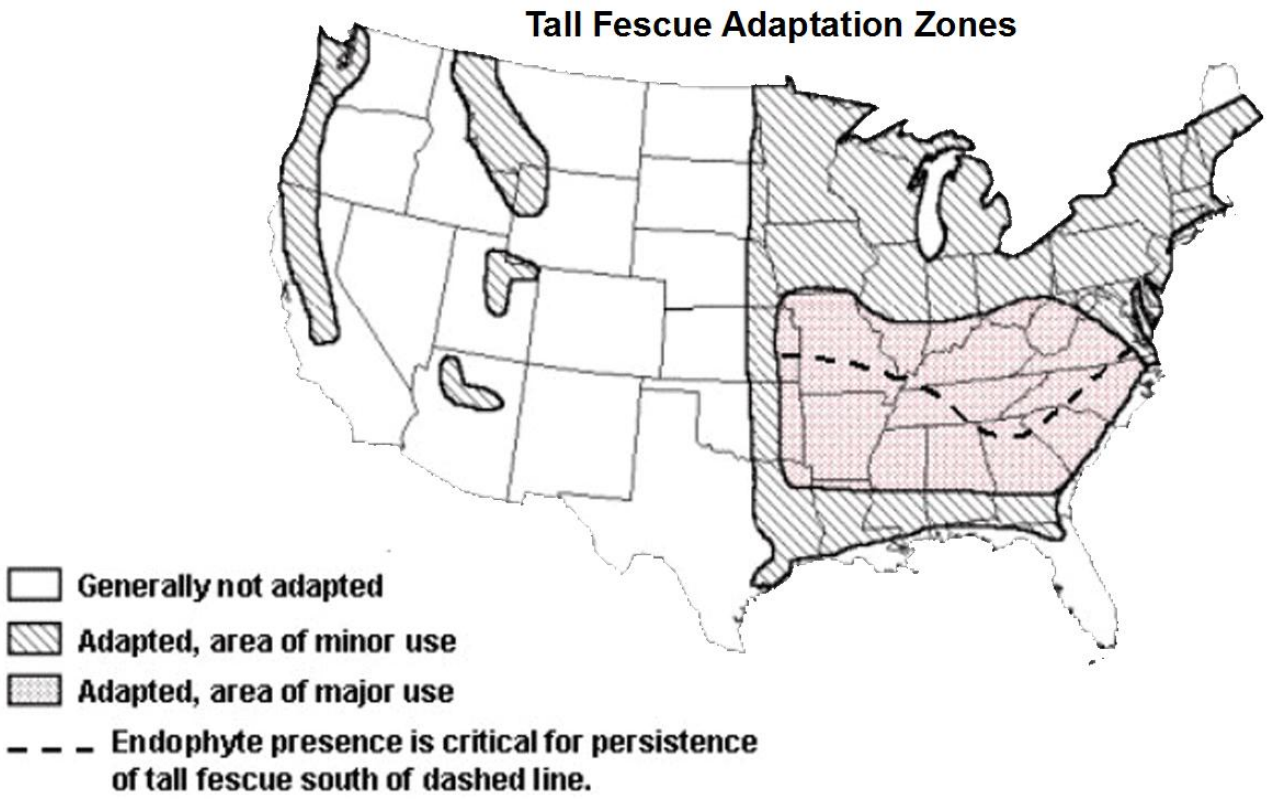
(Editor's note: With the work done by Gordon Jones, it is apparent that orchardgrass will need to be bred to better handle heat stress in the Mid-South. Naturalized orchardgrass holds up even under lawn cutting in NC. This may be due to partial shade. Selection of surviving orchardgrass plants in the Mid-South for a superior heat stress capability is needed, or overseas selections from hot climates. The University of Kentucky trials displayed by Joe had yields of 3 to 4 tons per acre average over 3 production years while Penn State Forage Trials, orchardgrass yields averaged 8 tons per acre in 2014 for second year hay stands and 8.5 tons per acre on first year hay stands for all cultivars in the trials.)

The Wisconsin 2012 orchardgrass data showed Barlegro doing well on the first full harvest year of 2012 in what was a droughty year for the Midwest. Last cutting was in August. However, Pennlate, a much older variety, was not far behind. By 2013, Pennlate actually was in a virtual tie with Barlegro over 3 harvest years, recovering somewhat better and producing a half ton more forage for the year where 5 cuttings were taken. Orchardgrass yields in Wisconsin are about 2-3 tons/acre behind Penn State's. Colder winters and hotter, drier summers make WI less than ideal compared to PA, generally wetter during the growing season and milder in the winter. Barlegro had lower NDF and higher NDF digestibility than other orchardgrass varieties in the 2010 Penn State orchardgrass trials displayed by Joe. Mr. Schmidlen also mentioned that discbines may also be affecting orchardgrass persistence and performance. Turfgrass heat stress is lessened with higher lawn mower settings in the Mid-South.

Tall fescue was the next grass to be covered. It is "The Grass People Love to Hate". It has these good attributes:

- High yielding
- Very Adaptable - suited both for light and heavy soils
- Deep rooted - good drought tolerance
- Performs reasonably well on damp soils, and
- No major disease issues.

However, its common varieties, such as Kentucky 31 (primarily), have an endophyte fungus that produces a toxin and its rough (and tough - high lignin content) leaves makes it less palatable than other fescues and grasses. Dairy cattle will avoid it in mixed grass stands. This is why Barenbrug has introduced soft-leaved tall fescues, such as found in STF-43 blend (Not Your Grandfather's Tall Fescue). Since it has tall fescue varieties in it bred for soft leaves, it is a more palatable tall fescue that allows higher intake by grazing livestock. These soft leaves have a lower lignin content which improves digestibility resulting in higher energy values. Its NDF digestibility is higher than older tall fescue varieties. STF-43 has no toxic endophyte, a very high stand density, and very good seedling vigor. These qualities make it good for interplanting into old alfalfa stands or seeding pastures. Bariane soft-leaved tall fescue was 73% removed in a grazing study while other older tall fescue varieties had 37% or less of their forage mass removed by grazing livestock. Dairy cattle will readily consume soft-leaved tall fescue.



Above is the adaptation zone map for tall fescue, the dashed line is the 60° F isotherm as delineated 80 years ago. This has undoubtedly shifted northward now. To the north of the major use area (cow-calf beef farms), this has been traditionally the dairy area of the US. Tall fescue was rarely used there for forage due to dairy cow rejection issues. Improved tall fescue varieties may change this with time.

Summer Syndrome / Fescue Toxicosis is biggest reason why it is "the grass people love to hate". The results are many to livestock:

- Failure to shed winter hair coat
- Increased respiration rate
- Intolerance to heat (head for water or shade, and camp there)
- Reduced feed intake
- Poor weight gains
- Reduced milk production, and
- Low conception rates.

The cost to farms with endophyte infected tall fesue runs $600 million - $1 billion annually.

Plants, such as tall fescue, meadow fescue, and ryegrass, and their endophytes have a mutualistic relationship. Here is how they benefit:

- Plant serves as host to the endophyte and feeds it.

- Plants with endophytes have greater resistance to drought stress.
- Plants have improved tolerance to insects, diseases, and nematodes.
- Endophytes improve plant persistence under stressful environments and close grazing.
- They improve plant tillering.

This is why tall fescue became so dominant in areas less conducive to cool season grass growth. Meadow fescue also has a endophyte fungus, but it is a beneficial one and not toxic to livestock. A ryegrass endophyte, *Neotyphodium lolii*, can cause ryegrass staggers in cattle, horses, and sheep as it produces a mycotoxin, Lolitrem. The toxin is named after the genus name for ryegrass and the condition it imparts in consuming livestock, trembling. Low endophyte ryegrasses usually are not a problem especially if they do not contain *Neotyphodium lolii*.

Bar Optima+34 is a tall fescue variety with a beneficial endophyte. It increased weight gain by 59% over K-31 tall fescue in a University of Arkansas 2-year trial. It also is as persistent as K-31.

The next grass covered was perennial ryegrass (PRG). Four cultivars from Barenbrug were mentioned:

- Remington - tetraploid - excellent winter hardiness
- Mara - diploid - Standard for winter hardy PRG
- Bargala - tetraploid - high yielding, and
- Barsprinter - excellent winter hardiness and rust resistance.

Remington AR1, NEA2, and NEA3 all showed good persistence over 2 years at Kentucky with a 97-98 percent stand and the highest yields of the other Barenbrug PRG varieties seeded in 2010 and yield tested from 2011 to 2012. Each Remington accession has a beneficial endophyte in it.

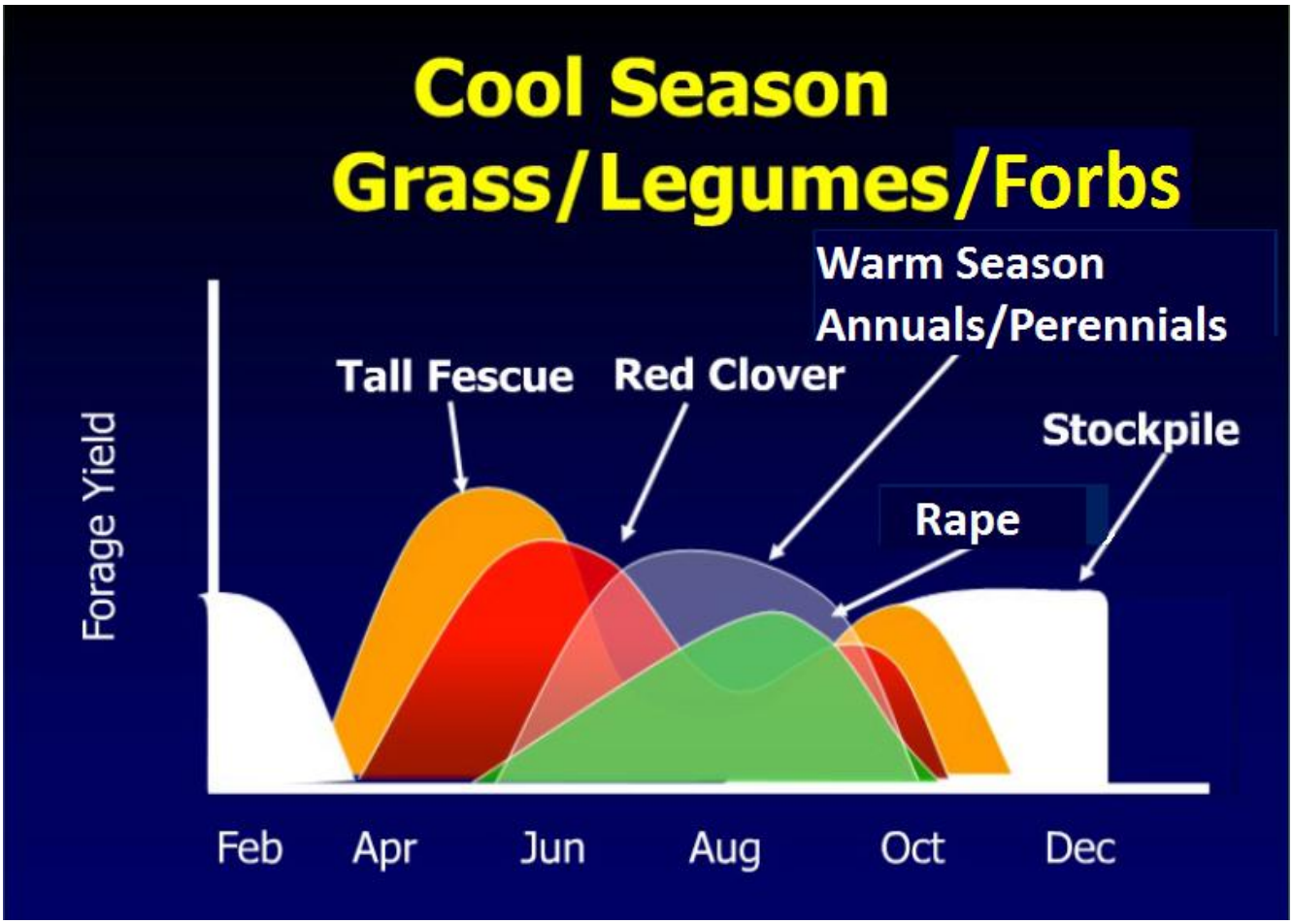
Barenbrug has also developed NutriFiber technology to maximize total-tract neutral detergent fiber digestibility in their grasses and blends. These blends have the NutriFiber technology in them:

- Green Spirit Italian ryegrass blend
- E2 – Hybrid Alfalfa + Soft-Leaf Fescues
- Milkway – Meadow & Soft-Leaf Fescues, and
- STF-43™ – Soft-Leaf Fescues

The last grass Mr. Scmidlen talked about was meadow fescue. It traits are:

- Morphologically closely related to tall fescue
- Digestibility is significantly better than tall fescue
- Tolerates both wet and dry soils
- Tolerates moderate grazing pressure
- Outperforms perennial ryegrass in drier weather, and
- Very cold tolerant.

HDR (high yielding, high digestibility, and disease resistant) meadow fescue is a blend of meadow fescues sold by Barenbrug. In NY trials, several varieties of meadow fescue averaged 5 tons/acre annually over a 3-year period. Heading dates tend to be in late May in NY ranging from 19-31 May.



The diagram above shows how to extend the grazing season with a combination of grasses, legumes, and forbs, such as rape or several other Brassicas. Rape is depicted by the green growth curve. This particular distribution of forage growth during the growing season for the various forages listed would be appropriate for the southern part of the Northeast Region. In the northern part of the Northeast the summer slump for tall fescue and red clover is much less pronounced except in unusually hot and dry summers, and their growth curves would be shorter beginning in late April - early May and ending in October with a killing frost. A later planted Brassica can actually be used in October through December. Tall fescue or meadow fescue can be stockpiled the best among the forages typically grown in the Northeast provided the forage is not needed for grazing before fall and early to mid-winter.

Mr. Schmidlen recommended adding red and white clover to pastures by frost seeding to maintain nitrogen fixation at 150 to 175 pounds per acre. This boosts grass yields and adds a very digestible forage to the pasture mix. Two red clovers by Barenbrug were Freedom and Barduro. Two white clovers they sell are Alice and Barblanca. Alice is a medium white clover and Barblanca is a Ladino type. They are more productive than the common white clover that often appears in pastures or lawns.

Barenbrug also offers Master Series Mixes such as Paddock, Beefmaster, Stockmaster, Browsemaster, and Dairymaster.

Mr. Tim Fritz of King's Agri-Seed wrapped up the session saying that it is important to have local evaluation of forage varieties in cooperation with land grant universities so the suitability of those varieties is tested before they are used on farms in a big way. Yield stability is important, especially in pastures. Complex mixtures allow for something in the mix to backfill a weaker forage for the conditions that are faced by random weather events, soil variability, and grazing pressure.