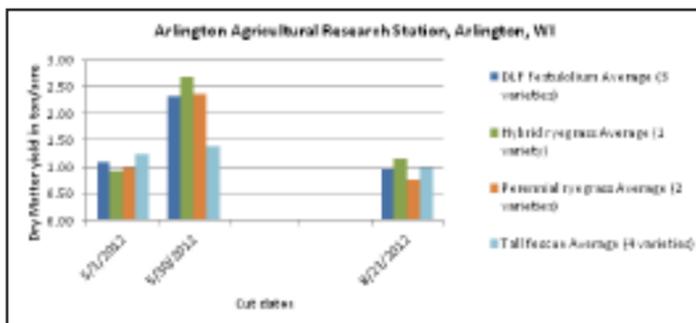


Graph 6 is the second year (2012) data from the Arlington trial. This year was the driest year on record since 1945 in Wisconsin and not indicative for the annual production of the various grasses. But even under these extreme circumstances, the festuloliums came through remarkably well.



Graph 6: Seasonal production (tons/acre) of DLF festulolium compared to tall fescue and perennial ryegrass in second production year.



Use of Festuloliums:

Because of their broad genetic diversity, festuloliums can be adapted to growing conditions as far south as the transition zone and as far north as Canada. They can be utilized in various forage production systems.

New Pasture Seedings:

Ryegrass-types can be used as a component in the mixture that establishes quickly, provides high forage quality, and persists multiple years. Ryegrass-types can also be used as a monoculture. On the other end of the spectrum, tall fescue-types can be a long lived component that provides high forage yield similar to tall fescue, but with a higher forage quality. Tall fescue-types improve summer performance.

Overseeding / Grasshancing®

Because of their establishment vigor, ryegrass-types can be used to strengthen thin pastures and hay fields. Ryegrass-types can be used to reinvigorate winter damaged alfalfa, improving both DM yield and fiber digestibility. The later maturity of the festuloliums allows cutting management beneficial to alfalfa.

Companion Planting with Alfalfa:

Ryegrass-types can be planted with alfalfa as a high quality nurse crop. Later maturing tall fescue-types can be planted with alfalfa to provide higher forage yields, increase total forage fiber digestibility, or to improve the persistence of the hay stand. The alfalfa-festulolium combination can produce >10% DM yield than alfalfa-timothy or alfalfa-meadow fescue combinations. (DLF trials in the UK)

Emergency Feed:

Festulolium can match the short term yield of annual grasses, provide longer growth into the summer, and then persist into the following crop years.

Combinations:

Festuloliums can be partnered effectively with many forage species including alfalfa, clovers, annual ryegrass, perennial ryegrass, orchardgrass, tall fescue, timothy, brome and others.

Seeding Rate:

- 25-35 lbs/acre pure stand
- 3-20 lbs/acre in a mixed stand

Festulolium

Hybrid Grass

Festulolium is the name for a hybrid forage grass developed by crossing meadow fescue (*Festuca pratense*) or tall fescue (*Festuca arundinacea*) with perennial ryegrass (*Lolium perenne*) or Italian ryegrass (*Lolium multiflorum*). This enables combining the best properties of the two types of grass. The resulting hybrids have been classified as:

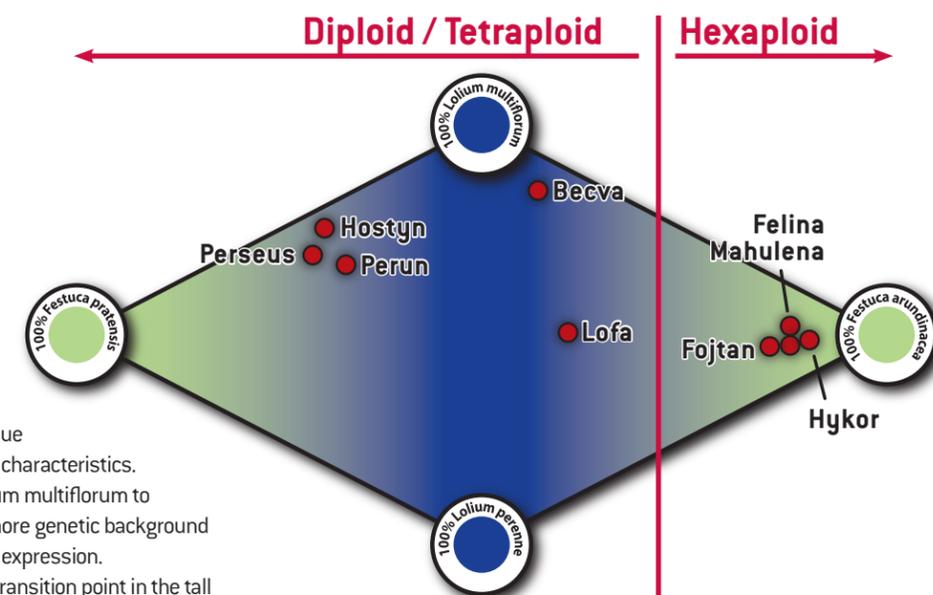
Maternal Parent	Paternal Parent	Hybrid Progeny
<i>Festuca arundinacea</i>	<i>Lolium multiflorum</i>	<i>Festulolium pabulare</i>
<i>Festuca arundinacea</i>	<i>Lolium perenne</i>	<i>Festulolium holmbergii</i>
<i>Festuca pratensis</i>	<i>Lolium multiflorum</i>	<i>Festulolium braunii</i>
<i>Festuca pratensis</i>	<i>Lolium perenne</i>	<i>Festulolium loliaceum</i>

The fescues contribute qualities such as high dry matter yield, resistance to cold, drought tolerance and persistence, while ryegrass is characterized by rapid establishment, good spring growth, good digestibility, sugar content and palatability. The individual festulolium varieties contain various combinations of these qualities, but all are substantially higher yielding than their parent lines. While festuloliums have been around for many years, the true potential had never been pursued in earnest. DLF has developed a substantial breeding program in hybrid festulolium that has produced a unique range of hybrid festulolium varieties. After initial hybridization and subsequent selection on the hybrid progeny or back crossing the hybrid

Festulolium Diamond®

Festulolium Diamond® Explained

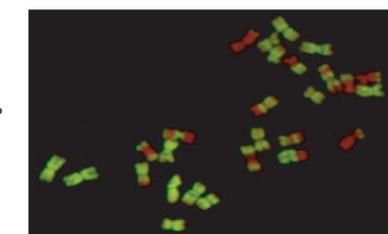
The Festulolium Diamond® shows the relationship between the genetic makeup and the morphological expression of the various festulolium varieties. More blue means more ryegrass genetics and thus more ryegrass characteristics. Within the blue section, there is transgression from *Lolium multiflorum* to *Lolium hybridum* to *Lolium perenne*. The less blue, the more genetic background from either fescue parent and associated morphological expression. Tall fescue is a hexaploid species and there is a distinct transition point in the tall fescue – ryegrass festuloliums when a variety will be diploid or tetraploid with a ryegrass seed head to hexaploid and express the tall fescue type seed head.



progeny to its parental lines, a wide range of varieties with varying characteristics and phenotypes has been created. They are classified according to their degree of phenotypical similarity to the original parents, not to their genotype heritage. One can regard them as high yielding fescues with improved forage quality or as high yielding, more persistent ryegrasses.

This genotype make-up of festuloliums can be made visual. The chromosomes of festulolium can be isolated and then colored to show the parental origin of chromosome sections. It provides a very visual effect of the hybridization between the two species.

Photo right: Chromosomes of a festulolium, colored to show the parental DNA in the hybrid. Green = Ryegrass DNA, Red = Fescue DNA



Via a newly developed marker analysis, Diversity Array Technology (DArT), the actual percentage of parental DNA can be determined and the characteristics of a newly made hybrid can be fairly well predicted. This makes the selection process after initial hybridization more efficient and much shorter.

Use of Festuloliums

Varieties: **Perun** (*Festulolium braunii*), **Perseus** (*Festulolium braunii*), **Hostyn** (*Festulolium braunii*), **Becva** (*Festulolium pabulare*), **Lofa** (*Festulolium pabulare*).

Morphologically, these varieties resemble Italian ryegrass but with a persistence of up to four years. This type is suitable for both cutting and grazing. The object of the DLF breeding program is to retain the Italian ryegrass yield and quality combined with resistance to rust and xanthomonas plus winterhardiness and persistency from the fescue.

In general, ryegrass-type festulolium can be characterized by:

- High seedling vigor, comparable to annual ryegrass
- Very early spring growth
- Very high yield
- Slightly lower energy concentration and sugar content than ryegrass
- Tendency for heading in regrowth
- Upright growth
- Better persistency than their ryegrass parent lines
- Susceptible to winter kill in absence of snow cover

Tall Fescue-Type

Varieties: **Fojtan** (*Festulolium pabulare*), **Hykor** (*Festulolium pabulare*), **Mahulena** (*Festulolium pabulare*), **Felina** (*Festulolium pabulare*).

Morphologically and in terms of cultivation, these types resemble tall fescue. They combine tolerance to frost, drought and heat and persistency of tall fescue with the better feed quality and rapid establishment of ryegrass. The result is a high quality “tall fescue” with excellent persistency. Trials at the DLF research station in the Czech Republic are ongoing already for 15 years without any loss of stand or productivity.

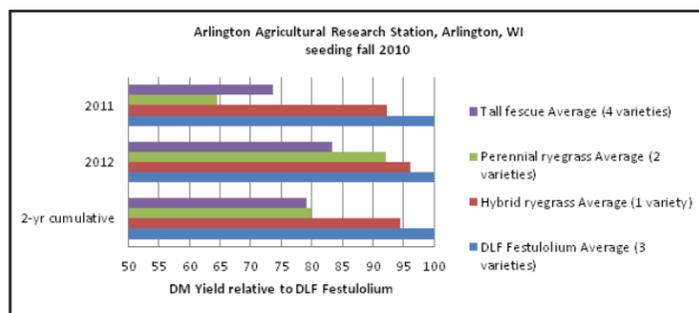
Tall fescue-type festuloliums can be characterized by:

- High seedling vigor compared to tall fescue
- Earlier spring growth than tall fescue
- High yield
- High quality, close to that of ryegrass
- Tendency for heading only in 1st cut
- Very persistent
- Upright growth
- Tolerates drought and periodical flooding
- Good winter hardiness



Forage Yield

DLF festuloliums have a much higher yield than perennial ryegrass or fescues and start producing earlier in the season. Even in an annual ryegrass trial in Ohio, DLF festulolium variety Perun was the top yielding variety (Ohio State University, South Charleston, 2006). In a University of Wisconsin trial (Arlington 2011,2012), the DLF ryegrass-type festuloliums (Perun, Lofa, Perseus) outyielded all other grasses in the trial. (Graph 1 below).



Graph 1: Forage Yield Comparison

The dry matter yield increase compared to perennial ryegrass and tall fescue is as high as 25% for the two trial years combined. There can be a tradeoff with forage quality compared to perennial ryegrass, but the total Milk per Acre Index is very much in favor of festulolium. (Graph 3)

Forage Quality

Table 1 below gives the RFQ and RFV values for samples taken from the last cutting in fall 2012 of a Eucarpia trial planted in spring 2012 at the DLF Hladke Zivotice Research Station in Czech Republic. The NIR analysis of the samples was conducted at FFR Cooperative, Lafayette, IN.

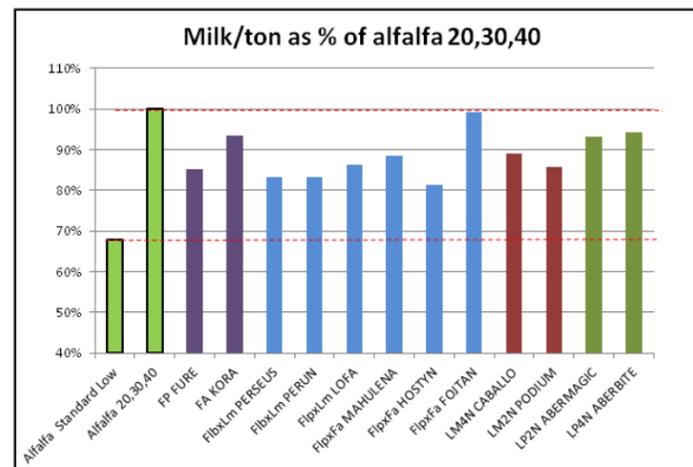
Festulolium overall is slightly lower in RFQ and RFV than ryegrass, but there is an interesting exception with the tall fescue-type festulolium Fojtan. Tall Fescue Kora is a high quality type and not indicative for tall fescue in general. Quality trials in 2013 will refine these findings.

Species	Variety	RFQ	RFV
Fp	FURE	125	116
Fa	KORA	140	127
Flb x Lm	PERSEUS	123	114
Flb x Lm	PERUN	124	114
Flb x Lm	HOSTYN	121	112
Flp x Lh	LOFA	128	119
Flp x Fa	MAHULENA	131	124
Flp x Fa	FOJTAN	152	133
Lm 4n	CABALLO	133	124
Lm 2n	PODIUM	128	119
Lp 2n	HIGH SUGAR TYPE	139	126
Lp 4n	HIGH SUGAR TYPE	142	130

Table 1: Forage Quality Data of Various Varieties.

Milk per Ton

From the NIR analysis data and the University of Wisconsin Alfalfa/Grass Evaluation System - Milk 2006, the Milk per Ton can be derived and compared to the standard high quality alfalfa, “Alfalfa 20,30,40”. Graph 2 below shows the Milk per Ton for each variety expressed as a percentage of the high quality alfalfa (Alfalfa 20,30,40 = 100%).

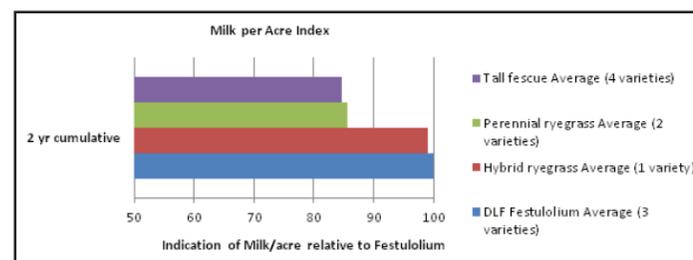


Graph 2: Milk per Ton Analysis

All grasses are above the 80% level and above the “Standard Low” alfalfa. As expected, high-sugar perennial ryegrass rates amongst the highest for the grasses and festuloliums score in between the meadow fescue (Fp Fure) and the ryegrasses. Festulolium Fojtan is a remarkable exception, almost equal (99%) to high quality alfalfa! Tall fescue Kora is a high quality type and not indicative for tall fescue in general

Milk per Acre

Graph 3 below is derived from the yield data from the WI trial referred to above and the NIR quality data from samples referred to above. The festulolium varieties in this trial are the same as in the WI trial. The tall fescues and ryegrasses in this trial are not the same as in the WI trial and their NIR quality data was used to estimate the quality of the same species in the WI trial. The graph below can thus only be seen as a broad indication. Quality data collection from existing trials at DLF US Research Stations and at Universities will be done during the 2013 growing season.



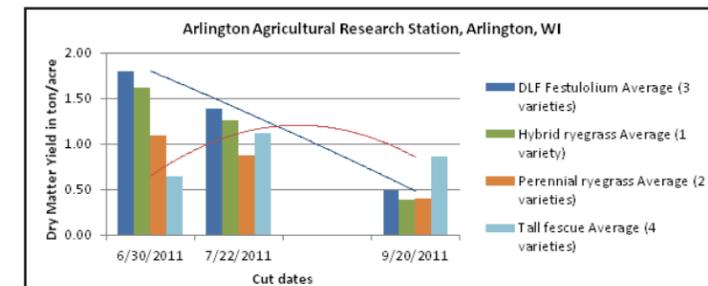
Graph 3: Milk per Acre Analysis



Festulolium offers the highest milk per acre of forage species trialed.

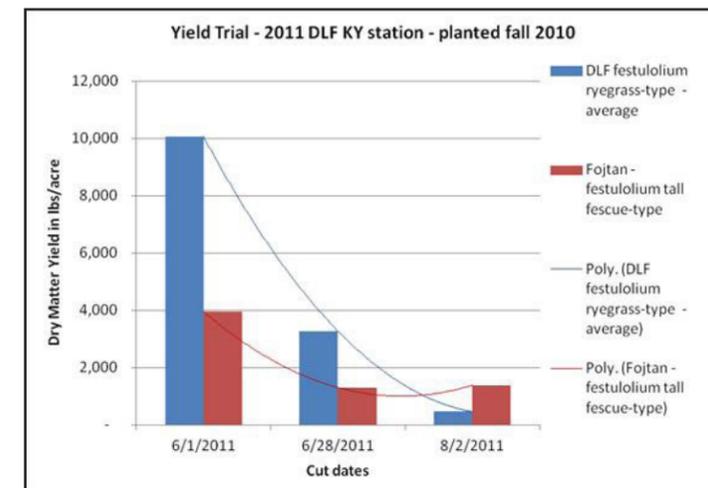
Growth Patterns

Ryegrass-type festuloliums have a very early and high spring production, whereas tall fescue will come on much stronger later in the season. Ryegrass’ spring growth starts slower than ryegrass-type festuloliums but follows to some degree the same growth pattern.



Graph 4: Seasonal production (tons/acre) of DLF festulolium compared to tall fescue in first production year.

DLF tall fescue-type festuloliums have a slower spring start and will produce more during summer and fall. Graph 5 shows yield data from the first production year, comparing a ryegrass-type with a tall fescue-type. In subsequent years, the tall fescue-types will outperform the ryegrass-types in summer and fall production and will be more persistent.



Graph 5: Seasonal production of DLF festulolium ryegrass-type compared to Fojtan, a DLF festulolium tall fescue-type, in first production year at DLF KY research station.