INTENSIVE GRASS MANAGEMENT FOR DAIRY COWS

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INTENSIVE GRASS MANAGEMENT FOR LACTATING COWS

Properly managed perennial grass can produce high quality grass for lactating dairy cows, as well as improve the manure/nutrient management situation on most dairy farms. We currently have perennial grass experiments at Willsboro, Valatie, Canton, Chazy, Mt. Pleasant, Ithaca, and Aurora, NY. Grass species, varieties, cutting managements, manure management, and commercial fertilizer treatments are among the factors being evaluated relating to grass production for lactating dairy cows. Timothy and orchardgrass varieties also have been sown on 8 farms across NYS in the fall of 1996 to evaluate heading date (and possibly quality) of over 30 varieties. Grass samples also were taken from three feeding trials have been completed comparing low fiber grass, high fiber grass and alfalfa. This is a summary of our results to-date, mostly referring to grass that will be harvested and stored, as opposed to grazed grass. A more extensive summary, including economic analysis of alternative managements, is currently in progress.

Species/Variety Selection

For New York state, a world wide web program will be available shortly to provide site-specific forage species recommendations based on soil type and intended forage use (http://www.forage.org). The two primary factors to consider when selecting perennial forages species and varieties are 1) persistence, and 2) heading date. Of course, anti-quality factors must be taken into account. Choose only low-alkaloid reed canarygrass varieties (*Palaton, Venture, Rival*), and low-endophyte tall fescue varieties (many available).

Persistence. Grass species vary in their tolerance of pH and moisture extremes. Species ranking in adaptation to poorly drained soil conditions is:
Reed canarygrass > Timothy > Tall fescue > Smooth bromegrass > Perennial ryegrass > Orchardgrass.

Species ranking in adaptation to excessively drained soil conditions is:
Reed canarygrass > Tall fescue > Orchardgrass > Smooth bromegrass > Timothy > Perennial ryegrass.

Species ranking in ability to tolerate low soil pH is:
Tall fescue > Reed canarygrass > Timothy > Orchardgrass > Perennial ryegrass > Smooth bromegrass.

The general order of grass species to consider for intensive management where overwintering of grass is of concern is:
Reed canarygrass > Timothy > Tall fescue > Smooth bromegrass > Orchardgrass > Perennial ryegrass.

2) Heading date. Maturity is the single most important factor controlling forage quality in grasses (assuming no anti-quality components). Several varieties and/or species should be considered to spread out the spring heading date and the spring harvest window. In the past the general order of grass species heading date from earliest to latest has been:

Orchardgrass > Perennial ryegrass > Reed canarygrass = Smooth bromegrass = Tall fescue > Timothy.

New releases of orchardgrass are generally all later maturing, while new releases of timothy tend to be earlier maturing, to better match up with alfalfa. As a result, some new timothy varieties have headed as early as the latest new orchardgrass varieties. We determine heading date as the date that six heads were visible emerging from the boot. In 1997, grass varieties at eight sites across New York state headed relatively late in the spring, and varied considerably across sites and varieties as follows:

Orchardgrass (17 varieties), May 25 to June 11.
Timothy (16 varieties), June 9 to June 29.
Reed canarygrass (1 variety), June 1 to June 15.
Smooth bromegrass (1 variety), May 31 to June 11.
Perennial ryegrass (1 variety), June 1 to June 13.
Tall fescue (2 varieties), June 1 to June 14.

Species mixtures. Rarely is it advantageous to consider two perennial grass species in mixture. Sites with great soil variability may be candidates for grass mixtures, but heading dates of varieties in a mixture should be matched up as closely as possible. Otherwise, quality will be optimal in one part of the mix, but not the other(s). Relatively few soil types in Eastern Canada or the Northeastern U.S.A. are perfectly adapted to seeding pure alfalfa. Also, widespread mid-winter thaws in the region usually result in significant ice sheeting, placing pure alfalfa stands at great risk. Where alfalfa can be grown, alfalfa-grass mixtures generally are recommended. Reed canarygrass or timothy in mixture with alfalfa will result in a relatively small grass component in the mixture. Orchardgrass or tall fescue mixed with alfalfa, on the other hand, will result in considerably more grass in the mixture. Smooth bromegrass has large, fluffy seed that can be difficult to sow in mixture with other species. Smooth bromegrass also will likely not persist in a mixture with alfalfa, if intensive harvest management is practiced. Harvest of smooth bromegrass in the spring during stem elongation, prior to flowering, greatly stresses plants. Perennial ryegrass is very competitive with alfalfa, and varieties have not yet been identified that will consistently overwinter in our region.

Forage Yield

All perennial grasses will produce reasonable yields if present in good stands and fertilized adequately. On good alfalfa soils, alfalfa will typically yield about 0.5 tons/acre more dry matter than grass with recommended N fertilization. However, if the soil resource is not well adapted to growing alfalfa, grass will outyield alfalfa. Grass yields will range from less than 1 and 2 tons/acre without any N fertilization, with the variation related to native soil fertility. Table 1 contains hay yields for 5 grass species, sown in 1993, managed under commercial N fertilization at recommended rates (Willsboro, Essex county, NY). Varieties were selected to have similar heading dates across species. Tall fescue consistently outyielded other species. Yields were considerably reduced in a dry growing season (1995). Timothy produced unexpectedly high yields, but was more affected than other species by dry conditions (1995). Application up to 30 tons/acre of semi-solid manure (data not shown) resulted in yields about 1/3 lower than

recommended commercial N fertilizer in 1994-1996, with equal yields for commercial N applications vs. manure applications for orchardgrass and tall fescue in 1997. The site did not have a history of manure application prior to 1993.

Table 1. Yield (tons/acre @ 12% moisture) of grass species under commercial N fertilization, at 75 lbs actual N/acre in the early spring, and 50 lbs actual N/acre prior to each regrowth. Four harvests were taken in 1994, and three harvests in 1995-97.

Species	1994	1995	1996	1997
Timothy (Tiller)	5.3	2.4	4.4	3.6
Orchardgrass (OKAY)	5.1	2.8	3.9	3.9
Reed canarygrass (Palaton)	5.5	2.9	4.4	3.7
Smooth bromegrass (York)	5.3	2.8	4.4	4.0
Tall fescue (Stargrazer)	7.0	3.3	5.1	5.1

Timothy and orchardgrass varieties (six of each) were established at two sites differing in soil drainage in 1993 at Canton, St. Lawrence county, NY. Grass was fertilized with commercial N according to recommendations and harvested 4 times in 1994 and 3 times in 1995-97. Grass yields (Table 2) shows that timothy maintained its yield on the more poorly-drained sited, while orchardgrass yield was reduced. Across years, *Richmond* and *Tiller* timothy outyielded other timothy varieties, while orchardgrass varieties were more variable, with *OKAY* tending to be consistently lower yielding than other orchardgrass varieties. Yields vary by soil type and season. A two-fold difference in yields from a given field can be expected in wet vs. dry years. Grass yields over the past 4 years at recommended N fertilizer rates have ranged from 3 to over 7 tons hay (12% moisture) per acre across northern NY.

Table 2. Yield (tons/acre @ 12% moisture) of timothy and orchardgrass varieties under commercial N fertilization, at 75 lbs actual N/acre in the early spring, and 50 lbs actual N/acre prior to each regrowth. Four harvests were taken in 1994, and three harvests in 1995-97. Grasses were sown in 1993 on a better-drained site (up slope) and a less well-drained site (down slope).

Species	1994	1995	1996	1997	
Timothy					
	Up slope site	4.6	4.2	5.0	4.1
	Down slope site	3.9	4.2	4.9	3.8
Orchardgrass					
	Up slope site	5.0	4.2	5.2	3.8
	Down slope site	4.3	4.0	4.3	3.0

Timothy varieties: Chazy, Climax, Mariposa, Mohawk, Richmond and Tiller.
Orchardgrass varieties: Benchmark, Dawn, Haymate, OKAY, Pennlate and Axiom.

Forage Quality

Neither grass species nor varieties vary much in total fiber (NDF) when compared at similar maturity stages. Strive to harvest grass between 50 and 60% NDF, which means 3-4 harvests per year. Optimum forage quality (55% NDF) occurs in very early to early boot stage, and is likely to occur the last week of May (earlier for early to medium maturity orchardgrass). This compares to 40% NDF in alfalfa (ideal) which may occur from late May to June 10 or so. As soon as there is sufficient regrowth to justify a harvest, the NDF content will likely be between 50 and 60%. With recommended applications of nitrogen, crude protein (CP) content should range between 16 and 20%. Recommended N applications will rarely result in nitrate accumulations dangerous to livestock. Nitrogen applications exceeding recommended levels will greatly increase the risk of unacceptable nitrate levels in forage. Timothy tends to be 1-2 percentage units lower in CP than other perennial grass species, when compared at similar maturity stages. While tall fescue has very good yield potential, the palatability of new varieties for high producing dairy cows has yet to be evaluated sufficiently.

Fertilization and Harvest Management

Grass management begins as soon as the grass begins growth, with application of 75 lbs of actual N/acre or an equivalent amount of manure, if possible (depends on form of the manure). Nitrogen fertilizer or manure should be applied as soon after subsequent harvests as possible (50 lbs actual N/acre or equivalent). Manure should be applied such that no manure ends up in the harvested forage. High forage potassium content is not a problem for lactating dairy cows, as it is for dry cows. Regrowth should be harvested as soon as there is sufficient regrowth to justify a harvest. This may occur 25 to 35 days after spring harvest, depending on available moisture. An early first harvest may result in an equal amount of dry matter yield in the second harvest as was obtained in the first harvest. Depending on temperature and moisture conditions, three to four harvests are possible in northern NY. After each harvest (except the last harvest of the season) 50 lbs of actual N/acre should be applied. There will be little carryover of N from the previous application to permit regrowth (that is, N applied after lst cut will benefit 2nd cut regrowth, but will not benefit 3rd cut regrowth).

Feeding Grass

Grass forage can be used in balanced rations to yield similar milk production to high quality alfalfa. Several feeding trials in Ohio and New York state have supported this. A New York study involved feeding alfalfa and orchardgrass hay at two maturities to mid-lactation dairy cows (Table 3). Milk yield was actually higher with the mature orchardgrass ration compared to the alfalfa ration, due to higher dry matter intake and higher concentrate intake. Rations were balanced for fiber, protein and energy, such that similar milk yield was expected from all rations.

Another feeding trial involved 60 Holstein cows in mid-lactation fed diets containing alfalfa-corn silage, immature orchardgrass-corn silage, or mature orchardgrass-corn silage as the forage source. All forages had been ensiled. Approximately 20% of forage dry matter fed was corn silage. Forages comprised 53, 47 and 44% of the total diet dry matter for alfalfa, immature and mature orchardgrass, respectively, with resulting milk production of 35, 39, and 33 kg milk/day. A third feeding trial involved 50 early-lactation Holstein cows fed immature or mature orchardgrass silage in balanced rations. The immature orchardgrass silage ration produced 35 kg milk/day compared to 31 kg milk/day for the mature orchardgrass silage ration. Quality of orchardgrass silage affected DM intake, which subsequently affected milk production.

Table 3. Milk yield of balanced rations utilizing alfalfa, immature orchardgrass and mature orchardgrass hay fed to mid-lactation dairy cows.

	Alfalfa	Orchardgrass (immature)	Orchardgrass (mature)
NDF, % of DM	43	54	67
CP, % of DM	21	16	10
Lignin, % of DM	8	5	6
% of diet consisting of forage	57	46	37
Milk, kg/day	29	30	32

Economics of grass. When production costs of alfalfa are compared to intensively managed early cut grass at 55% NDF (including proper manure management and fertilizer credits for manure), dollar return per acre was found to be similar for grass and high quality alfalfa, on good alfalfa land. Grass permits a higher level of forage NDF to achieve a similar milk production level, compared to alfalfa. Grass also is a slightly higher quality source of protein than alfalfa protein, resulting in less total protein required in the diet with grass compared to alfalfa. That is, alfalfa at 20% CP has the protein equivalent of grass at 19% CP.

Summary

If perennial grass is managed for production of high quality forage, milk production similar to that found using alfalfa forage can be achieved. Good grass haylage however, tends to be more difficult to make than good alfalfa haylage. High quality grass, in general, requires a higher level of management than does alfalfa. Intensive, aggressive perennial grass management and feeding is essential for economic survival on diary farms with soils not suited to alfalfa production.

INTENSIVE GRASS MANAGEMENT FOR DRY COWS

In Canada and the USA, potassium (K) concentration in perennial grass forages is considerably more important than nitrogen (N) or crude protein (CP) content, when used as dry cow forage. Many dairy farms are in a state of potassium surplus, and use perennial grass both as a manure sink and as dry cow forage. This results in potentially severe problems in properly managing potassium content of dry cow rations. A tactical solution to this problem is to manage 10 to 15% of your forage production specifically for dry cow forage. We have ongoing perennial grass experiments at several sites in New York state investigating proper grass species and variety selection, cutting management, as well as N and manure management necessary to produce an adequate supply of low K grass for dry cows. This is a summary of our results to-date, and concerns grass that will be mechanically harvested and stored, as opposed to grazed grass. A more extensive summary of grass for dry cows is currently in progress.

Species/Variety Selection

For New York state, a world wide web program will be available shortly to provide site-specific forage species recommendations based on soil type and a range of intended forage uses, including forage for dry dairy cows (http://www.forages.org). The two primary factors to consider when selecting perennial forages species and varieties for dry cow forage are 1) persistence and 2) K content.

Persistence. This involves the same set of considerations as those for lactating cow grass forage. Grass species vary in their tolerance of pH and moisture extremes.
Species ranking in adaptation to poorly drained soil conditions is:
Reed canarygrass > Timothy > Tall fescue > Smooth bromegrass > Perennial ryegrass > Orchardgrass.

Species ranking in adaptation to excessively drained soil conditions is:
Reed canarygrass > Tall fescue > Orchardgrass > Smooth bromegrass > Timothy > Perennial ryegrass.

Species ranking in ability to tolerate low soil pH is:
Tall fescue > Reed canarygrass > Timothy > Orchardgrass > Perennial ryegrass > Smooth bromegrass.

The general order of grass species to consider for intensive management where overwintering of grass is of concern is:
Reed canarygrass > Timothy > Tall fescue > Smooth bromegrass > Orchardgrass > Perennial ryegrass.

Potassium content. Potassium content of perennial grasses has been reported from as low as 0.1% K up to as high as 7.0% K. Warm season grasses tend to be lower in K content than cool season grasses. Although species rankings are not completely consistent, orchardgrass tends to be significantly higher in K content at a given maturity stage than other grass species. Both orchardgrass (Table 1) and perennial ryegrass tend to be mineral accumulators, with high levels of K and other minerals, if there is an adequate soil supply of these minerals. Timothy on the other hand, tends to have less luxury consumption of minerals, when surplus minerals are available in the soil. Therefore, with moderate to high available soil K, orchardgrass may

accumulate up to 1 percentage unit or more K than timothy. Under conditions of stress (e.g. drought) or low available soil K, the difference in K content of forage across species will be minimized.

Table 1. Potassium concentration in Timothy and Orchardgrass at four harvest dates at Canton, St. Lawrence County, NY, in 1994

	Timothy		Orchardgrass	
	Harvest date	K, %	Harvest date	K, %
	June 3	3.5	May 31	4.6
	July 12	2.8	July 8	3.6
	Aug. 29	2.4	Aug. 23	3.0
	Oct. 27	2.4	Oct. 27	3.0

Averages of six varieties and four replicates.
Timothy varieties: Chazy, Climax, Mariposa, Mohawk, Richmond and Tiller.
Orchardgrass varieties: Benchmark, Dawn, Haymate, OKAY, Pennlate and Axiom.

There may be some differences in K content among varieties within a grass species, but significant differences among varieties have yet to be characterized. Breeding for low K content has rarely been attempted in grasses. Selection may be very difficult, because there is a significant effect of environment on K uptake in grasses, compared to uptake of other minerals, such as magnesium (Mg) and calcium (Ca). Breeding for high magnesium in tall fescue, however, has been attempted. High Mg may alleviate some of the problems caused by high forage K. We are currently evaluating a high Mg tall fescue variety at Miner Institute in Chazy, NY.

Site Selection

Most soils contain large quantities of K, but very little of it is available to plants. Physical, chemical and biological processes in the soil result in release of mineral K over time. Most soil K is found in fine-grained clays, and clay content is a good indicator of the potential K-supplying power of a soil. There is a wide range in K-supplying power of soils in most regions. Organic soils, as well as sandy soils, are typically low in available K.

Soils with relatively high K-supplying power may never need any K fertilizer applied to maintain sufficient K available for grass growth and persistence. On the other hand, soils with low K-supplying power will require additional K fertilizer to avoid K deficiency in grass and reduce the risk of winter damage caused by low plant K. The amount of K released by the soil each year and made available for plant uptake varies with climatic conditions. Soil testing will identify fields with lowest soil K. These fields are prime candidates for dry cow grass management.

Stage of Maturity and Time of Season

Grass forage declines in K content with increased plant age. Plant uptake of K is very high early in the season, but later on K uptake cannot keep up with plant dry matter accumulation and is diluted out. Potassium content of orchardgrass has exceeded 4.5% in late May in our studies. Grass harvested at flowering may have half the K concentration as grass earlier in the season. Concentration of K in grasses also tends to be significantly lower in regrowth, and also lower

towards the end of the growing season. As a result, the grass forage with the highest K content is usually in the spring harvest.

N and K Fertilization

Most perennial grasses harvested twice per season should maintain high yields with approximately 1.5% K in spring growth forage (harvested at flowering or later) and 1.2% K in regrowth forage (harvested in the fall). Visible K deficiency symptoms in grass will not appear until forage K content drops to around 0.8% K. Deficiency symptoms are difficult to identify and attribute to K, because symptoms are similar to those due to drought or normal senescence. Deficiency of K is seen as a yellowing and browning of dying leaf tips and margins.

Nitrogen fertilization greatly increases uptake of K, if there is sufficient K available for uptake. We have almost doubled the K content of grass through high N fertilization rates, compared to no fertilizer N applied. Recommended N applications are 75-100 lbs actual N/acre at spring greenup and 75-100 lbs actual N/acre after spring harvest. Once excessive available soil K is removed however, the opposite trend in forage K content emerges. High N fertilization produces high yields, but very low soil K availability results in very low forage K concentrations. It may take one season of moderate to high N fertilization to remove excess soil K. The forage produced the first season will likely be high in K content, but may be very low in K content in all succeeding years. After two years, soil test K dropped from "Medium" to "Very Low" (32 lb K/acre) in high N/no K stands on a soil type with average K-supplying power.

It will be difficult to impossible to produce low K grass forage on stands receiving significant manure applications. All forms of K fertilization must cease if low K grass forage is desired, until spring growth harvested near flowering drops to under approximately 1.7% K. It then may be time to consider some K fertilization, to maintain sufficient plant K for overwintering. The amount of K applied will depend on the K content of the spring harvested forage and the native K supplying power of the soil. From 50 to 100 pounds of potash fertilizer equivalent may be needed. This could come from a manure application after spring harvest. Never apply K prior to spring growth, as there should be adequate soil K released during the winter and early spring for spring grass growth. Monitoring of forage K levels will allow the production of low K forage without risking damage to the stand.

Forage Yield and Harvest Management

Recommended N fertilizer applications of 75-100 lbs/acre for each of two harvests will produce total yields similar to a four harvest regime. Reed canarygrass yields for three years in Ithaca, NY are shown in Table 2. Stands (established in 1992) were fertilized to soil test recommendations for K in 1994, with no K applied in subsequent years. Stands receiving 200 lbs actual N/acre/season had reduced yields in 1997, due to very low soil K. Forage K levels for the high N treatment were under 1% K. We have produced hay equivalent yields up to 6 tons/acre with a two-harvest system on very productive soil types, with very low K content in the forage. Forage produced in the first year in a dry cow grass management system will likely contain high K forage. Forage produced in the second year will likely be low K forage.

Table 2. Yield (tons/acre @ 12% moisture) of *Palaton* reed canarygrass harvested in mid-June and in mid-September.

Nitrogen fertilizer applied per harvest	1995	1996	1997	
	0	1.6	1.5	1.9
	50	3.1	3.1	3.5
	100	4.2	4.7	4.0

0, 50 or 100 lbs actual N fertilizer/acre applied prior to each harvest.
Stands receiving 100 lbs N/acre in 1997 showed K deficiency symptoms.

Forage Quality

Forage quality of grass in a two harvest system will not be of sufficient quality for lactating cows, but is sufficient for dry cows. The fiber content of grass harvested in mid to late June in northern New York state will be 65-70% NDF. Fiber content of regrowth grass harvested in mid to late September will be in the 50-60% NDF range. If 75-100 lbs actual N/acre are applied to each cutting, CP content of forage should be between 12-15% for both harvests. In vitro true digestibility will be around 60% for both harvests.

Feeding Grass

Hypocalcemia results from a deficiency in plasma Ca at the onset of lactation in dairy cows, and is the main cause of several severe metabolic disorders. Animal nutritionists tend to be concerned with the dietary cation-anion difference (DCAD, expressed as milliequivalents per 100 grams dietary DM) in the total ration of a dairy cow. DCAD = [(K + Na) - (Cl + S)], although more complex forms of this relationship are sometimes used. During the transition period 3 to 4 weeks prior to calving, it is desirable to have a moderately anionic diet, to avoid milk fever and hypocalcemia. Immediately after calving, a cationic diet is essential.

Although sodium (Na) content of grasses varies by species, the values are low, compared to K. Because grass has potential for very high K concentrations, K receives the most attention. It is desirable to minimize K content of grasses (K < 2%) to produce an anionic diet for dry cows. Consideration may also be given to increasing the energy content of the ration during the late transition phase, using corn silage or gain. The increased energy from these sources may help improve the cow's physical condition as well as dilute the higher K levels of other forages in the diet. Rations for dry cows based predominately on corn silage, however, are discouraged.

Summary

If perennial grass is managed specifically for production of dry cow forage, relatively high yields of low K forage are possible. Several feeding problems associated with lactating cows can be minimized if low K forage is available for dry cows.

The current prescription for grass forage for dry cows is as follows:

- Select fields that have soils with low K supplying power, if you have a choice.
- Use soil testing to identify fields with low K soil test for dry cow forage.
- Use timothy, reed canarygrass, or smooth bromegrass, and avoid orchardgrass or perennial ryegrass.
- Avoid all forms of K fertilization (No Manure).
- Use moderate to heavy N fertilization (75-100 lbs/acre/harvest).
- Harvest 2x/year, approximately mid-June and mid-September.
- Use grass regrowth for cows close to calving, as it should be lowest in K content.
- If K content of spring grass forage is below 1.7%, consider modest K fertilizer or manure additions after spring harvest (50-100 lbs potash or equivalent).