

COOL SEASON PERENNIAL GRASSES FOR HAY

Kevin B. Jensen, Blair L. Waldron, and Joseph G. Robins¹

INTRODUCTION

In 1897 Agrostologist F. Lamson-Scribner stated that “There is no line of work more intimately connected with the Agricultural interests of the country than that pertaining to investigations of grasses and forage plants.” (F. L-Scribner, 1897). Scribner continues, “No other country has so large a number of useful grasses and forage plants as our own.....In all this wealth of varieties, unequalled in any foreign land, there is abundant opportunity for selection of good kinds adapted to every soil and climate or purpose.....our work chiefly lies in determining which are the best kinds, and to which condition or purpose the several kinds are best adapted.” He goes on to state “In order to supply correct information as to the best forage crops for meeting the needs of the various sections and climatic divisions of the United States, the soils, temperature, and rainfall must be studied, and the character, habits, and probable value of the grasses and forage plants native to several regions must be investigated.”

Isn't it interesting that the same questions are still being asked 100 years later when trying to decide what grass species to plant for hay or pasture? In choosing appropriate species or mix of species information regarding 1) how much available water (annually) and when it is available, 2) soil type (texture, depth, salinity, water table etc.), 3) soil fertility (nitrogen availability - best determined with a soil test), and 4) management objectives is critical in the planning process.

IRRIGATION/SOIL TYPE

Proper irrigation of pastures requires an understanding of fundamental soil, water, and plant relationships. In addition, irrigation must be coordinated with management practices. The timing and amount of irrigation water required by pastures, like any other crop, depends on the soil water-holding capacity, weather conditions, and crop growth. Unless there is a limiting layer in the soil, most of the plant roots in a grass pasture will be found within the top 2 to 3 feet.

The soil-water holding capacity varies from about 1 inch per foot of depth in a loamy sand to about 2 inches per foot depth in a loamy soil (Table 1). This means that in a sandy soil, approximately 2-1/2 inches of water are available for plant use in the 2-1/2 foot root zone; whereas, in a loamy soil approximately 5 inches of water would be available for the grass to use in the same 2-1/2 foot root depth.

¹ K.B. Jensen, B.L. Waldron, J.G. Robins Research Geneticists, USDA-ARS Forage and Range Research Lab, Logan, UT 84322-6300; Email kevin@cc.usu.edu; blw@cc.usu.edu; joseph.robins@usu.edu. In: Proceedings, 2006 Western Alfalfa & Forage Conference, December 11-13, 2006, Reno, Nevada. Sponsored by the Cooperative Extension Services of AZ, CA, CO, ID, MT, NV, NM, OR, UT, WA, WY. Published by: UC Cooperative Extension, Agronomy Research and Extension Center, Plant Sciences Department, University of California, Davis 95616.(see <http://alfalfa.ucdavis.edu> for this and other alfalfa proceedings)

For optimum forage production (grass), it is recommended that irrigation take place when approximately 50% of the water has been used or depleted from the root zone. Grass pastures need to be irrigated about twice as often as a deeper-rooted alfalfa crop (Intermountain Planting Guide, 2001).

Table 1. Typical available water holding capacity of various soils

Soil type	Water Holding Capacity (inches/foot)
Coarse sand	0.50
Fine sand	0.75
Loamy sand	1.00
Fine loamy sand	1.25-2.00
Silt loam	1.75-2.00
Silty clay loam	2.00
Clay loam	2.00
Heavy clay	1.75-2.00

(Source: Intermountain Planting Guide (2001), Utah State Univ. Extension Publication AG510, Utah State Univ., Logan, UT 84322-6300)

In environments where irrigation amounts and frequency are not limiting, the following grass species should be considered: tall fescue, orchardgrass, meadow bromegrass, timothy, smooth bromegrass, and possibly perennial ryegrass. Under environments where irrigation is available during the spring and early summer, but not available later in the growing season species of interest would include intermediate wheatgrass, tall wheatgrass, tall fescue, meadow and smooth bromegrass, NewHy, crested wheatgrass, and possibly a dryland orchardgrass. Under soil salinity, the following species should be considered: tall wheatgrass (high salinity tolerance), NewHy (moderate to high salinity tolerance), tall fescue (moderate to high salinity tolerance), and creeping foxtail (moderately salinity tolerance). Brief descriptions of these species are under the species section in this proceedings.

FACTORS AFFECTING HAY QUALITY

The ultimate test of hay quality is animal performance. Two factors that influence animal performance are: 1) *intake* – hay must be palatable if it is to be consumed in adequate quantities to produce the desired animal performance and 2) *digestibility and nutrient content* – once hay is eaten, it must be digested and converted to animal products.

Maturity

As grasses mature from the vegetative to the reproductive (seed) stage, they become higher in fiber and lower in protein, digestibility, and palatability. In addition, animal intake and milk production often decline (Table 2 and 3). Jensen et al. (2003) reported that crude protein concentrations in orchardgrass and perennial ryegrass increased as water stress increased. Some

have suggested that within each forage species, the most important factor that affects grass hay quality and the one where the greatest improvements can be made is the stage of maturity.

Table 2. Effects of plant maturity on Timothy Hay Quality

Growth stage	CP%	ADF%	NDF%	TDN%
Late vegetative	17	29	55	66
Early bloom	15	32	61	61
Mid bloom	9.1	36	67	58
Late bloom	7.8	40	70	54

(Source: Nutrient Requirements of Dairy Cattle, 6th Edition. 1989. National Research Council)

Table 3. Effect of stage of maturity at harvest of timothy on hay quality, animal intake, and milk yield.

Stage of Harvest	Crude Protein	ADF	Intake	Intake	Milk
	%	%	(lb DM/day)	(% of body wt.)	(lb/day)
late boot	11.3	35.9	33.3	2.84	37.5
late bloom	5.4	42.1	24.3	2.17	20.1

(Source: Nutrient Requirements of Dairy Cattle, 6th Edition. 1989. National Research Council.)

Fertility:

Cool-season grasses readily respond to increased nitrogen fertilizer. If moisture and soil test levels of P and K are adequate, applying nitrogen (N) to N-deficient soils greatly stimulates plant growth during periods of rapid forage production, particularly in the spring and early summer. Applications of nitrogen fertilizer throughout the summer can often lessen the forage production slump observed during the hotter portions of the growing season (Table 4 and 5). The best fertilizer response, particularly from nitrogen, will be from deep, well-drained soils of high yield potential. An ideal soil pH range to establish cool-season grasses would be 6.0 to 6.5.

Table 4. Production of dry matter (lb/a) of tall fescue with half the N applied early March and half applied in mid-August

Total (lb N/Acre)	Production from March to Early May	Production from May to Early August	Production from Mid August to Mid November
0	1400	1625	675
80	3350	2325	1800
160	3825	2575	2350
240	3925	3400	2350

Source: <http://www.ca.uky.edu/agc/pubs/agr/agr103/agr103.htm>

Table 5. Production of dry matter (lb/a) of orchardgrass with half the N applied early March and half applied in mid-August

Total (lb N/Acre)	Production from March to Early May	Production from May to Early August	Production from Mid August to Mid November
0	1475	1900	500
80	3375	2375	1425
160	3650	2525	1775
240	3575	3175	1925

Source: <http://www.ca.uky.edu/agc/pubs/agr/agr103/agr103.htm>

It is recommended that fertilizer for hay production should be applied in late winter to early spring. Fertilizing for pasture production should be done in late winter to early spring and then again in late summer if stockpiled late-season grass is desired. A general rule-of-thumb is that a ton of cool-season grass hay will remove 45 lbs N, 12 lbs of P₂O₅ and 50 lbs of K₂O. Under intensive management, 100-cow days per acre of cool-season grass will remove 60 lbs of N, 5 lbs of P₂O₅, and 17 lbs of K₂O. (www.mfa-nc.com/agronomy/forages/coolseason/tips/fertility.asp)

ADAPTED SPECIES

CREEPING and MEADOW FOXTAIL [*Alopecurus arundinaceus* Poir. and *Alopecurus pratensis* L.] are long-lived perennial grasses adapted to a wide range of poorly drained and strongly acidic soils from sea level to high meadows where they are utilized as pasture, hay, or silage. Creeping foxtail is similar morphologically to meadow foxtail, but has more vigorous rhizomes and wider leaves than meadow foxtail. Creeping foxtail seed is generally black, hairy, and occasionally may have awns. The foxtails are adapted to wet meadows from the central US to the Pacific Northwest. Creeping foxtail is adapted to a wide range of soils provided sufficient moisture is available. It performs well on sand, loam, clay, peat, and muck soils. It is tolerant of moderately acid and alkaline soils and has persisted on very wet soils with higher pHs. Creeping foxtail can tolerate up to 35 inches of standing water for 30 days without injury. The foxtails are not drought tolerant or resistant to continuous high temperatures. However, they have excellent cold tolerance at high elevations or northern latitudes. Perhaps the major limitation to establishing creeping foxtail is that the seed is light and hairy and difficult to plant with traditional equipment unless the fine hairs are removed. Creeping and meadow foxtail are responsive to high levels of N. However, with high N fertilization, the potential for unsafe nitrate accumulations in the foxtails is present. Adequate N fertilization is required to maintain productive hay and pasture fields. At high elevations and wet meadows, creeping foxtail is used extensively for hay. It produces excellent forage if harvested before flowering. Creeping foxtail tolerates grazing. The cultivar Garrison is the most widely grown creeping foxtail in North America. Garrison is an increase from a naturalized population in central North Dakota. It possesses vigorous rhizomes and is well adapted to wetland sites in temperate regions. The newest cultivar, Retain, was selected from Garrison. Yields of Retain are similar to Garrison.

However, Retain has reduced seed shattering that allows seed to be harvested by direct combining.

CRESTED WHEATGRASS - [*Agropyron cristatum* (L.), *A. desertorum* (Fisch. ex Link) Schult., and *A. fragile* (Roth.) Candargy] is an extremely long-lived, drought tolerant, bunch to moderately rhizomatous (occasionally) range grass that is adapted to a wide range of ecological sites and zones receiving as little as 8-10 inches of precipitation. It is very winter hardy and has an extensive root system that gives it excellent drought resistance. Forage production and palatability are high from mid-April to mid-June and begin to decline rapidly by early July. It has very vigorous seedlings. In North America, crested wheatgrass is particularly well adapted to the northern and central Great Plains and the more arid intermountain region. In general, crested wheatgrass is a long-lived perennial that has excellent drought resistance and has been used successfully on rangeland sites receiving from 8 to 16 inches annual precipitation. All crested wheatgrasses have excellent seedling vigor which results in stands that are relatively easy to establish under harsh environmental conditions. The crested wheatgrasses are adapted to foot hills, sagebrush, ponderosa pine, mountain brush, and pinyon-juniper ranges. Crested wheatgrass will tolerate short periods of spring flooding if they do not exceed 7 to 10 days. It is intolerant of soils with high water tables. Crested wheatgrass is less tolerant of soil salinity than tall wheatgrass, western wheatgrass, and quackgrass. At elevations above 6,500 ft in the Great Basin, expect reduced plant vigor and poor stands of crested wheatgrass. Crested wheatgrass produces abundant forage and is more widely used for grazing than for hay. The greatest utility of crested wheatgrass is likely achieved when it is used as a cool-season component in a grazing system with native range or species that are more productive during the hot summer period. Crested wheatgrass compares well with other grasses in hay yield and quality in the early spring, but quality deteriorates rapidly after heading. Under a haying operation, regrowth in crested wheatgrass is slow to none. Adapted bunch-type varieties include Hycrest, CD-II (superior seedling vigor), Vavilov, P-27, Nordan, and Fairway. Adapted spreading crested wheatgrass varieties are Ephraim and the recently released RoadCrest.

INTERMEDIATE WHEATGRASS [*Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey]. is a sod-forming, late-maturing, moderately long-lived grass suited for use as hay and pasture, alone or with alfalfa. Forage production begins early in the spring, and remains green and palatable into the summer when soil moisture is adequate. Intermediate wheatgrass extends the availability of high-quality forage during the summer by greening up 1 to 2 weeks later than smooth brome grass and crested wheatgrass. It also retains its forage quality relatively well after fall frosts and can be used as a late-fall or early-winter forage. Intermediate wheatgrass grows best on well-drained, fertile soils that receive 14 to 18 inches of annual precipitation. It is moderately tolerant of shade and alkalinity. As a general rule-of-thumb, intermediate wheatgrass will do well on sites currently occupied by smooth brome grass. Yields and stand persistence can be increased in intermediate wheatgrass if grown with a legume. In the drier areas (< 15 inches of precipitation), intermediate wheatgrass yields more than smooth brome grass and crested wheatgrass initially. However, after the third year, yields of intermediate wheatgrass begin to decline. Intermediate wheatgrass is not as drought resistant as crested wheatgrass. Persistence of intermediate wheatgrass stands is greatly reduced when planted on highly saline sites or on sites with high water tables. Forage quality of intermediate wheatgrass also declines rapidly at advanced stages of maturity. Under irrigation, an annual application of 50 to 100 lbs/acre of N

fertilizer extends the forage production further into the summer. Adapted varieties are: “Greenar”, selected for forage production and compatibility with alfalfa; “Oahe”, improved for seed production, forage yield, and rust resistance; “Tegmar”, which is a low-growing cultivar noted for erosion control, sod-forming, and seedling vigor; “Luna”-Pubescent-type is the most commonly used in the Great Basin and the most drought tolerant. Several new varieties include “Reliant”, which was selected for its improved persistence, forage quality, and forage, and seed yields. The cultivar “Manska” is adapted to the northern Great Plains and is noted for its high nutritive value based on in-vitro dry matter digestibility and animal performance.

MEADOW BROMEGRASS [*Bromus riparius* Rehm.] is a long-lived perennial that offers promise for non-irrigated or irrigated pasture. In the Intermountain West, forage yields in meadow brome are higher than smooth brome and it recovers from grazing much more rapidly than smooth brome. Meadow brome greens up two to three weeks earlier than orchardgrass and tall fescue. Early in the growing season it has excellent regrowth after grazing. Meadow brome can be distinguished from smooth brome by the presence of awns, hairy leaves and stems, and the lack of aggressive rhizomes. Meadow brome leaves are pubescent and light green in color. Reproductive culms are 23-47 inches tall. Seed morphology is similar to smooth brome and may cause problems with typical seeding equipment. Meadow brome is adapted to a wide range of soils varying from slightly acid to mildly alkaline. It is an excellent irrigated forage grass, but it is also productive as a dryland pasture grass where annual precipitation exceeds 15 inches. Seedlings are vigorous and stands are easy to establish on well-prepared seedbeds. As a hay species, meadow brome is less aggressive than smooth brome and retains a better balance in hay fields planted with legumes. Animals should not be allowed to graze meadow brome until the forage is 8-12 inches high, and the animals should be removed when forage is grazed to a stubble height of 3-4 inches. A typical rest period of three to four weeks is required for maximum forage and the health of the stand. Currently available cultivars include Cache, Regar, Fleet, Paddock, and Montana.

NEWHY - Wheatgrass Hybrid [*Elymus hoffmannii* K.B. Jensen and K.H. Asay] is a cross between quackgrass and bluebunch wheatgrass. This cross combines the vigor, productivity, salinity tolerance, and persistence of quackgrass with the drought resistance, caespitose growth habit, seed characteristics and forage quality of bluebunch wheatgrass. This hybrid cultivar is recommended for range sites and pastures with moderate salinity problems that receive at least 13 to 15 inches of effective annual precipitation. It is note worthy that NewHy did not spread beyond its plot borders into adjacent plots. Forage quality is similar to that reported for intermediate wheatgrass. NewHy begins growth early in the spring and retains a more succulent and palatable forage for livestock and wildlife later in the growing season than all other wheatgrasses on semiarid sites. Under conditions of high soil fertility and ample irrigation, forage yields of NewHy are lower than other pasture grasses (i.e., orchardgrass, meadow and smooth brome, perennial ryegrass, and tall fescue). However, on saline soils where irrigation is limited or absent, NewHy will persist and provide high-quality forage when other pasture grasses are short lived and less productive. NewHy is very responsive to applications of nitrogen throughout the growing season. Under a hay management, NewHy should be cut at the pre-heading stage to maximize forage quality. When harvest is delayed forage quality declines with plant maturity. Under the proper management, you could expect to harvest two crops of hay from a NewHy field. Another option used by many growers, is to harvest a hay crop in the early

summer and then graze the regrowth in late fall - early winter as a winter forage. On saline soils as either a hay or pasture crop, the forage quality (palatability and nutritional value) of NewHy is substantially better than that of tall wheatgrass, suggesting that this hybrid cultivar is another alternative to planting tall wheatgrass on salt-affected lands.

ORCHARDGRASS [*Dactylis glomerata* L.] is a medium to long-lived, high-producing perennial bunchgrass that is highly preferred by livestock as a hay, pasture, or silage throughout the growing season. It produces long, folded, light-green leaves, most of which are at the base of the plant. The flowering stems have few leaves and are 35-60 inches high; the flowering head is a tufted panicle 3-6 inches long. Orchardgrass is compatible in a mix with alfalfa and clover. It can be grown under irrigation or on dryland where the effective precipitation is at least 16 inches. One of the major limitations to the distribution of orchardgrass is its need for high moisture. Orchardgrass is more drought tolerant than timothy, but less than meadow and smooth brome grass and tall fescue, suggesting that the latter species are more appropriate when planting in areas of limited water. Orchardgrass is only moderately winter hardy, and it will not survive northern climatic conditions if snow cover is lacking. It is less winter hardy than smooth brome grass or timothy and is more vulnerable to diseases than many pasture grasses. Orchardgrass requires soil with good internal drainage. At high levels of nitrogen and adequate water, orchardgrass is among the most productive cool-season grasses in the Great Basin. In general, split applications of N give a better distribution of feed throughout the year. For hay, silage, or green chop, apply between 50 and 100 lbs N per acre in early spring and between 50 and 75 N lbs per acre after each cutting. Orchardgrass is tolerant to moderate salinity but not tolerant of alkaline soils. Under hay management, orchardgrass should be harvested at the boot to early head stage for first cut and every 4 to 6 weeks thereafter. When most temperate grasses slow down growth in the hot summer days, orchardgrass maintains its forage production. Fall growth is good. There are early-, mid-, and late-season varieties. Late-maturing varieties are preferred in mixtures with alfalfa. Later-maturing cultivars of orchardgrass are higher in digestibility and protein than earlier cultivars on the same date. The cultivar Latar is a late-maturing hay-type orchardgrass and is recommended as the grass component with alfalfa mixtures. Other early-maturing cultivars adapted to the Great Basin include Ambassador, Paiute, Dawn, and Potomac. These varieties are known for their improved seedling vigor, high yield, and good recovery after mowing.

PERENNIAL RYEGRASS - [*Lolium perenne* L.] Perennial ryegrass is a temperate (cool-season) short-lived perennial bunchgrass that is utilized in many forage-livestock systems. Because of its high forage quality and rapid establishment, perennial ryegrass has become an important forage within the coastal Northwest, irrigated intermountain valleys of the West, Midwest, and northeastern regions of North America. Most of the forage is concentrated near the base of the plant. Perennial ryegrass should be restricted to the moister regions of the Great Basin. To produce high yields, perennial ryegrass requires 30-50 inches of rainfall or supplemental irrigation annually and high fertility requirements. It is adapted to a wide range of soils, including heavy clay and poorly drained soils, but prefers medium to high fertility. Perennial ryegrass will grow on soils that have a pH between 5 and 8. Due to its shallow root system, perennial ryegrass is not adapted to extended periods of heat or drought. In the Great Basin, during the later part of July and through August, perennial ryegrass production declines due to high temperatures and water stress. In general, when temperatures exceed 80° F forage

production declines. Within the Great Basin, perennial ryegrass is much less winter hardy than other perennial pasture grass species such as orchardgrass, tall fescue, timothy, meadow and smooth brome, and Kentucky bluegrass. Perennial ryegrass will not tolerate standing water for extended periods of time during the growing season. Due to its low growth habit, perennial ryegrass is not recommended for a hay crop.

REED CANARYGRASS - [*Phalaris arundinacea* L.] is a vigorous, productive, long-lived, perennial, native sod-forming grass that is naturalized throughout the northern United States where moisture is adequate and the climate is cool. Stands of reed canarygrass can reach up to 8 feet tall with the majority of the leaves remaining near the base of the plants. Reed canarygrass is difficult to establish, but once established, under optimum conditions, produces excellent spring forage that is high in nitrogen and organic matter. Reed canarygrass is unsurpassed among cool-season grasses for land utilization of N and other nutrients that occur in municipal and industrial waste effluents. Reed canarygrass is adapted to a wide range of soil conditions. In addition, it can withstand continuous water inundation for 70 days in cool weather. It also invades wet areas along river banks, sloughs, and canals, where it thrives on land with a high water table. It does well on soils that range from moderately acidic to weakly saline-alkaline. It will tolerate saline soils when accompanied with frequent irrigations or natural flooding. Reed canarygrass is adapted to soils that range in pH from 4.9 to 8.2. It has moderate drought tolerance on upland soils that receive above 18 inches of annual precipitation. Reed canarygrass is very cold tolerant and will withstand temperatures well below -30° F. In general, reed canarygrass is adapted to soils too wet for brome grass, fescue, and orchardgrass. Lack of palatability when grown in a species mixture is the most frequently cited reason why this grass has not become a leading forage in its area of adaptation. Reed canarygrass may contain alkaloids that are correlated with reduced forage intake. Two to three years may be required for stands to reach full productivity. The forage should be harvested prior to heading as both quality and palatability decline rapidly after heading. To maintain good yields an annual application of nitrogen will be required on most sites. The cultivar Vantage, was developed at Iowa State University and has better seed retention and heads 2 to 3 days earlier than the cultivar Rise. The cultivars Venture and Palaton were released by the Minnesota Agricultural Experiment Station and the USDA as the first commercial cultivars with enhanced palatability, low gramine, and low alkaloid containing cultivars. 'Rival' is another low-alkaloid cultivar, however it has higher concentrations of some of the alkaloids than Venture and Palaton.

SMOOTH BROME - [*Bromus inermis* Leyss.] is a leafy, long-lived sod-forming grass used for hay and early-spring pasture. It is palatable, productive, and shade tolerant. Plant height ranges between 24 and 47 inches. Currently, smooth brome grass is the most widely used of the cultivated brome grasses. Smooth brome grass is tolerant of drought and heat. In dry summer periods it becomes dormant until fall precipitation. It is best adapted to moist, well drained soils, but it can be found on a wide range of soil and moisture conditions. It is adapted to both irrigated and dryland regions. It is fairly tolerant of alkaline and less tolerant of saline and acidic soils. It is shade tolerant and winter hardy. Smooth brome cultivars have traditionally been divided into three adaptation types-northern, southern, and intermediate. Only southern and intermediate types are currently recommended for use in the Great Basin. The recommended planting depth for smooth brome grass is 1/4 to 1/2 inches. Because of the increased length of the seed (long and narrow) it often plugs the seed drills, making it difficult to plant. It is also slow to establish

and may take up to three years before full production. It recovers slowly when cut for hay, and it tends to become sod bound, particularly in the southern types. Split applications (2 or 3) of nitrogen fertilizer at 40-60 lbs per acre give a better distribution of smooth brome forage throughout the growing season. The intermediate-type cultivar Manchar is best adapted to higher-elevation mountain rangelands. Manchar is recommended for forage plantings on meadows, for hay or pasture in the Great Basin. Manchar is characterized by moderate spread, improved seedling vigor, and increased seed and forage yields. The southern-type cultivar Lincoln is best adapted to mountain brush and favorable sites in the sagebrush and pinyon-juniper zone. Lincoln is recommended as a plant material for erosion control and waterways; it produces less forage but is more aggressive in vegetative spread than Manchar.

TALL FESCUE - [*Festuca arundinacea* Schreb.] is a long-lived, deep-rooted, high-producing, cool-season bunchgrass suited for use under a wide range of soil and climatic conditions associated with irrigated and semi-irrigated pastures. With the advent of irrigated pastures, tall fescue has become an important pasture species that can be either grazed or hayed and that will persist under hot summers and cold winters. Tall fescue is less palatable than other pasture grasses, and when planted with other grasses it may become the dominant grass over time. Under optimum conditions, tall fescue can reach a height of nearly 6 feet. It has numerous shiny, dark green, ribbed leaves. Tall fescue is adapted to irrigated, subirrigated, or moderately wet conditions, as well as dryland, in areas where effective precipitation exceeds 18 inches. For optimum yields, tall fescue is best adapted to moist soils rich in humus or clays. However, tall fescue can effectively produce forage on soils that vary from strongly acidic (pH 4.7) to alkaline (pH 9.5). Tall fescue is not well adapted to sandy soils having long periods of drought. Fungal endophyte problems can occur when livestock graze tall fescue in single species stands; this problem can be precluded by using endophyte-free seed at planting time. Symptoms of fescue toxicity include reduced weight gain/or milk production, rapid breathing, and increased body temperatures resulting in the animals always standing in the shade or watering holes. Apply 150 to 200 lbs of N per acre either in split applications (50 lbs of N each) or in a single spring application. Tall fescue makes excellent hay and should be harvested in the late boot stage to maximize quality. Subsequent harvests can be made every 4 to 6 weeks. Most forage-type tall fescue cultivars were developed for hay or pasture production. Forage-type cultivars are characterized by having soft lax leaves. Commonly grown tall fescue cultivars in the Great Basin include Alta, Fawn, and Forager.

TALL WHEATGRASS [*Thinopyrum ponticum* (Podp.) Liu and Wang] is a long-lived, coarse, vigorous, perennial bunchgrass with leaves that are long and erect. It is the latest maturing of the grasses adapted to the temperate rangelands of the West. Tall wheatgrass is particularly noted for its capacity to produce forage and persist in areas that are too alkaline or saline for other productive crops. Tall wheatgrass remains green 3 to 6 weeks later than other range grasses and is often valued as a source of forage during the late summer and into the fall and early winter when other forages are often in short supply. Tall wheatgrass has comparatively large seeds and good seedling vigor. It has been used successfully in wildlife plantings because it provides excellent nesting sites and cover for upland game birds. Tall wheatgrass is adapted to semiarid range sites receiving a minimum of 14 to 16 inches of annual precipitation, irrigated or sub-irrigated soils, or imperfectly drained alkali soils. To ensure a successful seeding, it is recommended that one growing season be required for establishing tall wheatgrass on irrigated

land and two growing seasons on dryland. Under extreme drought tall wheatgrass is not long-lived. Due to its late maturity and ability to become coarse during the growing season, it is recommended that tall wheatgrass be seeded alone instead of in a mixture with other grasses. Tall wheatgrass produces high yields of fair-quality hay and can be harvested as silage. At the early heading stage, tall wheatgrass is higher in digestible protein and total digestible nutrients than other wheatgrasses. An 8-inch stubble height should be left at the season's end. The variety Alkar is widely used in the Pacific Northwest and the Great Basin on alkaline soils. The variety Jose has been used for pasture and hay in irrigated areas of New Mexico and Colorado at elevations up to 7,500 ft, as well as on range sites where alkaline and saline soils prohibit the use of other productive grasses.

TIMOTHY [*Phleum pratense* L.] is a widely grown forage species in cool and humid regions including northeastern and northwestern North America. It is a bunchgrass that performs well with moderate to high yields on wet fertile meadowlands with moderate palatability. Timothy is adapted to cool, moist climates at high elevations where the effective precipitation is 18 inches or more. It can survive extremely hard, cold winters where snow cover may be limited, thus making it adapted to regions in the Great Basin with short growing seasons and cold winters. Timothy will not tolerate dry or hot periods throughout its growing season. Timothy plants are tolerant of low soil acidity, moderately water logged soils, and can withstand a limited amount of spring flooding. Timothy can persist and produce adequate yields on clay, silt, and sandy soils provided adequate moisture is available. Of all the pasture grasses, timothy is the latest to reach maturity. Within cultivars of timothy they are classified as early, medium, and late maturing. Perhaps the greatest limitation within timothy plantings, is the rapid decline in forage quality as the plant matures. Timothy should not be grazed or cut during a 2-week period prior to the heads emerging from the plants. The application of fertilizer, especially N, increases both yield and protein. Multiple applications of 50-60 lbs of N in the spring and then 50 lbs after each cutting (usually 2 harvests) or grazing event is recommended. Timothy is a hay-type forage grass, with relatively few basal leaves below the cutting height. Cutting timothy once or twice for a hay crop and grazing the aftermath is a common practice in livestock farming. The recovery and regrowth rate in timothy is very slow, thus extending the rest period needed between grazing or cutting. Forage production during mid-July through August declines rapidly in timothy plantings. There are early-, mid-, and late-season varieties. Early maturing cultivars have higher digestibility of dry matter than late cultivars when harvested at the same growth stage.

References

- Jensen, K.B., K.H. Asay, B.L. Waldron, D.A. Johnson, and T.A. Monaco. 2003. Forage nutritional characteristics of orchardgrass and perennial ryegrass at five irrigation levels. *Agron. J.* 95: 668-675.
- Jensen, K.B., W.H. Horton, R. Reed, and R.E. Whitesides. 2001. Intermountain Planting Guide. 104 pp. Utah State University Extension Publication. AG510.
- Scribner, F.L. 1987. Division of Agrostology. In: Yearbook of the United States Department of Agriculture 1987. p. 160-175. Government Printing Office, Washington, DC.