TECHNICAL NOTE

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PASTURE

SPECIES SELECTION AND GRAZING MANAGEMENT GUIDELINES

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Figure 1 'Regar' Meadow Brome Pasture, Bonners Ferry, Idaho. Photo by Dan Ogle, NRCS

INTRODUCTION

Pastures are commonly cultivated fields planted to introduced grasses and legumes. The objective or goal of pasture plantings vary and may include:

Forage for livestock	Forage to improve animal health
Forage to improve animal nutrition	Forage to balance the forage supply
Forage for low production periods	Forage for earlier/later season of use
Forage for wildlife	Forage for winter use
Habitat for wildlife	Reduced erosion and sedimentation
Improved water quality	Improved soil quality

Any one or all of these goals are achievable when the established pasture plant community is healthy and effectively capturing solar energy, water and nutrients.

GRAZING MANAGEMENT

Prescribed grazing is the management practice used on pasture to maintain healthy plant communities; sustainable forage base; achieve acceptable livestock production and protect natural resources. Without mechanical harvest or grazing of the plant materials stems and leaves, plant litter, builds up over time and shade the photosynthetically active plant material reducing the capture of energy that drives the system.

Figure 2 Cat Creek Summit, Idaho; photo by Dan Ogle, NRCS

Grazing during the vegetative period when forage plants are most nutritious and digestible reduces leaf area for energy capture. Careful management of the timing, intensity and frequency of grazing during the vegetative growth stage is important to allow recovery from grazing and to maintain stand vigor. Timing is generally referred to

as the season of use (i.e. spring, summer, fall or winter utilization). Intensity is usually determined by the stubble height of the remaining forage. Frequency is the number of times the pasture is grazed during the year and is regulated by the length of the rest periods between grazing. See Table 1 for a summary of the recommended growth stage before grazing or harvesting forage; the recommended amount of stubble that should remain at the end of the grazing season; the optimum season of use for each forage species and; the regrowth ability of each forage species.

HOW GRASSES, LEGUMES AND FORBS GROW

Established forage plants have two general stages of development; vegetative and reproductive. Plants in the vegetative stage have more leaf than stem material. Being the predominant site of photosynthesis, leaves have more amino acids and proteins, non-structural carbohydrates and fatty acids that are readily digestible. Stems, being support structures have a higher cellulose level and thicker lignified cell walls that provide rigidity; consequently, they are more difficult for digestive systems to break down into energy. Plants in the vegetative stage are functioning at their optimum photosynthetic capacity, producing energy for root growth, development of buds, reproduction and storage for future growth and survival. As forage plants transition from the vegetative stage to the reproductive stage, forage quality decreases because energy is allocated to the production and dispersal of seed and to other forms of reproduction such as rhizomes or stolons. Forage species vary in their timing during the growing season of vegetative and reproductive stages and therefore the time at which forage value is highest. Forage species also vary in the quality of forage after they have reached maturity which determines a species value to stockpile useable forage for use in fall and winter.

Perennial pasture plants regenerate each year from buds produced the prior year. These buds are on the plant crown at or just below the soil surface, on stolons on the soil surface or on rhizomes just below the soil surface. Dormant buds are activated to grow stems in the spring. Forage plants vary in the timing of active growth in the spring. In some species, regrowth during the fall if adequate soil moisture is present also occurs.

Forage grasses produce two forms of vertical stems, vegetative and reproductive, both with the shoot apex at the stem tip. The apex has cells capable of cell division and therefore growth. The apexes of vegetative stems produce leaves. These stems are short and consist of nodes where the leaves grow and non-elongated internodes. They are close to the ground and enclosed within a whorl of leaf sheaths where they are more likely to escape removal by grazing. When leaves are grazed above the apex, regrowth of new leaves from the apex is rapid. If enough leaf area remains after grazing, energy from photosynthesis can fuel regrowth with little to no cost to the plant from stored food reserves. If the stem apex is removed by grazing, the plant can only resume vegetative growth by breaking dormancy of the buds on the plant crown, stolons or rhizomes. It may take one to two weeks or more to activate dormant buds and usually at the cost of stored reserves. When the plant allocates stored energy to recover from close grazing, less energy is available for root growth, reproduction and the ability to recover from natural and competitive stresses. Repeated close grazing that removes the growing apex increases

the time required to activate buds. If continued, the plant eventually loses its ability to regrow and dies. Grass species differ in the length of vegetative stems, the height above the ground of the growing apex and the ability to recover if grazed too closely.

Reproductive stems are the other form of vertical stems. When temperature or day length stimulates the plant to flower, the dormant internodes of the vegetative stems begin to elongate and elevate the apex above the leaves. The apex also differentiates into the reproductive inflorescence. Grazing after the transition to the reproductive stage is likely to remove the growing apex because it is higher in the canopy causing the stem to die and requiring regeneration of new tillers. The timing of initiation for reproduction and the time it takes to complete this stage of growth varies among forage species.

After reproduction, forage plants commonly go into a period of dormancy that enables them to endure periods of low soil moisture or freezing temperatures. However, most cool-season forage plants are capable of breaking summer dormancy to initiate vegetative growth in the fall if moisture and temperature conditions are suitable. The ability to regrow during the summer and to break dormancy in the spring and fall varies considerably between species.

There are a number of differences between forage grasses, legumes and forbs. Grasses have fibrous root systems where as legumes and forbs are, for the most part, tap-rooted. The tap-root of legumes and forbs not only absorbs water and nutrients from the soil, but also stores carbohydrates and proteins needed during regrowth after defoliation and for winter survival. Legumes have the ability to develop a symbiotic relationship with rhizobia bacteria which makes legumes markedly different from grasses and forbs. Rhizobia infect root hairs of legumes result in their ability to fix nitrogen. Nitrogen fixation is a high-energy demand process and the rhizobia obtain energy from carbohydrates stores in the legume roots. The fixation process is more effective for vigorous plants verses those under high stress. Defoliation causes nitrogen fixation to stop temporarily and repeated frequent defoliation can result in sloughing of root nodules that contain the rhizobia.

Carbohydrate storage in legumes is highest at or shortly after bloom. Frequent grazing reduces the ability of legumes to regrow and survive winter. Defoliation during mid to late fall increases the chance of winter injury compared to late summer to early fall defoliation. Similar to grasses, legumes and forbs have root crowns that contain buds for new growth. Grazing tolerant legumes have many crown buds on low-set, broad crowns. Also similar to grasses, the apex of the vegetative shoots is at the tip of the stem and the ends of stem branches. However, the terminal bud is at or near the top of the plant and nearly always removed by grazing. When the terminal bud is removed, regrowth comes from buds at the leaf axils, the nodes of grazed stems or the crown buds. Heavy grazing of some legumes can impede upright growth and trigger prostrate growth.

SPECIES SELECTION

Dryland Pasture

Under normal conditions, only perennial species should be considered on non-irrigated sites. Perennial plants provide a dependable source of nutritious forage and do not require annual seedbed preparation and seeding. Annual pastures are most useful for short-term needs and cleaning up weedy fields before seeding perennial pastures.

In the selection of proper plant species, the following questions should be asked before planting; 1) what are my management goals; 2) do I have a reasonable understanding of soil and species management; 3) are enough desirable plants (species) still present on the proposed seeding site to promote recovery without planting if proper management is applied: 4) how risky is a new seeding; 5) what impact will disturbance of soils and plant life have on the biological health of the area; and 6) will the expected increase in forage offset the possibility of weed invasion, particularly on dryland pastures?

Plant species should be selected on the basis of what they can contribute to the objectives. The planned seeding must be within the landowner's economic ability, and the landowner must also be able to complete the planting with available manpower and equipment. Prior to choosing a species or mixture of species consult species descriptions in this or other pasture guides for detailed characteristics and adaptations. Needless to say, they must be adapted to the conditions of the site. Water is the most limiting adaption factor so there is a greater risk of failure as annual precipitation declines. For example, an area that receives 16 inches of annual rainfall has a greater chance of seedling establishment than an area that receives less than 12 inches of annual precipitation.

Siberian wheatgrass, crested wheatgrass, Russian wildrye, forage kochia and sweetclover are species best adapted to areas receiving less than 12 inches of annual precipitation and are more widely used for grazing rather than haying. Altai wildrye, intermediate and pubescent wheatgrass, and alfalfa perform best in areas receiving 12 inches or more annual precipitation where they out produce crested wheatgrass. In regions exceeding 15 to18 inches or more of annual precipitation, meadow brome, smooth brome (generally not recommended for forage plantings), tall fescue, orchardgrass, small burnet, alfalfa, sainfoin, cicer milkvetch and birdsfoot trefoil provide increased forage and quality. On wet soils, creeping foxtail, timothy, tall fescue, cicer milkvetch, birdsfoot trefoil and clover species should be considered.

On wet saline sites that have a water table within 3 feet of the soil surface, consider tall wheatgrass, 'Newhy' hybrid wheatgrass, slender wheatgrass, Altai wildrye, tall fescue, western wheatgrass and strawberry clover. On dry saline sites with less than 16 inches of annual precipitation, consider Russian wildrye, tall wheatgrass, slender wheatgrass and western wheatgrass. For additional information, see Idaho Plant Materials Technical Note No. 9 Plants for Saline to Sodic Soil Conditions and Technical Note No. 10 Pasture and Range Seedings at: http://www.id.nrcs.usda.gov/programs/tech_ref.html#TechNotes

Adapted forbs and legumes should always be considered in pasture plantings. They add diversity, forage yield, fix nitrogen (legumes), and contribute to improved soil and forage

quality. Small burnet is a non-bloat forb and legumes such as sainfoin, birdsfoot trefoil and cicer milkvetch have very low bloat potential as compared to alfalfa.

Irrigated Pasture
When mixtures of two or more species are planted, their relative palatability is of major importance. If they differ in palatability, the more palatable species will decline from excessive utilization by grazing animals. This may ultimately result in a single species stand invaded with aggressive annual and perennial weeds. This can be overcome with intensive grazing management techniques. A good example is tall fescue which is high yielding and very competitive, but less palatable than many other irrigated forage species and in a mixed seeding will dominate the stand after several years.

Simple seed mixes including orchardgrass or meadow brome and a legume such as alfalfa, sainfoin or cicer milkvetch are recommended for irrigated seedings. They produce as much forage as complex mixtures and are easier to manage and graze uniformly. They require less total seed and are easier to establish in alternate rows, which is desirable and recommended when possible.

On irrigated sites (or dryland areas that receive greater than 16 inches annual precipitation), annual forage species, such as cereal grains and ryegrass may be a viable alternative based on the land managers' objectives and forage needs.

When fields include multiple soil types or moisture conditions, mixes of multiple grasses or grass-legume-forb mixes may be desirable. Complex mixtures including grasses such as intermediate wheatgrass, meadow brome, orchardgrass and/or creeping foxtail are most practical in mountainous or rolling areas and areas having a variety of soil and moisture conditions. In many situations the addition of a forb such as small burnet will add diversity to the planting and legumes that fix nitrogen such as alfalfa or non-bloat legumes such as sainfoin, birdsfoot trefoil and cicer milkvetch increase soil nitrogen and forage quality. As the number of species in a mixture increase, the management level must also increase to maintain the composition and health of the stand.

Single grass species seedings or single grass-legume seedings are usually advisable in areas with uniform soil, terrain and moisture conditions. They are easier to seed and establish, are more uniformly palatable and require a lower level of management than multiple species seedings.

FERTILIZER

Dryland Pasture
Research on dryland pasture indicates that fertilization is not economical on sites with less than 15 inches of mean annual precipitation.

Irrigated and High Precipitation Dryland Pasture
A long-term supply of phosphorus, potassium and sulfur are needed to enhance root growth and should be applied prior to land preparation at rates determined by a soil analysis and a nutrient budget developed using University fertilization guides.

Nitrogen fertilizer should not be applied before the stand is seeded or during the first growing season unless soil tests show a deficiency. Nitrogen generally benefits annual grasses and weeds at the expense of the more slowly establishing perennial species.

Legumes – When seed is properly inoculated, legumes can fix nitrogen from N_2 in the atmosphere and therefore need little or no additional nitrogen from fertilizer. However, legumes require relatively large amounts of phosphorus, potassium and sulfur, and will respond to additions of these nutrients as fertilizer when they are deficient in the soil. If mineralized nitrogen is available in the soil, legumes will use it at the expense of the rhizobium nitrogen fixing process. If nitrogen is added to a grass – legume mixture, both will respond well, but the legume will in effect become dependant on the commercial source, just as grass does. Excessive nitrogen fertilization will eventually shift plant composition toward a greater percentage of grass. Legumes generally respond to phosphorus when the soil analysis shows this element to be in the low to medium range and to potassium and sulfur when the soil analysis shows these elements to be deficient. Follow the recommended rates based on the appropriate fertilizer guides.

Grasses – Grasses require relatively large amounts of nitrogen fertilizer and smaller amounts of phosphorus, potassium and sulfur. Where moisture conditions are favorable, grasses will respond to high rates of nitrogen fertilizer and moderate rates of phosphorus, potassium and sulfur on soils deficient in these elements. Fertilizer guides commonly recommend up to 150 pounds of nitrogen per acre per year or as based on a soil test, the preferred option.

Grass–Legume Mixtures – It is not possible to apply fertilizer to supply the ideal combination of elements for both grasses and legumes. If nitrogen is applied to a grass-legume mixture, the grass will tend to increase at the expense of the legume. The legume will use some nitrogen fertilizer and obtain less from the atmosphere. In effect, some of the nitrogen applied is wasted because it is used in place of nitrogen that the legume would have fixed from the atmosphere. However, grasses do not obtain nitrogen directly from the legume and usually produce higher yields when fertilized with both nitrogen and phosphorus than when fertilized with phosphorus alone. In many cases, better results have been obtained from applying phosphate and potassium fertilizers at relatively high rates every 2-3 years than from applying the same amounts in annual applications. Do not attempt this with applications of nitrogen because runoff and leaching will pollute surface and ground water. Split applications according to the plant needs and soil type are recommended.

You can gradually increase the amount of grass in a mixed planting by applying larger amounts of nitrogen; legumes can be increased or maintained in the mixture by applying larger amounts of phosphorus, potassium and sulfur.

Broadcast application is the most common method of applying nitrogen fertilizer to established forage stands. It is best to fertilize forages in the fall or very early spring to provide an opportunity for natural precipitation to move the fertilizer into the root zone before the growing season. To avoid volatilization and loss of nitrogen to the atmosphere, fall and spring applications should be made when the soil temperatures are less than 50 degrees. Never apply fertilizer to frozen ground or over snow cover. Caution should be used to avoid runoff on clayey soils or deep percolation on sandy soils.

Nitrogen fertilizers are soluble and move readily in moist soils. Response to nitrogen application is usually rapid if moisture conditions are favorable. However, nitrogen fertilizers, particularly urea, may be lost by volatilization if they remain on the soil surface during warm, dry weather. On irrigated land, mid-season applications of nitrogen should be watered in immediately. Split applications following each haying or grazing event are recommended for nitrogen fertilization.

Phosphorus does not move as readily in soils. Therefore response to surface-applied phosphate fertilizers will not be as rapid or usually as dramatic as the response to nitrogen applications. On soils deficient in phosphorus, a relatively high rate of phosphate should be applied and worked in to the soil during land preparation prior to seeding the grass-legume mixture. Residual responses are common for 2-3 years after application. Some research indicates a positive response from deep banding phosphorus into established stands. Many fertilizer companies have specialized equipment that can deep band fertilizer with minimal disturbance to the pasture.

Manures and composts are a source of nutrients, and many times these materials are readily available. Nutrient content varies considerably depending on the source. For example, Dairy compost typically will have 12 lb/ton P_2O_5 and 12 lb/ac N; Broiler hen manure will have 73 lb/ton P_2O_5 and 64 lb/ac N. A little calculation will show that very large amounts are needed to completely meet the needs of the pasture. As a general rule, manure and compost applications are made during the dormant period. When the plants are actively growing no more than 10 ton/ac should be applied after each grazing period to prevent leaching and/or runoff. Liquid manure applications and “cow paddies” can cover a lot of plant surface area so producers may need to harrow in order to break up the manure surface area. Manures and composts can be high in salts, however it is unlikely that a soil salinity problem would develop in most situations because extremely large amounts of manure and/or compost would need to be applied annually for several years. Also, make sure that compost is thoroughly “cooked” to reduce unintended invasion of weedy seeds to the pasture.

Application rates can be determined by taking soil tests and developing a nutrient budget based on University fertilizer guide recommendations. Caution: Always consider water quality implications for all fertilizer applications.

LEGUME SEED INOCULATION

All legumes require inoculation with their corresponding strain of nitrogen fixing rhizobia bacteria. Some legume seed is sold already inoculated. Check storage conditions and shelf life of inoculated seed to be sure inoculum is still viable. If the seed is not inoculated or inoculum viability is in question, then the seed will require inoculation prior to or during planting.

The table below lists some legumes and their compatible strains of nitrogen-fixing bacteria. Some bacteria will cross-over to multiple legume species and some are specific to a particular legume species.

Legumes - Associated Rhizobia Bacteria Inoculants

Legume	Rhizobia
Alfalfa Sweetclover (yellow or white)	*Rhizobium meliloti*
Alsike clover Red clover Strawberry clover Subterranean clover* White clover	*Rhizobium trifolii*
Field peas (Austrian, dry, green)	*Rhizobium leguminosarum*
Birdsfoot Trefoil	*Rhizobium loti*
Cicer Milkvetch	*Astragalus*-specific *Rhizobium*
Sainfoin	*Rhizobium* spp.

*Selected strains of *Rhizobium trifolii* specific for this legume are most effective

PASTURE SPECIES—GRASSES

Bluegrass, Kentucky *Poa pratensis*

Kentucky bluegrass is a long-lived, introduced, shallow-rooted, sod-forming perennial grass.

Adaptation and use: Even with 18 inches of annual precipitation, Kentucky bluegrass does not provide much forage. Irrigation or additional rainfall is required for good forage production. In the Intermountain West, Kentucky bluegrass is not recommended for pasture planting except for use as a high-quality horse pasture. However, under irrigated conditions it commonly comes in on its own if the pasture is overgrazed. Existing Kentucky bluegrass pastures can provide highly palatable forage and fair to good yield if managed through irrigation, a good fertility program, and periodic ripping or chiseling of the root zone. Kentucky bluegrass generally is not harvested for hay because of its short stature and very fine stems and leaves, which can be difficult to cure properly for hay.

Grazing management: Grazing can begin in spring when grass is 5 inches tall. Remove livestock when stubble height is approximately 2 inches. Regrowth ability is excellent. Livestock can be rotated back onto Kentucky bluegrass pastures when regrowth is approximately 6 inches tall.

Brome, meadow *Bromus biebersteini (syn. B. riparius)*

Meadow brome is a long-lived, introduced, deep-rooted perennial grass with short (4 to 6 inch) rhizomes.

Adaptation and use: Meadow brome is an excellent choice in areas that are prone to frost in early to late spring. It is one of the earliest sources of spring forage available. This species is palatable to all classes of livestock and wildlife. It is productive and compatible in mixtures with legumes such as alfalfa, sainfoin, cicer milkvetch, and birdsfoot trefoil. Growth begins in early spring, and productivity is very high during the cool season. This species is also capable of strong summer growth when fully irrigated. Unlike smooth brome, meadow brome initiates regrowth more quickly following harvest even during high summer temperatures.

Grazing management: Meadow brome reaches full productivity in 2 to 3 years. Because it establishes roots slowly, livestock can easily uproot young plants. New seedings should not be grazed until late summer or early fall under irrigated conditions. Under dryland conditions, do not graze until the second year. Harvesting for hay during the establishment period is recommended. On established stands, begin spring grazing when the forage is 8 inches tall. Remove livestock when stubble is 4 inches tall. Meadow brome recovers quickly from grazing if soil moisture is available, as it initiates regrowth from existing tillers and not from the crown. A 21 to 28 day recovery period is recommended. Four to 6 inches of fall regrowth will build food reserves to provide for early growth the following spring.

Brome, smooth Bromus inermis

Smooth brome is a long-lived, introduced, aggressive, sod-forming grass.

Adaptation and use: Smooth brome is best adapted to moist, well-drained soils where annual precipitation is at least 14 inches or the pasture is irrigated. It is very shade-tolerant. Seedlings are often weak, but established plants spread via rhizomes to provide full stands. Smooth brome is a very aggressive grass that generally does not allow invasion by other species. It often invades adjacent pastures and areas along ditches, canals, drains, and streams. It can be a serious weed in these areas. Smooth brome is high in crude protein, low in crude fiber, and highly palatable. It is compatible in mixtures with legume species such as alfalfa, sainfoin, cicer milkvetch, and birdsfoot trefoil. Vegetative growth begins in early spring, and most growth occurs during the cool spring period. Smooth brome is slow to regrow because new tillers have to develop prior to initiating above ground growth even under fully irrigated conditions.

Grazing management: New stands do not tolerate heavy grazing and may die out if utilized heavily when young. Stockpiling for fall, winter, and early spring grazing should begin between the first of June and the beginning of July. Grazing should not occur until smooth brome has reached 8 inches tall. Remove livestock when stubble is 4 inches tall. Regrowth is initiated from the crown and rhizomes, and recovery is slow. A rest period of 35 to 42 days is recommended between grazing periods.

Canarygrass, reed *Phalaris arundinecea*

Reed canarygrass is a long-lived, introduced, widely adapted, coarse, vigorous, productive, sod-forming grass.

Adaptation and use: Reed canarygrass is frost-tolerant and suited to wet soils with a pH of 4.9 to 8.2. Initial stands are often poor because of poor germination and weak seedlings. Once established, reed canarygrass can withstand continuous water inundation for 70 days in cool weather. Reed canarygrass invades wet areas along ditches, canals, drains, streams and is a serious weed in these areas. *Note: Reed canarygrass is a Class C Noxious Weed in Washington and may not be planted. However, existing stands are frequently not practical to destroy because its removal results in a shift to other weed species filling the void.* This species produces high forage yields on moist, fertile soils that are high in N and organic matter. When fertility is limiting, it becomes sod-bound. Mature stands are unpalatable, requiring careful grazing and haying management for quality forage production. Reed canarygrass contains alkaloids that repel herbivores. The lack of palatability and poor animal performance often seen with this species may result from the presence of these alkaloids. Newer varieties have reduced alkaloid levels.

Grazing management: In spring, early and frequent grazing (with rotations as often as 2 weeks) helps prevent or reduce stem and panicle production. Grazing should occur when reed canarygrass has reached 8 inches tall. Remove livestock when stubble is 4 inches tall. The recommended rest period is approximately 14 to 21 days. Forage quality can be maintained by not allowing growth over 12 inches tall.

Fescue, tall *Schedonorus phoenix (syn. Festuca arundinacea)*

Tall fescue is a long-lived, introduced, deep-rooted, high-yielding, cool-season bunchgrass.

Adaptation and use: Tall fescue is suited to irrigation, sub-irrigation, moderately wet conditions, and dryland areas where effective annual precipitation exceeds 18 inches. It performs very well in acidic soils, as well as in soils that are moist, saline, and alkaline (pH 4.7 to 9.5). It is not well adapted to sandy soils with prolonged droughty periods. The leaves' thick cuticle helps tall fescue stay green into early winter. Thus, it can be stockpiled for winter use. Tall fescue is recommended as a monoculture seeding or as part of an alternate-row planting. It is very competitive and tends to out-compete other species in a mixture. It has lower palatability than most pasture grasses, so other species often are overgrazed and eventually eliminated from the pasture. Avoid turf-type tall fescues for grazing use. Fungal endophyte problems can develop in livestock grazing tall fescue. Endophyte infected tall fescue plants produce alkaloids that cause fescue foot, bovine fat disorder, and fescue toxicosis disorders. Toxin concentration is greatest in the inflorescence, moderate in stems and leaf sheaths, and lowest in leaf blades. You can reduce or eliminate this problem by using endophyte-free seed or some new varieties with endophytes that don't produce toxins.

Grazing management: Growth begins in early spring, and grazing should begin after plants are at least 6 inches tall. Maintain stubble height at 4 inches. Regrowth is good in cool spring and fall weather, but only fair during summer heat. The recommended rest period between grazing cycles is approximately 21 to 28 days. Frequent spring grazing cycles when plants are in the vegetative stage will help reduce alkaloid concentrations in animal diets if the endophyte is present.

Festulolium *Festulolium braunii*

Festulolium braunii is derived from a cross between Italian perennial ryegrass and meadow fescue. Meadow fescue traits provide persistence, ease of establishment and management and good disease resistance. The high palatability and forage qualities of ryegrass are combined with season productivity of the meadow fescue. Although first developed in the 1950's, most are relatively new varieties and not much forage research data or experience is available with this cross.

Adaptation and use: Festuloliums are suited to fertile soils with irrigation, sub-irrigation, and humid areas where effective annual precipitation exceeds 18 inches. Persistence may be short term.

Grazing management: Growth begins in early spring, and grazing should begin after plants are 8 to10 inches tall. Maintain stubble height at 3 to 4 inches. Regrowth is good in cool spring and fall weather and better than perennial ryegrass during summer heat. The recommended rest period between grazing cycles is approximately 21 to 28 days.

Foxtail, creeping *Alopecurus arundinaceus*

Creeping foxtail is a long-lived, introduced, cool-season, deep-rooted, dense, sod-forming grass. Creeping foxtail is similar in appearance to timothy, but seed heads generally are black and hairy.

Adaptation and use: Creeping foxtail is very well adapted to wet, acidic, poorly drained sites. It has slight to moderate saline/alkaline tolerance, but produces abundant excellent-quality forage on wet, fertile sites. It is suited to irrigation, sub-irrigation, moderately wet to very wet conditions, and to dryland areas where effective annual precipitation exceeds 18 inches. On wet sites, it is usually superior to other adapted grasses such as reed canarygrass and timothy. It is very cold-tolerant and can persist in areas where the frost-free period averages less than 30 days. Creeping foxtail invades wet areas along ditches, canals, drains, and streams and can be a serious weed in these areas. Creeping foxtail is productive and compatible in mixtures with legume species such as cicer milkvetch and birdsfoot trefoil. Seed is very light and difficult to drill without the use of cracked corn, rice hulls, or other carriers. Creeping foxtail has low seedling vigor, but once established it spreads readily by rhizomes. Productivity is very high during the cool season. This species is also capable of strong summer growth when fully irrigated, and leaves remain green until after hard frosts in the fall.

Grazing management: Growth begins early in the spring. Spring grazing should begin after the forage is 6 inches tall. Remove livestock when stubble is 4 inches tall. Creeping foxtail recovers quickly from grazing if soil moisture is available, and regrowth ability is excellent. A 21 to 28 day recovery period is recommended.

Orchardgrass *Dactylis glomerata*

Orchardgrass is a long-lived, deep-rooted, high-yielding, introduced bunchgrass.

Adaptation and use: Orchardgrass does best on soils with few limitations and good drainage. Avoid shallow and sandy soils. Below 18 inches of annual precipitation, orchardgrass does not provide much forage. Irrigation or additional rainfall is required for good forage production. It has a high nitrogen requirement and irrigated fields may need upwards to 150 lb N/ac/yr. Orchardgrass is shade-tolerant. It is more vulnerable to diseases than many pasture grasses. Orchardgrass is less winter-hardy than meadow brome, smooth brome, timothy, or creeping foxtail. It is not well adapted to areas with cold, dry winters. Production is also lower in areas that commonly experience mid- to late-spring frost. Other species may be a better selection under these conditions. Orchardgrass is highly palatable to livestock and wildlife, especially in the early part of the growing season. It is widely preferred by all classes of livestock and wildlife. It is used for hay, pasture, or silage. It is compatible in alfalfa, sainfoin, and clover mixes. It is also used in erosion-control mixes, primarily for its forage value. Varieties are early-, mid-, and late-season in maturity. Late-season varieties are preferred in mixtures with alfalfa.

Grazing management: Do not graze new plantings until late summer or fall of the first growing season. Harvesting for hay during the establishment period is recommended. On established pastures, orchardgrass initiates growth early in the spring, with long, folded leaves arising mostly from the plant base. For optimum forage quality and regrowth, harvest orchardgrass while still in the boot stage. Grazing should begin when growth

reaches approximately 8 inches. Remove livestock when plants have at least 4 inches of stubble height remaining. Regrowth is good when plants are properly grazed. A 28 to 35 day recovery period is recommended. Orchardgrass does not tolerate close or continuous grazing, because energy is stored mainly in the lower stems and leaf parts. Close grazing in the fall is associated with winter kill. Winter grazing should be limited to 60 percent of annual growth.

Ryegrass, perennial *Lolium perenne*

Perennial ryegrass is an introduced, short-lived, rapidly establishing, vigorous bunchgrass.

Adaptation and use: Perennial ryegrass is adapted to a wide variety of soil conditions. For high yields, it requires as much as 30 to 50 inches of precipitation or irrigation and large nutrient inputs. This species does best where winters are mild. Perennial ryegrass performs best in acidic to mildly basic soils (pH of 5.0 to 8.0). Perennial ryegrass is moderately productive and produces high-quality forage. Because it is strongly preferred by grazing animals, it is not recommended in mixtures with other grasses. It also may retard the establishment of other perennials if seeded too heavily in a mixture. In cooler regions of the Intermountain West, treat this species as an annual. It will provide good forage for grazing within 60 to 90 days following planting, but probably will not maintain a full stand the following year. Perennial ryegrass tends to go dormant when summer temperatures exceed 80ºF. Perennial ryegrass often contains a fungal endophyte that is linked to the occurrence of ryegrass staggers. There have been reports of ryegrass staggers in Oregon and California. You can reduce or eliminate this problem by using endophyte-free seed, although production may be lower. Because of the need for high fertilizer application rates, split applications are recommended.

Grazing management: Grazing can begin when vegetation is 8 to 10 inches tall. Leave a 3-inch stubble height. Perennial ryegrass has good recovery after grazing. A 21 to 28 day recovery period between grazing cycles is recommended.

Timothy *Phleum pratensis*

Timothy is a short-lived, shallow-rooted, introduced, perennial bunchgrass.

Adaptation and use: Timothy is adapted to cool, humid areas and to high elevations. It is adapted to irrigated areas and areas with effective annual precipitation of at least 18 inches. It produces moderate to high yields on wet, fertile soils. It is compatible in mixes with legumes. Timothy establishes quickly and volunteers readily on preferred sites. It invades wet areas along ditches, canals, drains, and streams and can be a serious weed in these areas. Timothy is preferred by cattle and horses, and timothy hay is a premium feed for horses. This species is very palatable in late spring and early summer, but only moderately palatable in late summer and fall (after seedhead development). It is late-maturing. Timothy can also be used for ground cover and erosion control on cut or burned-over timber land.

Grazing management: In spring, the crowns form swollen, bulb-like internodes that store energy. Close grazing and trampling during moist conditions can damage these internodes and severely reduce stands. Begin grazing during the vegetative stage, after

grass has reached at least 6 inches in height. A 4-inch stubble height should remain following grazing. Timothy should be hayed before seedheads have emerged from the boot. It regrows slowly following grazing or haying. A 28 to 35 day recovery period between grazing cycles is recommended.

Wheatgrass, crested

Crested wheatgrass growth begins early in the spring. Following heading, protein levels drop rapidly, and forage becomes coarse and less desirable. Growth may begin again in fall if fall moisture is available.

Standard-type ***Agropyron desertorum***
Standard-type crested wheatgrass is adapted to a wide range of sites and to precipitation zones as low as 9 to 10 inches. Above 6,500 feet elevation, expect lower plant vigor and reduced stands. This species is more drought-tolerant than Fairway-type crested wheatgrass.

Fairway-type ***Agropyron cristatum***
Fairway-type crested wheatgrass is similar to standard crested wheatgrass but shorter statured and earlier maturing. It also has finer stems and leaves. It establishes on similar sites (10 to 18 inches annual precipitation), but is better adapted to higher elevations. It does not survive as well as standard crested wheatgrass under prolonged drought conditions.

Hybrid-type ***Agropyron cristatum x A. desertorum***
This crested wheatgrass is a hybrid cross between standard-type and induced tetraploid Fairway-type crested wheatgrass. Seedlings are very vigorous during germination and early establishment. It is adapted to a wide range of sites and to annual precipitation zones as low as 9 to 10 inches. This species is more drought-tolerant than Fairway-type crested wheatgrass.

Grazing management: Begin grazing after the plants have reached the 6-inch growth stage. To maintain long-term plant health, leave 3 inches of stubble at the end of the grazing period or going into winter. In spring, a 28 to 35 day recovery period between gazing periods is recommended. Crested wheatgrass has poor regrowth ability in early- to late summer, primarily because it goes dormant following heading and in hot weather. Fall grazing is possible in some years following fall rains. Late-fall and winter grazing requires protein supplements. To avoid grass tetany, ensure that adequate stubble remains following fall grazing or supplement livestock with magnesium and calcium during spring grazing. Grazing stubble with spring green-up reduces the risk of tetany.

Wheatgrass, intermediate and pubescent *Thinopyrum intermedium*

Intermediate wheatgrass is a mildly rhizomatous, sod-forming, late-maturing, long-lived, introduced grass. Pubescent and intermediate wheatgrass are very similar, but pubescent wheatgrass has pubescence on the leaves and seedheads.

Adaptation and use: Intermediate and pubescent wheatgrass are recommended for upland, medium to fine-textured soils. Intermediate wheatgrass is best adapted to areas with 13 to 18 inches of annual rainfall, while pubescent wheatgrass is suitable for areas with 11 to 18 inches of annual rainfall. Both are somewhat saline-tolerant (electrical conductivity of 6 to 12 mmhos/cm). Neither is shade-tolerant. This species is excellent for situations where only one to three irrigation applications are possible. It readily responds to irrigation and fertilization with increased forage production, but can withstand extended drought periods without irrigation. Nitrogen application significantly increases forage production and regrowth following clipping or grazing under irrigated conditions. Intermediate and pubescent wheatgrass are suited for use as hay and pasture, alone or with alfalfa or other legumes. Both are useful for soil stabilization and erosion control on disturbed sites. This species begins growth early in the spring and remains green and palatable into the summer, producing large amounts of nutritious forage. Forage quality and growth are reduced during mid- to late summer.
Grazing management: On established stands, begin spring grazing after grass has reached a height of 8 inches. Regrowth following grazing is good if soil moisture is available. On irrigated pasture with high moisture conditions, allow a 21 to 28 day recovery period in the spring. A longer recovery period may be needed in late spring, early summer, and fall. Leave a 4-inch stubble height after each grazing period and going into winter. Heavier grazing will result in reduction and eventual loss of the stand.

Wheatgrass, Siberian *Agropyron fragile*

Siberian wheatgrass is a long-lived, drought-tolerant, vigorous, winter-hardy, introduced bunchgrass.
Adaptation and use: Siberian wheatgrass is well adapted to medium loam to light, sandy, droughty soils. Siberian wheatgrass has finer leaves than crested wheatgrass and retains its greenness and palatability later into the summer. It yields less than crested wheatgrass during normal rainfall years, but generally produces higher yields than crested wheatgrass during periods of extended drought. It is adapted to sites with as little as 7 to 18 inches of annual precipitation. Siberian wheatgrass is palatable to all classes of livestock. It is a preferred feed in spring and again in fall if soil moisture is available and regrowth occurs. Following heading, protein levels drop rapidly. Forage becomes coarse and less desirable in early- to mid- summer. Late-fall and winter grazing requires protein supplements.
Grazing management: Growth begins early in the spring. Begin grazing after plants have reached the 6-inch growth stage. To maintain long-term plant health, leave 3 inches of stubble at the end of the grazing period. In spring, a 28 to 35 day recovery period between gazing cycles is recommended. Siberian wheatgrass has poor regrowth ability in summer, primarily because it goes dormant following heading during the heat of the summer. Growth resumes with fall moisture, and fall grazing is possible in years when sufficient regrowth occurs. To avoid grass tetany, ensure that adequate stubble remains following fall grazing or supplement livestock with magnesium and calcium during spring grazing. Grazing stubble with spring green-up reduces the risk of tetany.

Wheatgrass, tall *Thinopyrum ponticum*

Tall wheatgrass is a long-lived, tall, coarse, vigorous, late-maturing, winter-hardy, introduced bunchgrass.

Adaptation and use: Tall wheatgrass is adapted to a wide range of soils and climates. It is recommended for 14 inch or higher annual rainfall zones or sites with high water tables. Once established, tall wheatgrass tolerates saline, alkali, and high water table conditions better than most grasses. It is adapted to saline areas such as greasewood and saltgrass sites where the water table is from a few inches to several feet below the surface. Tall wheatgrass is useful for erosion control and is also used as a wind barrier to control soil erosion and drifting snow. It provides nesting cover and food for upland game birds. This species is the latest maturing of the wheatgrasses. Palatability is acceptable early in the growing season, but mature plants become very unpalatable. Late-standing material becomes good winter forage for livestock when used with supplemental protein sources.

Grazing management: Grazing should not begin until grass is at least 10 inches tall. Stubble height should never be less than 6 inches between grazing periods and at the end of the grazing season. Regrowth is slow, and rest periods should be at least 35 days. Tall wheatgrass does not stand continuous close grazing. Mowing at an 8 to 10 inch stubble height can set grazing height; the remaining stiff stubble will prevent closer grazing.

Wheatgrass, western *Pascopyrum smithii*

Western wheatgrass is a long-lived, late-maturing, widely distributed, winter-hardy, strongly rhizomatous, native grass with coarse, blue-green leaves.

Adaptation and use: Western wheatgrass is adapted to lowlands prone to early-season flooding. It is particularly productive in clayey to silty swales and waterways and has moderate to high salt tolerance. It is best adapted to 12 to 14 inch and higher rainfall zones in the Intermountain West. It is a productive native hay producer during above-normal precipitation years and under irrigation. When used as pasture, this species is an excellent source of spring and early-summer forage, with crude protein content of 16 to 18 percent. However, forage quality declines rapidly as plants mature. Western wheatgrass provides good winter grazing if protein supplements are provided. Protein content of cured western wheatgrass is usually a little higher (4 to 5 percent) than that of other wheatgrasses. Western wheatgrass is typified by poor germination and low seedling vigor. Plantings usually result in scattered stands that spread in 3 to 5 years to dominate the site. Once established, western wheatgrass becomes very persistent and provides excellent soil-binding and erosion-control characteristics.

Grazing management: Western wheatgrass begins growth later than most wheatgrasses. Grazing should not begin until grass is at least 4 inches tall. Stubble height should not be less than 3 inches between grazing periods and at the end of the grazing season. Regrowth is slow, and rest periods should be at least 35 days.

Wildrye, Altai *Leymus angustus*

Altai wildrye is a long-lived, deep-rooted, winter-hardy, drought-resistant, cool-season, introduced grass with short rhizomes.

Adaptation and use: Altai wildrye is adapted to moderately deep to deep loam to clay loam soils with 14 inches or more of annual rainfall. Roots can grow and use moisture to a depth of 15 feet. This species can withstand saline conditions almost as well as tall wheatgrass and is almost as productive on saline sites. Seedlings develop slowly, and good seedbed preparation and weed control are essential. Altai wildrye begins growth in mid-spring and grows into late fall. Basal leaves are somewhat coarse, but are very palatable during late summer and early fall. Altai wildrye provides excellent winter forage. Coarse, erect, stiff stems reach 2 to 4 feet in height and tolerate snow loads. Protein levels of 8 percent are common in standing winter feed. This species can also be swathed into windrows, cured and utilized as winter feed.

Grazing management: Grazing can begin when grass is 8 inches tall. Remove livestock when stubble is 6 inches. This species has fair to good regrowth characteristics if soil moisture is available. Grazing cycles with approximately 35 days or more rest are recommended.

Wildrye, basin *Leymus cinereus*

Basin wildrye is a slightly spreading, robust, tall, coarse, long-lived, native bunchgrass.

Adaptation and use: Basin wildrye is especially suited to deep, fine-textured clayey to loamy soils that receive 10 to 16 inches of annual precipitation. It is well adapted to moderately saline or alkaline lowlands, floodplains, and areas with high water-holding capacity. Basin wildrye is useful for calving pasture and for wildlife forage and cover. Once established, this is a very high-yielding species. Basin wildrye is highly palatable in the spring, but palatability declines rapidly with maturity. The old, coarse growth is readily utilized by late-fall or winter grazing, as long as protein supplements are provided.

Grazing management: Poor seedling vigor usually results in sparse stands. Do not graze new seedings until seedheads are evident or until at least the end of the second growing season. On established stands, allow basin wildrye to reach at least 10 to 12 inches of growth before grazing. Take great care to avoid close grazing or clipping, which may result in high levels of plant loss in a single season. During active growth, do not graze below a 10-inch stubble height to avoid removing the growing point. Regrowth ability following grazing is poor, and multiple grazing cycles are not recommended. Maintain at least a 6 inch stubble height going into the winter.

Wildrye, Russian *Psathyrostachys juncea*

Russian wildrye is a long-lived, saline-, drought-, and cold-tolerant introduced bunchgrass.

Adaptation and use: Plant in areas that receive at least 8 inches of annual precipitation. Russian wildrye can withstand saline conditions almost as well as tall wheatgrass. It is useful on soils too alkaline for crested wheatgrass and too dry for tall wheatgrass. Once

established, Russian wildrye competes very effectively against undesirable plants. This species produces abundant basal leaves that remain green and palatable through summer and fall as long as soil moisture is available. Russian wildrye is palatable to all classes of livestock. It cures better on the stump than most cool-season grasses and makes excellent fall and winter feed. In late-summer, fall, and winter, it is more palatable than crested wheatgrass. Russian wildrye is not suited for hay production due to the predominance of basal leaves, which make it difficult to harvest. Russian wildrye is very sensitive to deep seed placement. Plant at 0.25 to 0.5 inch depth. Wide row spacing (at least 18 inches) results in the highest potential production.

Grazing management: Russian wildrye grows rapidly in the spring. It can be grazed when plant growth reaches 8 inches. At least 3 inches of stubble should remain following grazing. Manage stands carefully to avoid overutilization, as stands can be damaged by heavy spring use. In spring, a 28- to 35-day recovery period between gazing cycles is recommended. Recovery periods during summer should be more than 35 days. Russian wildrye regrows quickly if soil moisture is available, and it responds very well to supplemental irrigation.

PASTURE SPECIES—LEGUMES AND FORBS

Alfalfa *Medicago sativa*

Alfalfa is a very productive, palatable, perennial, introduced legume (plants which fix nitrogen). Many varieties are available, each with specific characteristics and purposes.

Adaptation and use: Alfalfa is adapted to well-drained sites. It does poorly at higher elevations and on sites with a high water table. It is suitable for irrigated sites or on dryland sites with effective annual precipitation of at least 12 inches. Varieties differ in their fall dormancy rating (the period when plants are not actively growing). Fall dormancy is correlated with winter hardiness in older varieties; newer varieties that have winter survival rating less than 3 are suitable for areas with hard winters. Alfalfa is suited for use as hay, pasture, or haylage. It is compatible with most dryland and irrigated forage grasses. Bloat can be a problem when grazing alfalfa. To reduce bloat problems, limit alfalfa to 25 percent of a mixed stand and seed at 1 pound per acre. The taproot of alfalfa is vulnerable to pocket gopher damage. Creeping varieties are less susceptible to damage. Creeping types are also more tolerant of grazing than are crown-type varieties. Plant alfalfa in mid-spring after the risk of a killing frost has passed or in summer at least 6 weeks prior to a killing frost. Seed requires inoculation with nitrogen-fixing bacteria before planting. See page 10 for proper inoculum.

Grazing management: Grazing can begin after alfalfa reaches a height of 6 inches. Following grazing or haying, alfalfa starts to regrow quickly but replenishes its food reserves slowly. Frequent defoliation at short intervals depletes reserves and reduces survival. A rest period of 28 to 35 days is recommended. Terminate grazing 3 to 4 weeks before the first killing frost to allow buildup of food reserves for winter survival.

Burnet, small *Sanguisorba minor*

Small burnet is a perennial, semi-evergreen, introduced forb that grows up to 2.5 feet tall. It is non-leguminous (does not fix nitrogen) and deep rooted.

Adaptation and use: Small burnet is best adapted to well-drained soils. It can be grown on low-fertility, droughty soils, as well as on moderately wet, acid soils. It establishes easily on good soils, but will not persist with less than 14 inches of annual precipitation or in areas that are shaded, poorly drained, or have a high water table. Small burnet provides moderate amounts of forage. It is very palatable to livestock and wildlife. Upland game and songbirds utilize its seed.
Grazing management: Defer grazing until the second growing season to allow plants to become established. In established stands, growth is most vigorous in spring and fall. Allow plants to reach a height of 12 inches before grazing. Recovery following grazing is good. Rest periods should be about 35 days. Stubble height at the end of the grazing period or season should be 6 inches.

Clover, alsike *Trifolium hybridum*

Alsike clover is a short-lived (3 to 5 years), perennial legume.
Adaptation and use: Alsike clover is adapted to flooded or poorly drained, acid soils. It makes good hay from wet bottomlands and tolerates moderately saline to alkaline conditions with high water tables. It produces best under irrigation or on dryland where the effective annual precipitation is at least 18 inches. This species is especially useful in cool areas, as it is very tolerant of cold temperatures and frost heaving. It does not tolerate droughty conditions or hot temperatures and is not well adapted to sandy soils or shade. Alsike clover produces abundant palatable foliage on fertile soils. It is most productive in mixtures with grasses. Bloat is a potential problem. To reduce bloat problems in grazing situations, limit alsike clover to 25 percent of a mixed stand and seed at 1 pound per acre. Seed requires inoculation with nitrogen-fixing bacteria before planting. See page 10 for proper inoculum.
Grazing management: Alsike clover is best if grazed in spring. Begin grazing after 6 inches of growth. In spring and early summer, a rest period of 21 to 35 days is recommended. Regrowth is excellent in spring when temperatures are low and soil moisture is available, but poor later in the summer. A stubble height of 3 inches should remain at the end of the grazing period or season.

Clover, red *Trifolium pratense*

Red clover is a short-lived (2 to 3 years), perennial legume.
Adaptation and use: Red clover is adapted to irrigated conditions or to dryland where effective annual precipitation is at least 25 inches. It requires well-drained soils and produces best under medium acid to neutral soil conditions (pH 6.0 to 7.5). It is tolerant of shade, but does not tolerate flooding, saline conditions, or waterlogged soils. It does not tolerate drought or hot temperatures. Red clover is suited primarily for hay and silage. It is compatible with white clover and grasses in pasture mixtures. Because red clover is short lived, production is usually greater in the second year than in the first or third. This species will reseed and spread under favorable conditions. Bloat is a potential problem. To reduce bloat problems in grazing situations, limit red clover to 25 percent of a mixed stand and seed at 1.5 pounds per acre. Seed requires inoculation with nitrogen-fixing bacteria before planting. See page 10 for proper inoculum.

Grazing management: Red clover is best if grazed in spring. Begin grazing after about 6 inches of growth or at the quarter- to half-bloom stage. In spring and early summer, a rest period of 21 to 35 days is recommended. Regrowth is excellent in spring when temperatures are low and soil moisture is available, but poor later in the summer. A stubble height of 3 inches should remain at the end of the grazing period or season.

Clover, white (Ladino) *Trifolium repens*

White clover is a long-lived, shallow-rooted, stoloniferous, low-growing, perennial legume.

Adaptation and use: White clover thrives in cool, moist mountain and intermountain areas with winter snow cover. It can be grown under irrigation or on dryland where effective annual precipitation is at least 18 inches. In general, it is best adapted to clay and loam soils in humid and irrigated areas. It grows successfully on sandy soils with a high water table or on irrigated, droughty soils when adequately fertilized. White clover seldom roots deeper than 2 feet, making it adapted to shallow soils as long as adequate soil moisture is available. It is not tolerant of strongly acid or strongly alkaline conditions or of poor drainage. It does not tolerate drought or hot temperatures. White clover is suited primarily for pasture and is best grazed in spring. It is compatible with red clover and grasses in pasture mixtures and will reseed and spread under favorable conditions. Bloat is a potential problem. To reduce bloat problems in grazing situations, limit white clover to 25 percent of a mixed stand and seed at 1 pound per acre. Seed requires inoculation with nitrogen-fixing bacteria before planting. See page 10 for proper inoculum. This species is also a good erosion-control plant, although usually lacking in persistence. There are three "height" types of white clover: 'Ladino' is a tall type, 'Grassland Huia' is an intermediate type, and 'Dutch' types are quite short.

Grazing management: Begin grazing after about 6 inches of growth. In spring and early summer, a rest period of 21 to 35 days is recommended. Regrowth is excellent in spring when temperatures are low and soil moisture is available, but poor later in the summer. A stubble height of 3 inches should remain at the end of the grazing period or season.

Milkvetch, cicer *Astragalus cicer*

Cicer milkvetch is a long-lived, slow-establishing, late-maturing, grazing-tolerant, winter-hardy, introduced, rhizomatous, non-bloat legume.

Adaptation and use: Cicer milkvetch is adapted to cold lowland areas and to soils with high water-holding capacity that receive at least 14 inches of annual precipitation. It is moderately tolerant of flooding. Cicer milkvetch is a heavy seed and forage producer with nutritious forage. The best time to utilize cicer milkvetch forage is summer and fall. This species is very tolerant of livestock trampling. It is a good species for fall and early-winter stockpiled forage, as nutrients are retained in later growth. Hay yield is nearly equal to that of alfalfa. Cicer milkvetch is very compatible with irrigated pasture grasses. It can substitute for alfalfa at higher elevations where alfalfa winter kills, or where a high water table limits alfalfa production. In a 50 percent mixed stand pasture, a seeding rate of 4 pounds per acre is recommended. This species is slow to establish due to very hard

seed. Scarification of seed is recommended. Seed requires inoculation with nitrogen-fixing bacteria before planting. See page 10 for proper inoculum.
Grazing management: Begin grazing after cicer milkvetch has reached a 4-inch height. After grazing, new shoots grow from buds on the rhizomes, crowns, and nodes of the lower leaves, allowing for relatively rapid recovery and growth. Rest periods of 35 to 42 days are recommended. Stubble should be 3 inches at the end of the grazing period or season.

Sainfoin *Onobrychis viciifolia*

Sainfoin is a deep-rooted, medium-lived, drought-resistant, introduced, cool-season, non-bloating legume.
Adaptation and use: Sainfoin is adapted to deep, well-drained, medium-textured soils. It tolerates high lime and slightly alkaline soils. It is adapted to irrigated conditions and to dryland with at least 14 inches of annual precipitation. It is not tolerant of wet soils or high water tables. Sainfoin can be grazed or used for hay. It blooms early, but is not as productive as alfalfa. It is highly palatable. The recommended seeding rate for a 50 percent mixed-stand pasture is 17 pounds per acre. Sainfoin has good seedling vigor, but seedlings are not competitive against weeds or other plants. Seed requires inoculation with nitrogen-fixing bacteria before planting. See page 10 for proper inoculum. Stands seldom live more than 10 years due to problems with stem and root rot. To maintain a stand long-term, allow established plants to reseed every 3 or 4 years. Sainfoin is a preferred species by deer and elk as well as cattle.
Grazing management: Begin grazing in the early-bloom stage or at about 12 inches of height. Rest periods of 35 to 42 days are recommended. A stubble height of 6 inches should remain at the end of the grazing period or season.

Sweetclover, yellow and white *Melilotus officinalis and M. alba*

Sweetclover is an introduced, tall, stemmy, deep-rooted, biennial legume.
Adaptation and use: Sweetclover is adapted to many sites, but does not tolerate acid soils. It is the most drought-tolerant legume commercially available. Sweetclover produces abundant forage the first 2 years and is commonly utilized as a cover crop for perennial seedings. It is also suited for green manure or green-chop haylage under irrigation or on dryland where effective annual precipitation is at least 9 inches. Sweetclover reseeds and maintains good stands in years of above-normal spring precipitation, as long as the perennials do not crowd it out. Forage quality is poor in mid- to late summer. Bloat is a potential problem. To reduce bloat problems in grazing situations, limit sweetclover to 25 percent of a mixed stand and seed at 1 pound per acre. Seed requires inoculation with nitrogen-fixing bacteria before planting. See page 10 for proper inoculum.
Grazing management: Begin grazing after sweetclover has reached 8 inches in height. In spring and early summer, a rest period of 28 to 35 days is recommended. This species has excellent recovery and growth in spring and early summer if soil moisture is available. Stubble height should be at least 6 inches at the end of the grazing period or season. Sweetclover contains coumarin, a derivative of dicoumarol, a blood

anticoagulant. Death may occur in animals foraging on pure stands or consuming spoiled hay or silage.

Trefoil, birdsfoot *Lotus corniculatus*

Birdsfoot trefoil is a short-lived, deep tap-rooted, non-bloat, introduced legume.
Adaptation and use: Birdsfoot trefoil can be grown under irrigation or on dryland where effective annual precipitation is at least 18 inches. It is very winter-hardy where protected by snow cover and is useful in high-elevation settings. It tolerates poor drainage and waterlogged soils. Under ideal growing conditions, it may invade adjacent areas. Birdsfoot trefoil is suited for use as pasture or hay. Compared to alfalfa, it retains higher quality forage on mature growth. The decumbent and intermediate types tolerate close grazing better than erect types. This legume is quite vigorous and is an excellent plant for erosion control. For grazing situations in a 50 percent mixed stand, a seeding rate of 1.5 pounds per acre is recommended. If the mixture includes grasses, alternate-row planting is recommended to allow birdsfoot trefoil to establish. Seed requires inoculation with nitrogen-fixing bacteria before planting. See page 10 for proper inoculum. Birdsfoot trefoil is short lived (2 to 4 years), making reseeding necessary. However, if plants are allowed to go to seed, stands will persist for many years.
Grazing management: New stands establish slowly and should be hayed the first growing season. On established stands, grazing can begin after 6 inches of new growth. Regrowth initiates from buds formed in the leaf axils. Allow 28 to 35 days between grazing periods. Terminate grazing 3 to 4 weeks before the first killing frost to allow buildup of food reserves for winter survival. Stubble height should be at least 3 inches at the end of the grazing period or season.

Table 1. Growth stage for grazing or harvesting forage, stubble height, optimum season of use, and regrowth ability.				
	Minimum plant height before and after haying or grazing			
Plant species	**Prior**	**Stubble**	**Optimum season of use**	**Regrowth ability**
Grasses				
Bluegrass, Kentucky	5	2	Spr/F	Exc.
Brome, Meadow	8	4	Spr/Su/F	Exc.
Brome, Smooth	8	4	Spr/Su/W	Poor
Canarygrass, Reed	8	4	Spr/Su	Exc.
Cereals, Grains	8	4	F/W/Spr	Good
Fescue, Tall	6	4	Spr/F/W	Fair
Festulolium	8- 10	3	Spr/F	Good
Foxtail, Creeping	6	4	Spr/Su/F	Exc.
Orchardgrass	8	4	Spr/Su/F	Good
Ryegrass, Perennial	10	8	Spr/Su	Good
Timothy	6	4	Spr/Su	Fair
Wheatgrass, Crested	6	3	Spr/F	Poor
Wheatgrass, Intermediate	8	4	Spr/Su/F	Good
Wheatgrass, Pubescent	8	4	Spr/Su/F	Good
Wheatgrass, Siberian	6	3	Spr/F	Poor
Wheatgrass, Tall	10	6	Su	Fair
Wheatgrass, Western	4	3	Spr/F/W	Fair
Wildrye, Altai	8	6	Spr/Su/F/W	Good
Wildrye, Basin	10- 12	10	F/W	Poor
Wildrye, Russian	8	3	Su/F/W	Good
Legumes and Forbs				
Alfalfa	6	3	Su/F	Exc.
Burnet, Small	12	6	Su/F/W	Good
Clover, Alsike	6	3	Spr	Exc.
Clover, Red	6	3	Spr	Exc.
Clover, White (Ladino)	6	3	Spr	Exc.
Milkvetch, Cicer	4	3	Su/F	Exc.
Sainfoin	12	6	Spr/Su	Good
Sweetclover	8	6	Su	Exc.
Trefoil, Birdsfoot	6	3	Su	Exc.

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