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Forage Crop Variety Trials in the Tanana Valley of Interior Alaska

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Forage crops make up almost 75% of the total crop acreage in Alaska. Over the past ten years, average yields were near 1.1 tons per acre in Alaska with an average of 1.0 tons/acre in the Tanana Valley (Benz et al. 2003). Most of the harvested forages grown in Alaska are perennial grasses but legumes and cereal species, such as oats and barley, are occasionally grown for forage. Results of recent cereal forage and grain trials in the Tanana Valley can be found in Van Veldhuizen and Knight (2004).

Smooth bromegrass is the most important perennial forage grass in Alaska, although timothy and other grasses are grown (Phil Kaspari, Delta Junction area Cooperative Extension Service agent, personal communication). In interior Alaska, most of the smooth bromegrass consists of two varieties, 'Carlton' or 'Manchar,' and 'Engmo' is the most common timothy variety. These are all old varieties. Manchar smooth bromegrass was released jointly by Washington State University and the University of Idaho Agricultural Experiment Stations in 1943; Carlton was released in 1961 by the Canada Department of Agriculture; and Engmo timothy was developed in the 1930s in Norway near latitude 70°N. Both smooth bromegrass varieties provide good hay yields when managed properly; however, they sometimes experience winterkill during severe Alaskan winters, as they are adapted to more southerly latitudes. Also, unless the first cutting is properly timed and the crop is carefully managed, second cut yields are often quite low (Klebesadel 1994a). Engmo timothy is adapted to high latitude environments, but is drought intolerant (Klebesadel 1997).While both smooth bromegrass and timothy can produce high quality forages, proper timing of cutting and fertilization are critical, as quality can decrease rapidly if not cut at the proper time or if the grass is limited by nitrogen or other nutrients. In addition, cutting too late in autumn can severely decrease winter survival of perennial forage crops (Panciera, 1998).

Legumes are seldom grown on a large scale as forage crops in Alaska, although a few farmers produce forage peas, red clover, and alfalfa. Forage legumes can produce high yields of high-quality forages when grown under optimum conditions. They also have the ability, in conjunction with bacteria that live in nodules on the plants' roots, to fix their own nitrogen, thus eliminating or reducing the need for application of nitrogen fertilizer (Sparrow et al., 1990). Unfortunately, perennial legumes are generally considered not hardy enough for long-term survival, especially in interior Alaska (Klebesadel 1983). Large-seeded annual legumes (such as peas and fababeans) are expensive to grow and small-seeded annual legumes are usually considered to be poorly adapted to Alaska conditions (Panciera and Sparrow, 1994).

Farmers in Alaska are interested in finding new species or varieties of grass or legume forage crops that will improve yields and quality and expand their management options.

We tested a large number of grass and legume crops (Appendix 1) for their potential as forage crops at several locations (Table 1) in Alaska's Tanana Valley during the period 1988 to 2002. We chose several different locations because climate and soils vary greatly across the region.

Plots were usually 6 x 20 feet in size, although plot size varied somewhat among locations. Some preliminary trials were done in single row plots seeded with a hand-pushed, belt driven seeder equipped with a shoe type opener. We seeded multi-row plots either with a plot drill equipped with double disk openers or with a Carter plot seeder with vee-furrow wheels and smooth rubber packer wheels. All plots were fertilized with phosphorus, potassium, and sulfur based on soil tests. Grass plots were fertilized with nitrogen, usually at a rate of 100 lb/acre. We did not add nitrogen fertilizer to legume plots but instead we inoculated them with nitrogen-fixing bacteria. We used four replications for each crop at each site except for Nenana, where three replications were used.

At Sawmill Creek, we established plots under both irrigation and dry-land; however, the farmer irrigated when optimum for his crops, which was not always the optimum time for the crops in our trials. We found little difference in yield or quality between irrigated and dry-land plots for a given crop at Sawmill Creek, thus we combined data for the two. At Tanana Loop, we used several locations on Paul Knopp's farm. Overwinter survival there was so poor that we seldom obtained harvestable yields in years subsequent to the seeding year. This was probably due to several factors, including poor snow cover coupled with high available nitrogen levels in the soil. Both of these factors are known to increase susceptibility of perennial forage crops to winterkill (Panciera, 1998; Volenec and Nelson, 2003). At Fairbanks, weeds, including shepard's purse, chickweed, and quackgrass,

were a major problem. Most legumes appeared to have lost vigor by their second growing season and usually did not survive past two years, but when they did the weed problem had become so severe that we destroyed the plots. The Nenana site was at Bill Spencer's farm on land that had been recently cleared and never cropped.

Plots were treated with appropriate herbicides when suitable ones were available. Unfortunately, registered herbicides are not available for some of the crops used in our trials or any available herbicides were not effective against some of the weeds in the plots.

We attempted to harvest when grass was at the early heading stage, alfalfa at about 10% bloom, and clovers at about 50% bloom. This was often not possible because remoteness of and large numbers of sites made optimum timing of harvest logistically impossible.

We harvested plots by hand-clipping an area 2 x 2 feet (in some cases 3 x 3 feet) from within each plot or by harvesting an area approximately 3.5 x 10 feet with a flail-type plot harvester. When we harvested by hand, we separated weeds from the crop; when we harvested with the flail type harvester we hand-clipped weed-free samples for forage quality analysis. We usually harvested each plot once per year but sometimes obtained two harvests per year for some crops. Selected samples were analyzed for crude protein, neutral detergent fiber (NDF), and acid detergent fiber (ADF) concentrations in tissue, as indicators of forage quality.

Results and Discussion

Yield

Delta Junction area

Yields for all crops at the Delta Junction Bison Range were fairly low (Table 2). Grasses were slow to establish, but both smooth bromegrass and Kentucky bluegrass persisted until the end of the study, with smooth bromegrass yields gradually increasing to >1.5 tons/acre by the fifth and sixth years. Altaswede red clover was the only crop producing yields near 1 ton/acre in the establishment year. Alfalfa, kura clover, and cicer milkvetch were slow to establish and thus produced very low yields in the seeding year. Of the legumes, only Anik yellow-flowered alfalfa and Alaskland and Altaswede red clover persisted to produce yields greater than 0.5 tons/acre after the establishment year, and red clover, which needs good snow cover for good survival in Alaska, had mostly died out after the third year. Anik alfalfa persisted throughout the study (6 years), but yields never reached 1 ton/acre. We tested several varieties and species of forage crops in single-row plots at several locations on the Bison Range. These included: A-syn-B alfalfa, Norgold sweetclover, Aurora alsike clover, mammoth red clover, Empire birdsfoot trefoil, big trefoil, and several Alaska native legumes. Yields of these crops never exceeded 1.0 ton/acre per season, and were often <0.5 tons/acre. The low yields at the Bison Range were probably due to a combination of factors, including droughty conditions in most years, acidic conditions which would be especially detrimental to many of the legumes, and fairly low N fertilizer rates for the grasses.

At the UAF Delta Field Research Site, we did not test forage grasses, but tested several annual and perennial legumes. The perennial legumes never survived the first winter in large enough quantities to obtain second year harvests. Yields of small-seeded legumes seldom reached 1 ton/acre; the only exception was arrowleaf clover. Only one alfalfa variety (Nitro) exceeded 0.5 tons/acre (Table 3). We obtained highest yields with pulse-type legumes (large-seeded types), with Poneka peas yielding >2 tons/acre (Poneka peas yielded 3.3 tons/acre in one trial) and Friedrichs fababeans yielding almost 2 tons/acre. Unfortunately, seeds of Friedrichs fababeans are now difficult to obtain. The low yields for most crops were probably because of droughty soils and acidic conditions. These factors, in addition to lack of snow cover in winter (due to high winter winds), probably contributed to the very poor overwinter survival of the perennial crops (Panciera, 1998). We tested several legume crops following liming of the soil to raise the soil pH. Liming increased the soil pH from 5.3 to 6.4 and increased average yield from 1.5 to 1.8 tons/acre. Unfortunately, there are no in-state sources of agricultural limestone, thus it must be imported, making it expensive and likely not cost effective. We also tested 12 experimental lines of yellow lupines in single row plots in one year at the UAF Delta Field Research Site. Yields varied from 1.5 to 4.7 tons/acre. Yields in single-row plots are likely to be higher than in larger plots, and yields we obtained for yellow lupines were probably much higher than a farmer could expect. Even so, these results indicate that yellow lupines may have potential as a forage crop in Alaska, and further testing is needed. However, seeds of yellow lupines are difficult to obtain in commercial quantities; this may limit their use in Alaska.

At Sawmill Creek, we obtained fairly high yields for several of the forage grasses, even for perennial grasses in the seeding year (Table 4). Yields for perennial grasses were considerably lower in the second year after establishment than in the seeding year. Several of these grasses are varieties that are known to be hardy under Alaska conditions, so we do not know why yields were so low the second year, but it may have been partially due to poor vigor brought on by low soil pH and winter injury due to poor snow cover. Legume yields were generally low; only a few alfalfas and one red clover variety reached yields of 1 ton/acre. None of the legumes except Peace alfalfa survived the winter in sufficient quantities for a second-year harvest, and Peace yields in the second year were low. We did not find any yield differences between irrigated and dry-land crops at Sawmill Creek. Irrigation at non-optimum times for these crops may have contributed to the lack of an irrigation response.

In the 1997–1998 trials at Tanana Loop, yields in the seeding year for most crops were so low that we did not harvest the plots (Table 5). Several crops, especially the grasses, survived the winter, but second-year yields were usually low, although some

reached 1 ton/acre. Several varieties of alfalfa survived enough to obtain second-year harvests, but yields were usually quite low. Altaswede red clover produced an average yield of 1.3 tons/acre in the second year.

Seeding year yields in 1999 at Tanana Loop were quite high for some of the grasses, sometimes reaching >4.0 tons/acre (Table 6) and all of the grass yields exceeded 2 tons/acre. The site had good soil moisture and heavy amounts of dairy manure had been applied there for many years. Thus, both nutrients and water were in high supply, providing good conditions for rapid growth. Most of the legume crops reached or exceeded yields of 1 ton/acre but none exceeded 2 tons/acre. Weed populations at that location were very high, despite attempts to control them with herbicides. Most forage-type legumes are not competitive when young; thus weed competition likely reduced yields. None of the crops, even those known to be generally winter hardy, survived at that site. This was probably due to a combination of factors including a midwinter thaw followed by icing, spring flooding, poor snow cover, high levels of available soil nitrogen, and trampling by a herd of cows.

Fairbanks area

At Fairbanks, most of our trials have been with forage legumes and we began grass trials only recently, therefore, grass trial results are based on limited data. Several grasses showed potential for high yields at Fairbanks, with smooth bromegrass producing the highest yields (Table 7). The old standbys, Carlton and Manchar, produced at or near the maximum yield of all grasses. Other bromegrass species did not perform nearly as well as smooth bromegrass in these trials. Timothy produced better at Fairbanks, especially in the second year, than at most other sites, probably because moisture is not as limiting in these soils as at most other sites. Quackgrass was a major problem weed at Fairbanks, and took over many of the plots, thus, we often abandoned the grass plots after two years. We tested a large number of legume species and varieties at Fairbanks, and several of them showed potential for producing good yields. Alfalfa, red clover, and yellow sweetclover showed high potential for producing good yields. Many of the annual clovers flowered early in the growing season, probably in response to long photoperiods, thus putting much of their energy into reproductive rather than vegetative growth. Also, many of the annual forage-type legumes were very slow to establish. Large-seeded legumes, especially Friedrichs fababeans and some varieties of field peas showed quite high yield potential at Fairbanks, sometimes producing well over 3 tons herbage per acre. Many of the varieties of alfalfa and red clover died out after the seeding year, but a few survived and produced good yields in the second year. The best producers in the second year were those which were developed under northern conditions, and thus are likely more adapted to our conditions than more southerly types (Klebesadel, 1992, 1994b). The top-yielding varieties in the second year included Denali alfalfa, Peace alfalfa, Falcata collection (an Alaska collection of yellow-flowered alfalfa), Alaskland red clover, and Altaswede red clover. Unfortunately, seeds are not available for most of these varieties. Perennial forage legumes at Fairbanks often did not persist in harvestable quantities more than two or three years. We tested 18 experimental lines of yellow lupines in single row plots at Fairbanks and found yields to range from 2.3 to 6.5 tons per acre. Although yields may be much higher than obtainable in a commercial planting, they indicate potential for this crop in Alaska (see discussion for the Delta Field Research Site).

We planted grass trials at Eielson in only one year, and establishment was slow, so we did not harvest any of the grass plots in the establishment year. Second year yields ranged from <0.5 to >2 tons/acre (Table 8). We do not know why Manchar smooth bromegrass seemed to perform so much better than other smooth bromegrass varieties. Perennial legume (mostly alfalfa) yields were 1 ton/acre or more, but most of them experienced so much moose grazing and winterkill that little or no harvestable yield was obtained in the post-seeding years except for Peace alfalfa which produced an average yield of 1 ton/acre. Some of the annual legumes, especially the vetches, produced yields near 2 tons/acre.

Nenana area

At Nenana, most crops were slow to establish, and yields were thus usually quite low in the establishment years (Table 9). However, field peas produced yields >1.5 tons/acre. We planted several varieties of cicer milkvetch and birdsfoot trefoil, but poor germination prevented good enough establishment for harvestable yields. Of the perennial legumes, only Denali and Anik alfalfa survived enough to produce harvestable yields past their second growing season. Several of the perennial grasses survived well, and did not reach their maximum yields until the third year. Of those, Carlton and Manchar smooth bromegrass produced quite good yields. Other bromegrass varieties at Nenana were planted only recently and thus have not yet had time for long-term testing.

Forage Quality

Forage quality is affected by many factors including growth stage at which the plant is harvested, soil fertility (especially nitrogen availability for grasses), and other stress factors such as soil acidity and drought. Digestibility of protein and fibers in forages varies depending on plant species, plant growth stage, soil nitrogen availability, and degree of disease and insect infestation, and handling and treatment after harvest (for a good discussion of forage quality, see Bittman et al. 1999).

Crude protein, neutral detergent fiber (NDF), and acid detergent fiber (ADF) are common indicators of forage quality (Linn and Martin 1991, Grant et al. 1997). Crude protein is a measure of both the true protein and nonprotein nitrogen in the forage. Nitrogen is an essential nutrient for livestock animals

which often get most of or all their nitrogen from the forages they eat. Thus, the higher the crude protein in the forage the better the forage quality. Both NDF and ADF are measures of fiber in the forage. NDF measures the structural constituents (cell wall) of the plant, and provides what is sometimes refereed to as "bulk" in the forages. It tends to cause the animals to feel full when they consume it, thus limiting forage intake. Thus, NDF values can be used to predict intake of a forage. ADF measures the mostly indigestible components of the forage, so high ADF values mean low forage digestibility. High-quality forages have relatively low NDF and ADF values. A fairly new concept, relative feed value (RFV), which is calculated from NDF and ADF, is sometimes provided with forage quality analyses. The higher the RFV values of the forage the better the forage quality. The relative feed value concept was developed for and is often used in the marketing of alfalfa hay. Relatively little research has been done on use of RFV for evaluating the quality of grass forages or legumes other than alfalfa, so most forage quality experts recommend caution in using it for those purposes. Forage quality standards and typical values for various forage crops from different regions are given in Appendix 2.

In our trials, growth stage at time of harvest varied considerably, even at a given site, because logistics prevented harvesting when each variety reached the optimum stage. This likely caused some differences in forage quality.

Delta Junction area

Crude protein concentrations in tissues of crops at the Delta Junction Bison Range tended to be fairly low (Table 10) with most of the grasses falling into the fair to good hay grades described by Cash and Dixon (2002, see Appendix 2). For the grasses, fairly low protein concentration may have occurred because N fertilization rates were fairly low (80 lb/acre). The low crude protein concentrations for the legumes probably indicated that they were not fixing enough N to fully supply their needs. We did not apply N fertilizer to the legumes or to the legume/grass mixtures. Tissue ADF values were usually fairly low for crops in the Bison Range study, indicating good digestibility of the forages.

At the Delta Field Research Site, crude protein concentrations were usually quite low (Table 11) and only a few crop varieties produced forage with average tissue crude protein concentrations high enough to meet the standard for good quality hay under the USDA alfalfa hay quality guidelines (Appendix 2). Variability tended to be high among varieties within a species. The low protein concentrations for most crops probably reflects poor N fixation, likely due to low soil pH. Both NDF and ADF values were fairly low for most crops, often low enough to fall into the prime hay grade category described by Linn and Martin (1999, see Appendix 2). Perennial clovers usually had very low NDF and ADF concentrations. Values for alfalfa were generally lower than is considered typical for this crop at similar growth stages (see Kellems and Church, 1998, Appendix 2).

At Sawmill Creek, crude protein concentrations were usually higher for legumes than for grasses, although a few alfalfa and red clover varieties ranked among the lowest of all crops for tissue crude protein concentrations (Table 12). Crude protein concentrations for the grasses were considerably lower than the British Columbia average given by Bittman et al. (1999), but were near or above those given for grasses at boot stage in Alberta (Appendix 2). Ryegrass had among both the highest and lowest crude protein concentrations within the grasses. Tissue NDF and ADF concentrations varied greatly, with NDF ranging from 24 to 69% and ADF from 16 to 40%. White clover produced very low NDF concentrations; white clover and perennial ryegrasses generally produced forage with low ADF concentrations. Annual ryegrasses and some of the alfalfa varieties produced herbage which had among the highest ADF concentrations. Relatively high NDF and ADF concentrations for annual ryegrass probably reflects its tendency to early heading, thus putting more energy into stems and reproductive tissue, rather than high quality leaves. We do not know why some alfalfa varieties and Cinnamon red clover produced tissues with fairly high NDF and ADF concentrations.

Crude protein concentrations for forages at Tanana Loop tended to be fairly high, with some legume forages reaching or approaching the supreme hay quality crude protein standard (Table 13, Appendix 2). The relatively high tissue protein concentrations at Tanana Loop, relative to other Delta Junction area locations, may reflect the high soil fertility there. Clovers produced tissues with quite low NDF and ADF concentrations and some perennial ryegrasses produced tissues with NDF and ADF concentrations less than the low category value given by Bittman et al. (1999), which indicates they were highly digestible forages.

Fairbanks area

At Fairbanks, average tissue crude protein concentrations ranged from 10% for Mt. Barker subterranean clover to 26% for AC Nordica alfalfa (Table 14). Protein concentrations for many of the crops fell into the good to supreme hay grades based on tissue protein concentrations except for some of the annual clovers which sometimes had quite low values. The low protein values for these species may reflect inability to fix adequate nitrogen under subarctic conditions. Tissue NDF and ADF concentrations were quite low for some clovers. Fiber values varied greatly at Fairbanks, with NDF ranging from 23% for Alaskland red clover to 62% for Carlton smooth bromegrass and ADF ranging from 15% for Alaskland red clover to 36% for Carlton smooth bromegrass. Many of the legumes were below the threshold values needed for premium hay (see Appendix 2). Among the legumes, annual medics and clovers tended to give the highest concentrations. All of the grasses at Fairbanks had NDF and ADF concentration too high to be classified as prime hay under Linn and Martin's grading system. However, these values represent few samples; further analyses are needed to determine if these values are typical at this site.

At Eielson, only vetches produced herbage crude protein concentrations high enough to fall into the premium hay grade (Appendix 2), with values greater than 20% (Table 15). Protein concentrations in most of the grasses and some of the legumes were fairly low, and some including Manchar smooth bromegrass, Tiiti timothy, and Yuchi arrowleaf clover produced very low protein forages. We analyzed only a few of the forage samples from Eielson for NDF and ADF concentrations. Neutral detergent fiber values ranged from 39 to 64%, with lowest for alfalfa and highest for timothy. Acid detergent fiber varied much less than NDF, with values ranging from 28 to 37%.

Nenana area

Crude protein values at Nenana ranged from 11% to almost 20% (Table 16). Eejay Altai wildrye and Tonga perennial ryegrass ranked among the highest for crude protein, whereas bromegrasses tended to rank near the bottom. Some of the alfalfa varieties and the red clovers had relatively low protein concentrations at Nenana. Neutral detergent fiber values tended to be fairly high, with many exceeding the maximum 40% needed for prime hay. Most produced ADF concentrations which fell within the range needed for prime hay and many of the legume forages fell into the premium or supreme hay grades based on ADF concentrations (see Appendix 2), indicating highly digestible forages.

Conclusions and Recommendations

Smooth bromegrass, because of its ability to produce relatively high forage yields and its good survivability under most conditions, is the best overall choice for perennial hay crops under most conditions in the Tanana Valley. Carlton and Manchar still seem to be among the best smooth bromegrass varieties. Smooth bromegrass must be managed carefully (fertilized adequately, harvested at the proper time, proper weed control) to obtain hay with high forage quality and to maintain good stands over long periods.

Timothy should only be grown in sites with adequate soil moisture. Timothy is more acid tolerant than most forage grasses and thus more suited for soils with low pH. None of the varieties we tested outperformed Engmo.

Perennial ryegrass is a good choice for an annual forage crop if soil moisture is sufficient. It can produce high yields of high-quality forage in interior Alaska. No one variety consistently performed better than others in our trials. Perennial ryegrass will usually not survive interior Alaska winters, so we recommend it be managed as an annual crop.

Annual ryegrass has been found to perform well in south-central Alaska (Mitchell, 1984). However, we do not recommend planting annual ryegrass in interior Alaska, as it heads early under our conditions, thus usually producing low yields and poor quality forage.

We found several large-seeded legumes to produce good yields of high-quality forage. They are fairly expensive to produce, and seeds of some are not readily available. Field peas are probably the best choice as seeds are readily available, they are easy to establish, and do well in fairly acidic soils.

Annual vetches did well in some of our trials, however we found that in some years establishment was a problem. Also, they are not good competitors in the seedling stage, and there are few herbicides approved for use on them. They are vine-like with high moisture content, thus they are difficult to harvest and dry. We recommend that if you try them, plant them in a site with plenty of soil moisture on land that is fairly weed-free, and plant small acreages until you become familiar with the crop.

We do not recommend any of the annual clovers or medics. While we found them to occasionally produce good yields, they usually produced low yields and poor quality forage under our conditions.

We do not recommend perennial legumes in the Delta Junction area, as we have found them to not survive there. If you are determined to try them, then we recommend planting them in areas protected from winter winds and on soils that are not extremely acidic. For alfalfa, you will likely get best survival with Anik, but yields are likely to be low. Peace may survive under some conditions in the area. Altaswede red clover may survive if snow cover is sufficient to protect the plants. Alaskland red clover will likely do well in areas with good snow cover, but seeds are extremely difficult to find.

We have obtained better survival of perennial legumes in the Fairbanks/Nenana area than in the Delta Junction area, but even there, long-term survival has been unreliable. We recommend that if you plant them, start with small acreages at first until you learn how well they will do under your conditions. We recommend Peace alfalfa, but any of the hardy alfalfas from NW Canada are likely to do well. Altaswede or Alaskland red clover are best choices for clovers.

Table 1. Forage crop variety trial sites, site characteristics, and years of tests.

Delta Junction area				
Site name†	Bison Range	Delta Field Research Site	Sawmill Creek	Tanana Loop
Location	63°54'N, 145°19'W	63°56'N, 145°20'W	63°57'N, 145°08'W	64°08'N, 145°43'W
Elevation (feet) ‡	1275	1275	1225	1050
Years of tests	1991-1998	1988-2002	1999-2000	1995-1999
Soil series name	Beales and Volkmar	Beales and Volkmar	Volkmar	Salchaket and Tanana
Average annual precipitation (inches) §	-	-	-	12.3
Average growing season precipitation (inches) ¶	7.8	7.8	7.8	8.6
Average annual temperature (°F) §	27.3	27.3	27.3	26.7
Average growing season temperature (°F) ¶	53	53	53	53

Fairbanks/Nenana areas				
Site name†	Eielson	Fairbanks	Nenana	
Location	64°41'N, 147°13'W	64°51'N, 147°51'W	64°40'N, 148°57'W	
Elevation (feet)‡	525	450	400	
Years of tests	1994-1999	1988-2002	1996-2002	
Soil series name	Jarvis	Tanana	Fairbanks or Minto	
Average annual precipitation (inches) §	12.9	12.7	12.6	
Average growing season precipitation (inches) ¶	7.2	6.8	7.6	
Average annual temperature (°F) §	26	28	26	
Average growing season temperature (°F) ¶	55.5	55.8	54.8	

† Bison Range trials were located on the Panoramic Fields of the Delta Junction Bison Range.
The UAF Delta Field Research Site is located at Mile 1408 of the Alaska Highway.
Sawmill Creek trials were located on Scott Hollembaek's farm on Sawmill Creek Road.
Tanana Loop trials were located on Paul Knopp's farm on Tanana Loop Extension Road.
Eielson trials were located on Dan Cobin's farm on the Eielson Farm Road.
Fairbanks trials were located on the University of Alaska Fairbanks Experiment Farm.
Nenana trials were located on Bill Spencer's farm on the Park's Highway, about 10 miles NE of the town of Nenana.

‡ Elevations are estimated to the nearest 25 feet.

§ Weather data was obtained from the nearest official weather station. In some cases, the same weather station was used for more than one site.

¶ Growing season considered to be May through August.

Table 2. Forage crop yields at the Delta Junction Bison Range. All varieties were harvested once per year.

Common Name	Variety or type	Seeding year	2nd year	3rd year	4th year	5th year	6th year
		Yield (tons per acre)					
Monocrops†							
Kentucky bluegrass	Nugget	<0.5	0.8	1.1	1.0	0.9	0.6
Smooth bromegrass	Carlton	<0.5	0.9	1.2	1.3	1.7	1.7
Alsike clover	Aurora	0.7	nh‡	nh	nh	nh	nh
Cicer milkvetch	Oxley	<0.5	<0.5	nh	nh	nh	nh
Kura clover	NF-90	<0.5	<0.5	<0.5	<0.5	nh	nh
Red clover	Alaskland	<0.5	nh	1.2	nh	nh	nh
Red clover	Altaswede	1.0	1.2	1.0	nh	nh	nh
White clover	White Dutch, VNS§	0.6	nh	nh	nh	nh	nh
Yellow flowered alfalfa	Anik	<0.5	<0.5	0.5	0.6	0.6	0.9
Crops grown in mixtures†							
Kentucky bluegrass/cicer milkvetch	Nugget/Oxley	<0.5	<0.5	nh	nh	nh	nh
Smooth bromegrass/cicer milkvetch	Carlton/ Oxley	<0.5	<0.5	nh	nh	nh	nh
Kentucky bluegrass/kura clover	Nugget/NF-90	<0.5	<0.5	0.6	<0.5	nh	nh
Smooth bromegrass/kura clover	Carlton/NF-90	<0.5	0.6	0.7	<0.5	nh	nh
Kentucky bluegrass/red clover	Nugget/Altaswede	0.7	1.3	1.2	nh	nh	nh
Smooth bromegrass/red clover	Carlton/Altaswede	0.7	1.1	0.9	nh	nh	nh
Kentucky bluegrass/yellow flowered alfalfa	Nugget/Anik	<0.5	<0.5	0.7	0.6	1.1	1.3
Smooth bromegrass yellow flowered alfalfa	Carlton/Anik	<0.5	<0.5	<0.5	<0.5	0.6	0.7

† No nitrogen fertilizer was added to plots that were planted to legumes, whether in monocrops or mixtures with grasses.

‡ nh = no harvest due to poor survival or very poor growth.

§ VNS = variety not specified.

Table 3. Forage legume crop yields at the UAF Delta Field Research Site. Seeding year data only. All varieties harvested once per year.

Common name	Variety or type	Yield tons/ acre
Legumes, perennial		
Alfalfa	Nitro	0.7
Alfalfa	Peace	<0.5
Alfalfa	Spredor 2	<0.5
Birdsfoot trefoil	Norcen	<0.5
Alsike clover	Buckminster	0.5
Red clover	Altaswede	1.2
Red clover	Kenland	0.5
Red clover	Marathon	0.7
White clover	White Dutch, VNS†	<0.5
Legume, biennial		
Yellow sweetclover	Norgold	1.1

Common name	Variety or type	Yield tons/ acre
Legumes, annual		
Arrowleaf clover	Yuchi	1.3
Berseem clover	Bigbee	0.6
Crimson clover	Dixie	0.5
Barrel medic	Jemalong	<0.5
Fababean	Friedrichs	1.8
Field pea	Poneka	2.7
Hairy vetch	Lana	1.4
Lentil	Indianhead	1.4
Tingapea	Tenua	1.2
White lupine	Primorski	0.8

† VNS = variety not specified.

Table 4. Forage crop yields at Sawmill Creek.

Common name	Variety or type	1st year		2nd year	
		Yield (tons/acre)	# of cuts	Yield (tons/acre)	# of cuts
Grasses, perennial					
Reed canarygrass	Bellevue	2.1	1	nh†	-
Smooth bromegrass	Carlton	2.2	1	0.8	1
Smooth bromegrass	Manchar	1.8	1	0.8	1
Timothy	Bottnia II	nh	-	nh	-
Timothy	Engmo	2.1	1	0.6	1
Timothy	Tiiti	1.8	1	nh	-
Alaska wheatgrass	-	nh	-	0.9	1
Grasses, annual					
Annual ryegrass	Abundant	1.9	2	na‡	
Annual ryegrass	AM1	2.1	2	na	
Annual ryegrass	Cowcandy	2.5	2	na	
Annual ryegrass	Max	2.6	2	na	
Annual ryegrass	Molisto Hybrid	1.7	1	na	
Perennial ryegrass§	Amazon	2.2	1	na	

Table 4 Continued on page 9

Table 4, continued:

Perennial ryegrass	Madera	2.2	1	na
Perennial ryegrass	Rosalin	2.0	1	na
Perennial ryegrass	Tonga	2.7	1	na
Festolium (fescue X ryegrass hybrid)	Duo Festolium	2.8	1	na
Soft chess	Blando	2.3	2	na
Legumes, perennial				
Alfalfa	Alfagraze	0.7	1	ns¶
Alfalfa	Alfanure	0.7	1	ns
Alfalfa	Jade II	1.0	1	ns
Alfalfa	Legend	0.6	1	ns
Alfalfa	Nitro	0.5	1	ns
Alfalfa	non-dormant	1.0	1	ns
Alfalfa	Peace	0.6	1	0.5
Alfalfa	Renovator	0.7	1	ns
Alfalfa	Spredor 3	1.0	1	ns
Red clover	Acclaim	1.0	1	ns
Red clover	Altaswede	0.6	1	ns
Red clover	Cinnamon	nh	1	ns
Red clover	Kenland	0.8	1	ns
White clover	Alice	<0.5	1	ns
White clover	ladino, VNS#	0.6	1	ns
White clover	Jumbo ladino	0.5	1	ns
Legume, biennial				
Yellow sweetclover	Norgold	0.6	1	ns
Legumes, annual				
Arrowleaf clover	Zulu	<0.5	1	na
Balansa clover	Bolta	0.6	1	na
Berseem clover	Bigbee	0.8	1	na
Berseem clover	Elite II	<0.5	1	na
Persian clover	Leeton	<0.5	1	na
Persian clover	Nitro	0.5	1	na

† nh = no harvest due to very poor stand or little growth.

‡ na = not applicable.

§ We have listed perennial ryegrass under annual grasses because we recommend managing it as an annual crop in interior Alaska.

¶ ns = no over-winter survival.

VNS = variety not specified.

Table 5. Forage crop yields in 1997–1998 at Tanana Loop. All varieties harvested once per year.

Common name	Variety	1st year	2nd year
		Yield (tons per acre)	
Grasses, perennial			
Kentucky bluegrass	Nugget	nh†	<0.5
Smooth bromegrass	Carlton	nh	0.9
Smooth bromegrass	Signal	nh	0.7
Timothy	Engmo	nh	1.1
Timothy	Tiiti	nh	1.1
Legumes, perennial			
Alfalfa	Achiever	nh	<0.5
Alfalfa	Alfanure	nh	ns‡
Alfalfa	Falcon	nh	ns
Alfalfa	LM331	nh	0.6
Alfalfa	LM455	nh	<0.5
Alfalfa	LM456	nh	0.6
Alfalfa	LM459	nh	<0.5
Alfalfa	Nitro	nh	ns
Alfalfa	Peace	nh	0.8
Alfalfa	Rambler	nh	0.8
Alfalfa	Travois	nh	0.5
Red clover	Altaswede	nh	1.3
Legumes, annual			
Berseem clover	RK	nh	na§
Hairy vetch	Lana	nh	na
Field pea	Carneval	0.8	na
Field pea	Trapper	0.9	na

† nh = no harvest due to very poor stands or little growth.

‡ ns = no survival.

§ na = not applicable.

Table 6. Forage crop yields in 1999 at Tanana Loop (one harvest for each crop per year).

Stands were too poor to obtain harvests in the year following the establishment year.

Common name	Variety	Yield tons/acre
Grasses, perennial		
Kentucky bluegrass	Nugget	nh†
Reed canarygrass	Bellevue	4.1
Smooth bromegrass	Carlton	3.2
Smooth bromegrass	Manchar	3.2
Timothy	Engmo	2.6
Alaska wheatgrass	-	2.5
Grasses, annual		
Annual ryegrass	Abundant	2.0
Annual ryegrass	Gulf	2.6
Annual ryegrass	Molisto Hybrid	3.7
Perennial ryegrass	Amazon	3.2
Perennial ryegrass	Madera	3.1
Perennial ryegrass	Max	2.2
Perennial ryegrass	Rosalin	3.4
Perennial ryegrass	Tonga	2.8
Legumes, perennial		
Alfalfa	Alfagraze	1.3
Alfalfa	Alfanure	1.3
Alfalfa	Jade II	1.6
Alfalfa	Nitro	1.8
Alfalfa	non-dormant	2.0
Alfalfa	Peace	1.8
Alfalfa	Spredor 3	1.7
Red clover	Acclaim	1.0
Red clover	Altaswede	1.0
Red clover	Kenland	1.0
White clover	ladino, VNS‡	0.9
White clover	Jumbo ladino	1.0
Legume, biennial		
Yellow sweetclover	Norgold	2.0
Legumes, annual		
Berseem clover	Bigbee	0.8
Persian clover	Nitro	0.5
Field pea	Carneval	0.8
Field pea	Trapper	0.9

† nh = no harvest because of very little growth due to slow establishment.

‡ VNS = variety not specified.

Table 7. Forage crop yields at Fairbanks.

Common name	Variety or type	1st year		2nd year	
		Yield (tons/acre)	# of cuts	Yield (tons/acre)	# of cuts
Grasses, perennial					
Kentucky bluegrass	Nugget	nh†	-	1.0	1
Meadow bromegrass	Paddock	nh	-	2.3	2
Mountain bromegrass	Hakari	1.5	1	ns‡	-
Prairiegrass	Matua	1.9	1	ns	-
Smooth bromegrass	Carlton	2.4	1	3.7	2
Smooth bromegrass	Manchar	nh	-	3.3	2
Smooth bromegrass	Signal	2.1	1	3.6	2
Reed canarygrass	Bellevue	nh	-	1.7	2
Timothy	Engmo	1.9	1	2.7	2
Timothy	Tiiti	1.1	1	3.1	2
Alaska wheatgrass	-	-	-	2.4	2
Legumes, perennial					
Alfalfa	Achiever	2.2	1	ns	-
Alfalfa	AC Nordica	0.6	1	ns	-
Alfalfa	Alfagraze	1.2	1	2.1	2
Alfalfa	Alfanure	1.8	1	ns	-
Alfalfa	Denali	2.0	1	3.9	2
Alfalfa	Evolution	2.5	1	ns	-
Alfalfa	GS-88-2	nh	-	1.6	2
Alfalfa	GS 2000	nh	-	1.5	2
Alfalfa	Falcon	2.1	1	ns	-
Alfalfa	Jade II	0.9	2	ns	-
Alfalfa	Legend	1.3	1	1.8	2
Alfalfa	LM459	2.4	1	ns	-
Alfalfa	Nitro	2.0	1	1.5	1
Alfalfa	non-dormant	1.2	1	ns	-
Alfalfa	Peace§	1.9	2	4.3	2
Alfalfa	Rambler	1.7	1	ns	-
Alfalfa	Rampage	1.6	1	1.6	2
Alfalfa	Renovator	1.2	1	2.3	2
Alfalfa	Robust I	1.7	1	1.4	2
Alfalfa	Robust II	1.5	1	1.7	2
Alfalfa	Robust III	1.9	1	2.0	2
Alfalfa	Rowdy	1.5	1	1.6	2

Table 7 continued on page 12

Table 7, continued:

Alfalfa	Saranac	1.8	1	ns	-
Alfalfa	Spredor 2	nh	-	1.7	2
Alfalfa	Spredor 3	1.3	1	ns	-
Alfalfa	Travois	2.4	1	ns	-
Alfalfa, yellow-flowered	Falcata collection	nh	-	3.1	2
Birdsfoot trefoil	Norcen	1.3	2	1.1	2
Birdsfoot trefoil	Viking	2.0	1	1.9	2
Cicer milkvetch	Oxley	nh	-	1.6	1
Alsike clover	Buckminster	1.8	1	2.0	2
Alsike clover	Petra	1.2	1	2.8	2
Red clover	Acclaim	0.9	2	ns	-
Red clover	Alaskland	1.1	1	3.7	2
Red clover	Altaswede	2.4	1	3.3	2
Red clover	Cinnamon	0.8	2	ns	-
Red clover	FL 6 EF	2.3	1	ns	-
Red clover	FL MTC	2.6	1	1.8	2
Red clover	Kenland	1.8	2	ns	-
Red clover	Redland	2.1	1	ns	-
Red clover	Samsstadir	nh	-	1.6	1
Red clover	W115	2.2	2	ns	-
White clover	Alice	0.7	1	0.9	1
White clover	Brown Loam SM	1.3	1	1.6	2
White clover	CW 600	1.8	1.5¶	ns	-
White clover	ladino, VNS#	0.7	1	ns	-
White clover	Jumbo ladino	0.9	1	ns	-
Legume, biennial					
Yellow sweetclover	Norgold	2.6	2	ns	-
Legumes, annual					
Arrowleaf clover	Yuchi	1.8	1	na††	
Arrowleaf clover	Zulu	1.3	1	na	
Balansa clover	Bolta	<0.5	2	na	
Ball clover	Seagrest	1.4	1	na	
Ball clover	VNS	0.9	1	na	
Berseem clover	Bigbee	2.1	2	na	
Berseem clover	VNS	0.7	1	na	
Berseem clover	Elite II	1.0	2	na	
Berseem clover	RK	<0.5	1	na	
Crimson clover	Chief	2.0	1	na	

Table 7 continued on page 13

Crimson clover	VNS	2.0	1	na
Crimson clover	Dixie	1.1	1	na
Crimson clover	Tibbee	1.9	1	na
Persian clover	Laser	0.5	2	na
Persian clover	Leeton	1.4	2	na
Persian clover	Nitro	1.0	1	na
Subterranean clover	Meteora	2.1	1	na
Subterranean clover	Mount Barker	1.4	1	na
Barrel medic	Jemalong	1.7	2	na
Snail medic	VNS	1.6	1	na
Fababean	Friedrichs	3.9	1	na
Field pea	Poneka	3.1	1	na
Field pea	Trapper	1.5	1	na
Lentil	Indianhead	2.6	1	na
Tingapea	Tenua	2.5	1	na
Bigflower vetch	Woodford	1.2	1	na
Common vetch	Cahaba white	2.2	1	na
Common vetch	Nova II	1.7	1	na
Common vetch	Vanguard	1.4	1	na
Common vetch	Vantage	1.7	1	na
Common vetch	VNS	<0.5	1	na
Hairy vetch	Lana	2.2	1	na
Hairy vetch	VNS	1.8	1	na
White lupine	Kiev	2.0	1	na
White lupine	Primorski	2.9	1	na

† nh = no harvest due to very poor stand or little growth.

‡ ns = no survival.

§ Peace alfalfa was the only crop at Fairbanks that was harvested in its 3rd year, in which it yielded an average of 4.1 tons/acre.

¶ CW-600 white clover was harvested once in some years and twice in others.

VNS = variety not specified.

†† na = not applicable.

Table 8. Forage crop yields at Eielson. All varieties harvested once per year.

Common name	Variety	1st year	2nd year
		Average yield (tons per acre)	
Grasses, perennial			
Kentucky bluegrass	Nugget	nh†	<0.5
Smooth bromegrass	Carlton	nh	0.6
Smooth bromegrass	Manchar	nh	2.1
Smooth bromegrass	Signal	nh	1.4
Timothy	Engmo	nh	0.6
Timothy	Tiiti	nh	0.5
Legumes, perennial			
Alfalfa	Achiever	1.2	ns‡
Alfalfa	Alfanure	1.0	ns
Alfalfa	Falcon	1.2	ns
Alfalfa	LM331	1.5	ns
Alfalfa	LM455	1.2	ns
Alfalfa	LM456	1.4	ns
Alfalfa	LM459	1.5	ns
Alfalfa	Nitro	1.3	ns
Alfalfa	Peace	1.8	1.0
Alfalfa	Rambler	1.3	0.5
Alfalfa	Travois	1.4	<0.5
Red clover	Altaswede	1.8	<0.5
Legumes, annual			
Arrowleaf clover	Yuchi	0.8	na§
Berseem clover	Bigbee	1.9	na
Berseem clover	RK	0.8	na
Hairy vetch	VNS¶	1.1	na
Purple vetch	VNS	1.0	na
Woolypod vetch	VNS	1.9	na
Woolypod vetch	VNS	1.9	na

† nh = not harvested.

‡ ns = no survival.

§ na = not applicable.

¶ VNS = variety not specified.

Table 9. Forage crop yields at Nenana.

Common name	Variety	1st year		2nd year		3rd year		4th year	
		Yield (tons/acre)	# of cuts	Yield (tons/acre)	# of cuts	Yield (tons/acre)	# of cuts	Yield (tons/acre)	# of cuts
Grasses, perennial									
Altai wildrye	Eejay	<0.5	1	<0.5	1	na†	-	na	-
Altai wildrye	VNS‡	<0.5	1	<0.5	1	na	-	na	-
Altai wildrye	Eejay	<0.5	1	<0.5	1	na	-	na	-
Meadow bromegrass	Fleet	0.8	1	1.1	2	na	-	na	-
Meadow bromegrass	Paddock	nh¶	-	1.5	2	1.9	2	na	-
Smooth bromegrass	Carlton	<0.5	1	0.6	1	3.3	2	2.6	2
Smooth bromegrass	Leif	0.6	1	1.5	2	na	-	na	-
Smooth bromegrass	Manchar	<0.5	1	0.8	1	2.8	2	2.0	2
Reed canarygrass	Bellevue	<0.5	1	0.8	1	2.1	2	<0.5	1
Timothy	Bottnia II	<0.5	1	0.9	2	1.0	2	na	-
Timothy	Engmo	<0.5	1	0.5	1	2.2	2	1.1	2
Alaska wheatgrass	-	nh	-	1.1	1	2.7	2	1.6	2
Grasses, annual									
Annual ryegrass	Abundant	0.6	1	na					
Annual ryegrass	Cowcandy	0.5	1	na					
Annual ryegrass	Gulf	1.1	1	na					
Annual ryegrass	Molisto Hybrid	0.8	1	na					
Perennial ryegrass§	Blazer II	0.6	1	na					
Perennial ryegrass	Madera	0.7	1	na					
Perennial ryegrass	Rosalin	<0.5	1	na					
Perennial ryegrass	Tonga	0.5	1	na					
Festolium (fescue X ryegrass hybrid)	Duo Festolium	0.8	1	na					
Legumes, perennial									
Alfalfa	Denali	nh§	`	nh§	-	1.5	1	nh	
Alfalfa	Peace	nh	-	0.8	1	nh	-	nh	
Alfalfa, yellow-flowered	Anik	nh	-	0.6	1	2.0	1	nh	
Red clover	Altaswede	nh	-	0.8	1	nh	-	nh	
Red clover	tetraploid	nh	-	0.6	1	nh	-	nh	
Legume, biennial									
Yellow sweetclover	Norgold	nh	-	<0.5	1	nh			
Legumes, annual									
Field pea	Carneval	1.6	1	na	-	na			
Field pea	Trapper	1.9	1	na	-	na			
Common vetch	VNS‡	<0.5	1	na	-	na			

† na = not applicable because crop is not an perennial species or it had not been established long enough harvest in that year.

‡ VNS = variety not specified.

§ We have listed perennial ryegrass under annual grasses because we recommend managing it as an annual crop in interior Alaska.

¶ nh = no harvest due to very poor stand or little growth.

Table 10. Forage quality of crops at Delta Junction Bison Range.

Crop	Variety	Crude protein (mean)	Crude protein (range)	Acid detergent fiber (mean)	Acid detergent fiber (range)
		----------%----------			
Monocrops					
Kentucky bluegrass	Nugget	15.4	11.6- 16.3	26.6	21.4-34.7
Smooth bromegrass	Carlton	10.8	6.7- 20.1	30.0	25.7-35.5
Alsike clover	Aurora	15.0	13.5-16.4	20.1	19.0-21.1
Cicer milkvetch	Oxley	13.9	8.1- 19.7	19.6	18.9-20.4
Kura clover	NF-90	13.3	10.7- 17.5	23.6	18.2-28.0
Red clover	Alaskland	14.2	11.5-18.3	17.4	16.9-17.9
Red clover	Altaswede	13.2	12.0- 16.0	24.1	19.1-28.3
White clover	White Dutch, VNS†	15.1	12.5- 18.7	16.3	15.1-17.6
Yellow flowered alfalfa	Anik	12.7	9.2- 20.0	28.4	21.4-35.9
Crops grown in mixtures‡					
Kentucky bluegrass/ cicer milkvetch	Nugget/Oxley	8.9	4.0-13.9	27.5	26.4-28.3
Kentucky bluegrass/ kura clover	Nugget/NF-90	8.4	4.8-12.7	33.9	26.2-39.4
Kentucky bluegrass/red clover	Nugget/Altaswede	11.2	8.6-16.1	33.2	30.8-34.9
Kentucky bluegrass/yellow flowered alfalfa	Nugget/Anik	8.4	4.6-12.5	33.2	25.7-39.0
Smooth bromegrass/ cicer milkvetch	Carlton/Oxley	8.5	6.3-10.7	31.7	30.0-34.8
Smooth bromegrass/ kura clover	Carlton/NF-90	7.4	4.0-11.3	32.1	29.2-33.3
Smooth bromegrass/ red clover	Carlton/Altaswede	6.4	4.4-9.7	33.6	30.4-37.2
Smooth bromegrass/yellow flowered alfalfa	Carlton/Anik	9.0	4.1-11.5	32.2	29.2-33.9
Cicer milkvetch/ Kentucky bluegrass	Oxley/Nugget	9.2	2.6-12.9	17.4	15.8-19.2
Cicer milkvetch/smooth bromegrass	Oxley/Carlton	8.4	6.3-10.5	-	-
Kura clover/ Kentucky bluegrass	NF-90/Nugget	12.9	9.9-17.2	21.6	18.3-24.6
Kura clover/ smooth bromegrass	NF-90/Carlton	12.5	10.4-17.4	21.5	18.5-24.1
Red clover/ Kentucky bluegrass	Altaswede/Nugget	12.5	10.6-15.9	26.4	19.4-32.4
Red clover/ smooth bromegrass	Altaswede/Carlton	12.7	10.8-16.2	24.3	18.9-28.7
Yellow flowered alfalfa/ Kentucky bluegrass	Anik/Nugget	11.6	7.1- 16.7	27.9	23.8-33.6
Yellow flowered alfalfa/ smooth bromegrass	Anik/Carlton	11.7	7.1 - 16.6	28.0	23.3-32.8

† VNS = variety not specified.

‡ quality is for crop listed first in mixture.

Table 11. Forage quality of crops at UAF Delta Field Research Site.

Crop	Variety	Crude protein (mean)	Crude protein (range)	Neutral detergent fiber (mean)	Neutral detergent fiber (range)	Acid detergent fiber (mean)	Acid detergent fiber (range)
		----------%----------					
Legumes, perennial							
Alfalfa	Nitro	13.1	6.6-19.1				
Alfalfa	Peace	17.6	14.0-21.5	31.8	30.3-33.3	22.0	20.7-23.2
Alfalfa	Spredor 2	16.9	12.9-22.2	35.6	35.6-35.8	25.2	
Birdsfoot trefoil	Norcen	18.2	17.4-20.1	31.2	29.6-32.8	22.1	21.5-22.8
Alsike clover	Buckminster	16.0		27.7		19.8	
Red clover	Altaswede	14.0	7.4-19.1	27.6	24.8-30.4	17.4	15.3-19.5
Red clover	Kenland	12.5	11.1-14.2	33.2	29.0-37.4	21.1	19.1-23.2
Red clover	Marathon	15.6	14.0-17.2				
White clover	White Dutch, VNS†	13.3	12.0.-14.0	21.4		14.2	
Legume, biennial							
Yellow sweetclover	Norgold	14.9	7.7-18.4	29.4	25.0-33.7	20.0	17.2-22.8
Legumes, annual							
Arrowleaf clover	Yuchi	13.6	10.9-17.1	31.5	28.0-34.9	22.5	19.7-25.3
Berseem clover	Bigbee	12.4	11.6-13.3	34.0		21.3	
Crimson clover	Dixie	12.6	10.7-14.3	48.0	46.9-49.0	32.0	30.4-33.6
Barrel medic	Jemalong	14.0	11.3-15.7	38.2	32.6-43.8	23.8	20.4-27.1
Fababean	Friedrichs	16.0	11.1-19.8	35.4	35.2-35.5	25.5	25.3-25.7
Field pea	Poneka	14.0	12.5-17.3	36.1	34.4-37.8	24.6	
Lentil	Indianhead	13.4	10.0-15.9				
Tingapea	Tenua	13.4	10.5-15.9	39.4	36.2-42.6	25.4	23.7-27.1
Hairy vetch	Lana	14.1	10.5-16.8	40.8	36.5-45.0	26.0	25.0-27.0
White lupine	Primorski	12.7	8.4-22.6				

† VNS = variety not specified.

Table 12. Forage quality of crops at Sawmill Creek.

Crop	Variety	Crude protein (mean)	Crude protein (range)	Neutral detergent fiber (mean)	Neutral detergent fiber (range)	Acid detergent fiber (mean)	Acid detergent fiber (range)
		----------%----------					
Grasses, perennial							
Reed canarygrass	Bellevue	11.0	8.0-14.1	54.0	53.2-54.7	28.2	27.3-29.0
Smooth bromegrass	Carlton	11.5	9.2-13.9	51.6	43.9-55.2	27.6	21.4-30.6
Smooth bromegrass	Manchar	13.3	9.7-15.9	50.4	46.1-53.1	27.1	24.6-29.4
Timothy	Engmo	12.5	9.8-16.8	47.1	40.0-53.8	24.1	19.1-28.1
Timothy	Tiiti	11.0	7.7-14.3	44.6	42.4-46.8	22.3	20.6-22.7
Alaska wheatgrass	-	13.7	9.6-24.6	55.9	41.3-69.0	29.9	17.1-39.8
Grasses, annual							
Annual ryegrass	Abundant	12.6	7.9-16.4	55.6	53.2-58.1	30.5	27.9-32.6
Annual ryegrass	AM1	11.6	8.6-14.2	54.8	51.7-58.8	29.0	27.1-31.5
Annual ryegrass	Cowcandy	11.3	7.5-14.5	55.0	53.3-56.4	29.4	28.1-30.2
Annual ryegrass	Max	13.4	7.5-20.8	47.0	43.5-54.1	24.8	22.9-29.1
Annual ryegrass	Molisto Hybrid	15.7	9.3-23.6	34.3	32.5-36.7	17.3	16.1-18.2
Perennial ryegrass†	Amazon	11.0	8.6-11.0	36.5	34.7-38.2	17.2	15.9-18.5
Perennial ryegrass	Madera	12.8	10.5-15.1	36.5	34.8-38.2	18.1	16.8-19.4
Perennial ryegrass	Rosalin	11.7	9.8-13.5	34.4	32.9-35.9	17.6	16.3-18.8
Perennial ryegrass	Tonga	13.1	9.7-16.6	34.7		17.7	17.0-18.4
Festolium (fescue X ryegrass hybrid)	Duo Festolium	11.2	8.6-13.8	39.0	36.6-41.4	19.9	18.1-21.7
Soft chess	Blando	13.1	10.4-15.5	59.1	56.9-61.8	32.0	29.6-33.8
Legumes, perennial							
Alfalfa	Alfagraze	16.0	-	46.2	-	31.0	-
Alfalfa	Alfanure	12.0	10.8-13.1	47.1	45.2-48.9	31.5	31.3-31.7
Alfalfa	Jade II	14.6	14.1-15.0	46.2	45.5-47.0	32.1	31.1-33.0
Alfalfa	Legend	19.4	14.7-23.6	38.6	32.7-45.5	26.4	23.3-31.2
Alfalfa	Nitro	14.2	10.5-16.6	41.2	36.0-48.6	29.0	25.7-34.7
Alfalfa	non-dormant	11.5	10.1-12.9	48.4	43.7-53.2	35.7	32.2-39.2
Alfalfa	Peace	16.0	10.2-20.4	38.6	29.8-50.0	27.6	21.2-34.7
Alfalfa	Renovator	16.4	16.3-16.5	38.0	32.7-46.9	27.0	23.2-33.2
Alfalfa	Spredor 3	13.6	11.8-15.3	50.5	46.3-54.7	32.4	

Table 12 continued on page 19

Red clover	Acclaim	11.2	9.0-13.4	39.8	37.6-42.0	28.0	26.9-29.2
Red clover	Altaswede	14.6	11.9-15.7	27.0	23.6-30.5	18.6	15.7-22.4
Red clover	Cinnamon	19.1		51.5		38.5	
Red clover	Kenland	13.6	11.6-15.6	40.2	38.9-41.5	28.2	27.4-29.1
White clover	Alice	20.0		23.8		16.0	
White clover	ladino, VNS‡	17.1	15.4-18.8	25.8	25.0-26.6	18.6	17.8-19.4
White clover	Jumbo ladino	15.8	13.5-18.1	26.1	25.9-26.2	18.8	18.4-19.2
Legume, biennial							
Yellow sweetclover	Norgold	21.6	-	36.8	-	26.2	-
Legumes, annual							
Arrowleaf clover	Zulu	12.2	-	28.4	-	20.6	-
Balansa clover	Bolta	14.8	-	31.5	-	21.9	-
Berseem clover	Bigbee	11.9	11.3-12.5	36.9	36.0-37.8	25.3	25.2-25.4
Berseem clover	Elite II	13.7	-	34.3	-	23.5	-
Persian clover	Leeton	14.0	-	28.1	-	19.8	-
Persian clover	Nitro	15.8	14.1-17.5	37.1	34.7-39.5	26.2	24.2-28.2

† We have listed perennial ryegrass under annual grasses because we recommend managing it as an annual crop in interior Alaska.

‡ VNS = variety not specified.

Table 13. Forage quality of crops at Tanana Loop.

Crop	Variety	Crude protein (mean)	Crude protein (range)	Neutral detergent fiber (mean)	Neutral detergent fiber (range)	Acid detergent fiber (mean)	Acid detergent fiber (range)
		----------%----------					
Grasses, perennial							
Kentucky bluegrass	Nugget	21.6	-	-	-	-	-
Reed canarygrass	Bellevue	20.1	-	53.0	-	28.6	-
Smooth bromegrass	Carlton	20.8	-	51.2	-	27.5	-
Smooth bromegrass	Manchar	19.6	-	51.7	-	28.1	-
Smooth bromegrass	Signal	12.0	-	-	-	-	-
Timothy	Engmo	15.8	10.8-20.7	43.4	-	23.6	-
Alaska wheatgrass	-	22.8	-	44.2	-	23.3	-
Grasses, annual							
Annual ryegrass	Abundant	16.3	-	51.0	-	29.7	-
Annual ryegrass	Gulf	13.7	-	55.1	-	31.3	-
Annual ryegrass	Molisto Hybrid	22.4	-	41.4	-	22.0	-
Perennial ryegrass†	Amazon	23.6	-	40.8	-	21.1	-
Perennial ryegrass	Madera	22.8	-	39.2	-	21.7	-
Perennial ryegrass	Max	21.0	-	45.7	-	25.3	-
Perennial ryegrass	Rosalin	22.3	-	41.6	-	22.1	-
Perennial ryegrass	Tonga	22.7	-	37.9	-	20.8	-
Legumes, perennial							
Alfalfa	Alfagraze	24.4	-	41.4	-	28.6	-
Alfalfa	Alfanure	22.4	-	40.7	-	31.0	-
Alfalfa	Jade II	20.6	-	41.0	-	30.6	-
Alfalfa	Nitro	22.7	-	40.4	-	29.5	-
Alfalfa	non-dormant	18.1	-	38.3	-	27.6	-
Alfalfa	Peace	13.6	10.8-16.5	42.2	-	31.2	-
Alfalfa	Rambler	8.6	-	-	-	-	-
Alfalfa	Spredor 3	18.4	-	47.1	-	34.6	-
Red clover	Acclaim	20.6	-	35.1	-	24.5	-
Red clover	Altaswede	19.1	16.1-22.1	27.8	-	18.5	-
Red clover	Kenland	23.8	-	31.7	-	22.1	-
White clover	ladino, VNS‡	19.0	-	25.0	-	19.0	-
White clover	Jumbo ladino	21.8	-	26.2	-	19.5	-
Legume, biennial							
Yellow sweetclover	Norgold	19.6	-	49.8	-	37.9	-

Table 13 continued on page 21

Legumes, annual							
Berseem clover	Bigbee	21.7	-	31.0	-	20.4	-
Persian clover	Nitro	22.5	-	28.4	-	20.3	-
Field pea	Carneval	16.2	16.3-16.9	44.2	43.7-44.7	33.3	33.1-33.5
Field pea	Trapper	22.2	21.9-22.5	40.2	39.3-41.0	30.0	29.3-30.7

† We have listed perennial ryegrass under annual grasses because we recommend managing it as an annual crop in interior Alaska.

‡ VNS = variety not specified.

Table 14. Forage quality of crops at Fairbanks.

Crop	Variety	Crude protein (mean)	Crude protein (range)	Neutral detergent fiber (mean)	Neutral detergent fiber (range)	Acid detergent fiber (mean	Acid detergent fiber (range)
		----------%----------					
Grasses, perennial							
Reed canarygrass	Bellevue	15.2	9.2-19.9	61.6	55.1-68.0	32.1	25.2-37.4
Meadow bromegrass	Paddock	11.2	6.8-15.6	58.4	54.0-60.6	33.2	30.8-36.0
Smooth bromegrass	Carlton	15.3	9.6-25.3	51.7	29.4-61.5	42.4	26.2-67.9
Smooth bromegrass	Manchar	14.3	10.5-26.1	52.1	29.7-64.9	42.0	32.0-63.6
Smooth bromegrass	Signal	10.7	8.4-12.6	58.8	57.9-60.6	33.1	30.5-35.2
Timothy	Engmo	11.1	6.9-18.1	49.7	24.2-65.5	36.8	24.8-57.4
Timothy	Tiiti	9.9	6.6-13.6	57.1	49.8-61.1	29.5	26.1-33.0
Alaska wheatgrass	-	16.4	10.9-23.1	51.4	27.1-75.3	48.4	34.3-72.1
Legumes, perennial							
Alfalfa	AC Nordica	25.9	25.1-27.3	30.0	27.6-33.3	22.5	19.8-25.5
Alfalfa	Alfagraze	22.0	17.8-28.6	40.0	26.5-48.7	29.4	19.6-37.6
Alfalfa	Alfanure	20.0	19.3-20.9	44.1	37.8-47.5	33.2	27.5-36.5
Alfalfa	Denali	17.0	16.2-17.4	34.6	-	26.2	-
Alfalfa	Jade II	22.0	17.9-26.4	41.4	28.0-50.8	31.6	19.6-39.5
Alfalfa	Legend	23.6	18.0-28.8	36.6	28.1-45.0	26.0	21.3-30.3
Alfalfa	Nitro	20.4	18.1-22.7	43.6	38.4-50.5	32.3	28.7-33.5
Alfalfa	non-dormant	20.0	19.4-21.1	41.0	37.1-46.8	30.3	28.0-36.0
Alfalfa	Peace	21.1	16.9-23.1	39.2	28.0-50.7	28.6	19.4-38.5
Alfalfa	Renovator	22.0	17.4-26.8	39.2	29.7-45.7	28.7	20.5-35.2
Alfalfa	Spredor 2	21.3	15.7-25.9	37.9	30.4-41.9	26.8	22.2-29.1
Alfalfa	Spredor 3	19.9	18.9-21.3	50.3	44.0-54.7	38.4	32.6-42.6
Birdsfoot trefoil	Norcen	20.7	16.0-27.0	30.0	21.6-39.0	22.2	16.0-29.1
Birdsfoot trefoil	Viking	15.2	-	35.6	-	27.8	-
Cicer milkvetch	Oxley	10.2	-	-	-	-	-
Alsike clover	Buckminster	18.6	17.2-19.9	31.4	26.9-35.9	23.4	19.9-26.9

Table 14 continued on page 22

Table 14, continued:

Alsike clover	Petra	17.5	17.0-18.4	25.0	-	18.5	-
Red clover	Acclaim	19.1	16.6-22.5	33.5	27.8-39.5	22.9	16.1-30.1
Red clover	Alaskland	17.7	17.0-18.9	22.6	-	15.3	-
Red clover	Altaswede	20.4	15.8-24.1	33.3	22.2-44.1	22.9	15.2-31.1
Red clover	Cinnamon	18.9	14.8-23.1	33.5	24.7-39.5	22.6	17.0-27.4
Red clover	FL 6 EF	15.6	-	32.3	-	23.6	-
Red clover	FL MTC	15.7	14.3-18.5	33.2	-	24.3	-
Red clover	Kenland	16.1	14.8-17.8	38.9	37.0-40.5	25.7	24.6-26.4
Red clover	Redland	15.3	-	31.3	-	22.6	-
Red clover	W115	18.4	16.5-20.3	28.1	25.3-30.8	18.4	16.2-20.7
White clover	Alice	19.4	17.5-20.9	30.6	26.5-34.3	20.8	17.3-26.0
White clover	Brown Loam SM	16.8	-	28.8	-	21.9	-
White clover	CW 600	21.1	16.8-24.9	25.5	23.8-28.6	19.6	17.5-21.8
White clover	ladino, VNS†	21.1	20.1-21.8	32.3	31.4-34.0	23.4	22.4-24.0
White clover	Jumbo ladino	20.2	19.5-20.5	30.7	27.5-33.7	21.4	18.0-23.8
Legume, biennial							
Yellow sweetclover	Norgold	21.5	12.6-27.3	28.1	19.6-34.1	20.8	14.4-25.0
Legumes, annual							
Arrowleaf clover	Yuchi	14.5	12.8-17.7	36.8	33.3-39.6	27.9	25.4-29.9
Balansa clover	Bolta	12.3	11.5-13.1	31.1	29.9-32.2	23.1	22.9-23.4
Ball clover	Seagrest	12.2	-	33.9	-	25.7	-
Ball clover	VNS†	15.4	-	31.6	-	24.0	-
Berseem clover	Bigbee	16.8	11.9-20.8	39.5	36.2-43.0	25.8	23.2-28.1
Berseem clover	Elite II	15.3	14.2-16.3	31.9	29.4-34.0	22.4	20.5-23.8
Berseem clover	VNS†	15.2	12.4-19.2	39.9	33.7-44.4	26.9	21.6-29.7
Crimson clover	Chief	12.0	-	44.3	-	31.8	-
Crimson clover	VNS	12.3	-	44.8	-	32.4	-
Crimson clover	Dixie	11.6	10.3-14.4	45.2	43.4-47.3	31.4	28.4-33.0
Crimson clover	Tibbee	10.6	-	46.3	-	32.9	-
Persian clover	Laser	13.5	12.6-14.2	28.5	22.3-32.4	21.6	16.1-24.5
Persian clover	Leeton	12.8	11.6-13.9	28.4	26.8-30.4	21.3	19.2-24.0
Persian clover	Nitro	15.0	10.9-19.5	39.5	35.6-47.3	27.6	25.5-32.4
Subterranean clover	Meteora	10.6	-	33.1	-	23.3	-
Subterranean clover	Mt. Barker	9.7	-	36.1	-	25.5	-
Barrel medic	Jemalong	18.6	13.8-22.2	39.1	35.1-44.9	27.9	24.1-31.5
Snail medic	VNS	15.0	-	41.7	-	30.2	-
Fababean	Friedrichs	20.0	17.6-20.9	32.3	-	21.5	-
Field pea	Poneka	18.3	17.3-19.6	34.8	33.8-35.7	23.5	22.8-24.1

Table 14 continued on page 23

Field pea	Trapper	18.2	17.6-18.8	43.1	42.8-43.3	30.4	30.2-30.7
Lentil	Indianhead	18.6	17.6-19.2	-	-	-	-
Tingapea	Tenua	15.5	13.9-17.6	39.8	37.7-41.3	28.3	25.5-33.5
Bigflower vetch	Woodford	21.1	-	41.6	-	33.6	-
Common vetch	VNS	21.1	-	36.1	-	24.5	-
Common vetch	Cahaba White	18.7	-	36.1	-	26.3	-
Common vetch	Nova II	20.6	-	34.6	-	23.4	-
Common vetch	Vanguard	21.9	-	35.7	-	26.5	-
Common vetch	Vantage	20.1	-	37.1	-	26.9	-
Hairy vetch	VNS	20.3	-	44.3	-	35.1	-
Hairy vetch	Lana	17.4	16.0-18.4	42.2	38.7-46.5	29.1	27.0-30.6
White lupine	Kiev	18.1	15.0-22.3	40.3	38.6-41.7	30.2	29.8-30.4
White lupine	Primorski	15.5	8.5-20.0	-	-	-	-

† VNS = variety not specified.

Table 15. Forage quality of crops at Eielson.

Crop	Variety	Crude protein (mean)	Crude protein (range)	Neutral detergent fiber	Acid detergent fiber
		----------%----------			
Grasses, perennial					
Kentucky bluegrass	Nugget	13.5	-	-	-
Smooth bromegrass	Manchar	6.5	-	56.4	33.4
Smooth bromegrass	Signal	9.7	7.4-11.9	59.2	34.6
Timothy	Engmo	12.6	6.9-18.4	63.5	36.7
Timothy	Tiiti	6.3	-	62.5	35.9
Legumes, perennial					
Alfalfa	Peace	15.3	14.3-16.3	48.1	36.6
Alfalfa	Rambler	16.1	-	42.1	30.1
Alfalfa	Travois	17.5	-	38.8	27.8
Red clover	Altaswede	11.5	-	-	-
Legumes, annual					
Arrowleaf clover	Yuchi	5.8	-	-	-
Berseem clover	Bigbee	16.9	-	-	-
Hairy vetch	VNS†	21.4	-	-	-
Hairy vetch, woolypod	VNS	19.4	-	-	-
Purple vetch	VNS	21.1	-	-	-

† VNS = variety not specified.

Table 16. Forage quality of crops at Nenana.

Crop	Variety	Crude protein (mean)	Crude protein (range)	Neutral detergent fiber (mean)	Neutral detergent fiber (range)	Acid detergent fiber (mean)	Acid detergent fiber (range)
		%					
Grasses, perennial							
Altai wildrye	VNS†	13.5	10.1-18.4	59.4	58.8-60.0	32.5	31.2-33.5
Altai wildrye	Eejay	17.5	15.8-19.1	50.0	34.2-62.3	26.7	17.5-35.3
Meadow bromegrass	Fleet	13.1	8.4-18.1	53.2	49.5-54.9	30.6	27.8-35.1
Meadow bromegrass	Paddock	12.8	8.2-17.8	55.9	51.3-65.6	31.7	28.6-38.6
Smooth bromegrass	Carlton	11.9	7.0-18.9	57.4	38.0-64.4	31.8	21.2-37.3
Smooth bromegrass	Leif	12.6	8.1-22.6	55.4	48.0-63.2	30.5	25.0-36.2
Smooth bromegrass	Manchar	10.9	8.0-18.9	55.1	52.7-64.8	30.5	29.0-37.4
Reed canarygrass	Bellevue	16.3	12.6-18.1	59.2	54.6-61.4	30.1	28.0-32.2
Timothy	Bottnia II	12.1	7.6-19.2	51.0	39.5-57.2	25.5	20.5-30.1
Timothy	Engmo	13.6	9.1-17.9	48.0	32.9-56.8	23.1	14.3-29.2
Alaska wheatgrass	-	12.3	7.1-18.2	59.2	49.7-66.2	31.7	27.8-40.2
Grasses, annual							
Annual ryegrass	Abundant	10.3	-	48.6	-	25.4	-
Perennial ryegrass‡	Blazer II	13.9	13.0-15.8	40.5	36.7-50.5	20.7	18.0-28.5
Perennial ryegrass	Madera	14.5	13.4-16.6	46.9	28.8-57.1	23.8	14.4-28.9
Perennial ryegrass	Rosalin	15.2	8.8-23.2	47.4	33.5-56.0	24.6	17.8-30.2
Perennial ryegrass	Tonga	18.7	15.4-20.5	48.1	45.2-49.6	24.8	23.2-25.7
Festolium (fescue X ryegrass hybrid)	Duo Festolium	13.5	11.5-15.5	53.7	53.6-53.8	29.1	28.1-29.5
Legumes, perennial							
Alfalfa	Denali	13.0	9.1-16.5	40.4	37.2-42.5	28.7	26.2-31.9
Alfalfa	Peace	11.1	10.7-11.6	42.6	40.3-44.6	30.0	27.8-32.2
Yellow-flowered alfalfa	Anik	15.6	10.9-23.1	43.4	36.0-55.2	31.7	26.0-42.0
Red clover	Altaswede	12.2	11.7-13.2	38.6	33.6-41.7	26.6	22.6-29.0
Red clover	tetraploid	12.0	11.4-12.8	39.2	36.1-42.2	27.3	25.3-30.0
Legume, biennial							
Yellow sweetclover	Norgold	12.5	11.3-13.9	42.3	39.4-44.2	30.3	29.3-30.8
Legumes, annual							
Field pea	Carneval	15.0	13.6-16.4	46.6	44.6-48.6	33.3	33.0-33.6
Field pea	Trapper	18.2	17.6-18.8	42.2	41.5-42.8	31.5	30.8-32.1
Common vetch	VNS	19.5	18.2-20.8	37.0	36.5-37.6	27.3	26.4-28.3

† VNS = variety not specified.

‡ We have listed perennial ryegrass under annual grasses because we recommend managing it as an annual crop in interior Alaska.

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Appendix 1

The following is a list and description of plant species we tested in forage crop variety trials in interior Alaska (information obtained from Heath et al. 1973; Alberta Agriculture, Food, and Rural Development 1981; Balasko and Nelson 2003; McGraw and Nelson 2003; Sollenberger and Collins 2003):

GRASSES:

(plant family Gramineae): The grass family includes numerous species of cereal grain, grass forage, and turf grass crops. Many species of grasses are native to Alaska, but they have received only limited testing as potential forage crops.

Kentucky bluegrass (*Poa pratensis* L.): Sod-forming, long-lived perennial. Adapted varieties are very winter hardy. Produces high quality forage, but because most growth is in basal leaves, harvested yields are usually low. It is often considered a weed in hay fields, but is considered an excellent pasture grass. Fairly slow to establish.

Smooth bromegrass (*Bromus inermis* Leyss.): An aggressively creeping grass, good winter-hardiness. Has limited below ground reserves, especially if cut at wrong time, thus can be slow to recover from cutting and is not suitable for grazing.

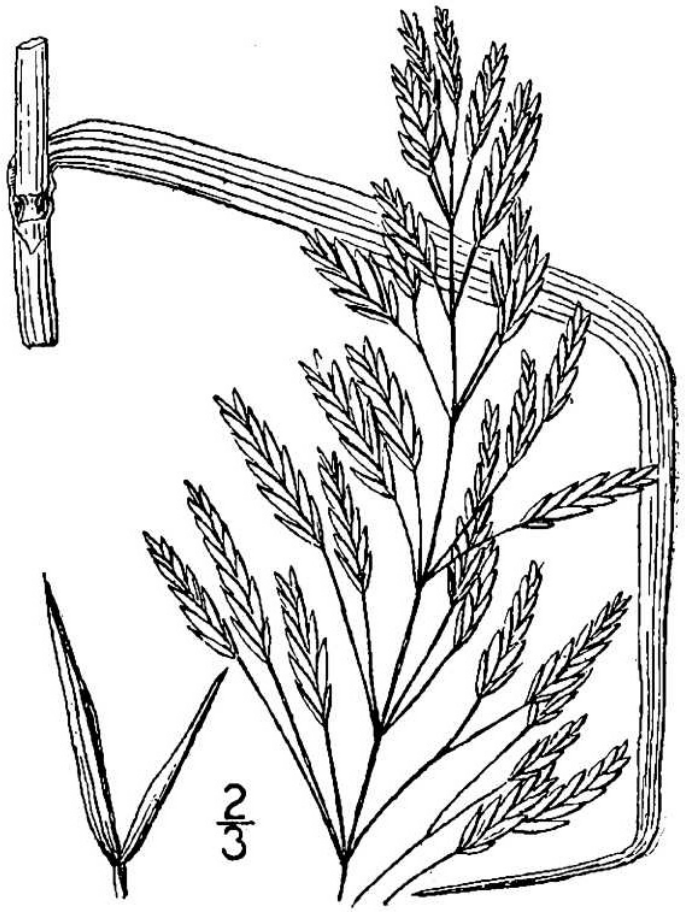
Meadow bromegrass (*Bromus biebersteinii* Roem. and Schult): Not as aggressively spreading and slower to establish than smooth bromegrass. Recovers quicker from defoliation than smooth bromegrass. Listed as very winter hardy.

Prairiegrass (*Bromus wildenowii* Knuth.): A cool-season, short-lived bromegrass species, sometimes used in pastures in areas with mild climates. We have done limited trials with it in interior Alaska and found it to be not winter hardy under our conditions.

Soft chess, soft bromegrass: (*Bromus mollis* L.): An annual bromegrass species, sometimes grown as an annual forage crop in temperate climates.

Annual ryegrass (*Lolium multiflorum* L.), also called Italian ryegrass: Because of similarity in name, ryegrasses are sometimes confused with cereal rye or wildrye, which are very different crops. Annual ryegrass germinates and establishes very rapidly, but requires lots of moisture for best production. Produces seed heads very early (prior to much vegetative growth) under long-daylight conditions, such as those found in interior Alaska in summer.

Perennial ryegrass (*Lolium perenne* L.): A short-lived perennial in temperate climate zones, but generally does not survive winters in interior Alaska and therefore should be planted as an annual crop. Does not produce seed heads as early as annual ryegrass under long-day conditions. Requires lots of moisture for best production.



Smooth bromegrass.
—USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 1:277.

Perennial ryegrass.
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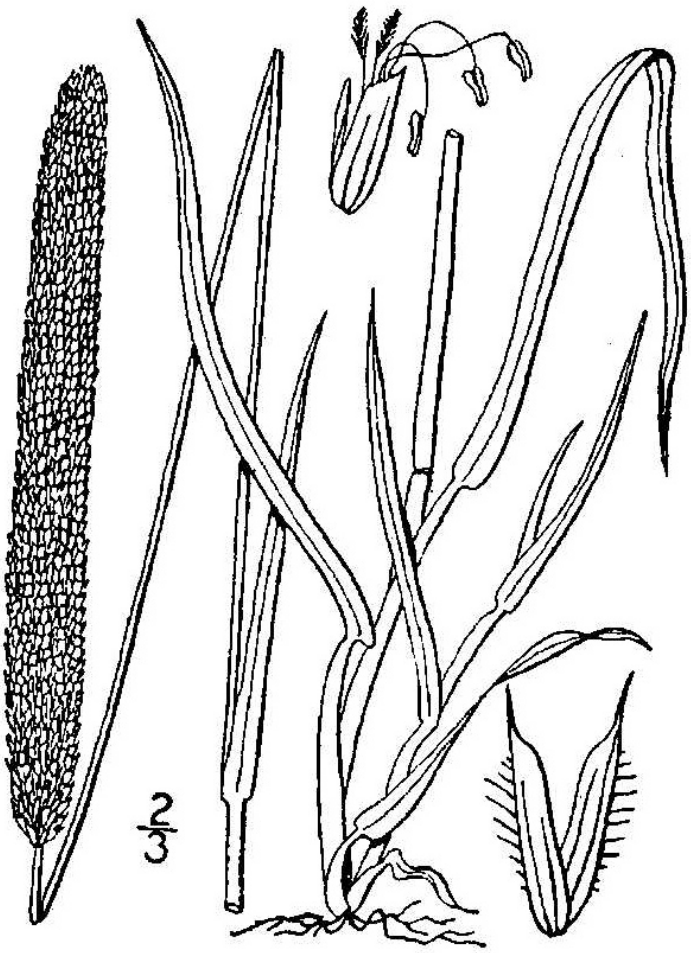

Timothy.
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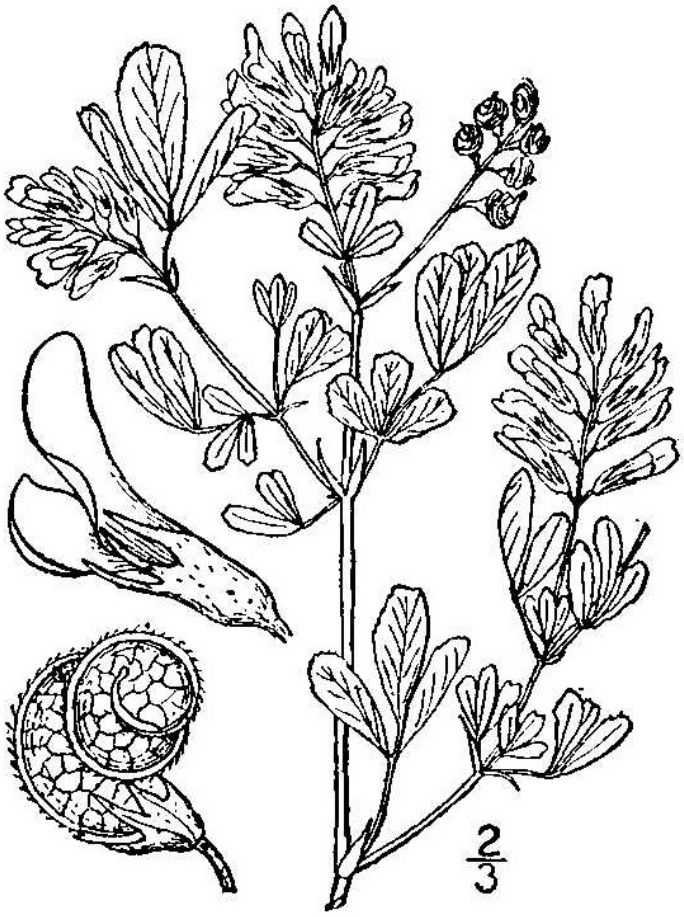


Yellow alfalfa.
—USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 2:351.

Timothy (*Phleum pratense* L.): Perennial bunchgrass, winter hardy, but drought intolerant. Tolerant of acid soils. Produces high quality forage if harvested at proper time, but forage quality declines rapidly after flowering. Often considered prime hay crop for horses. Often produces little regrowth following harvest in high latitude environments, thus farmers often obtain only a single annual harvest in interior Alaska.

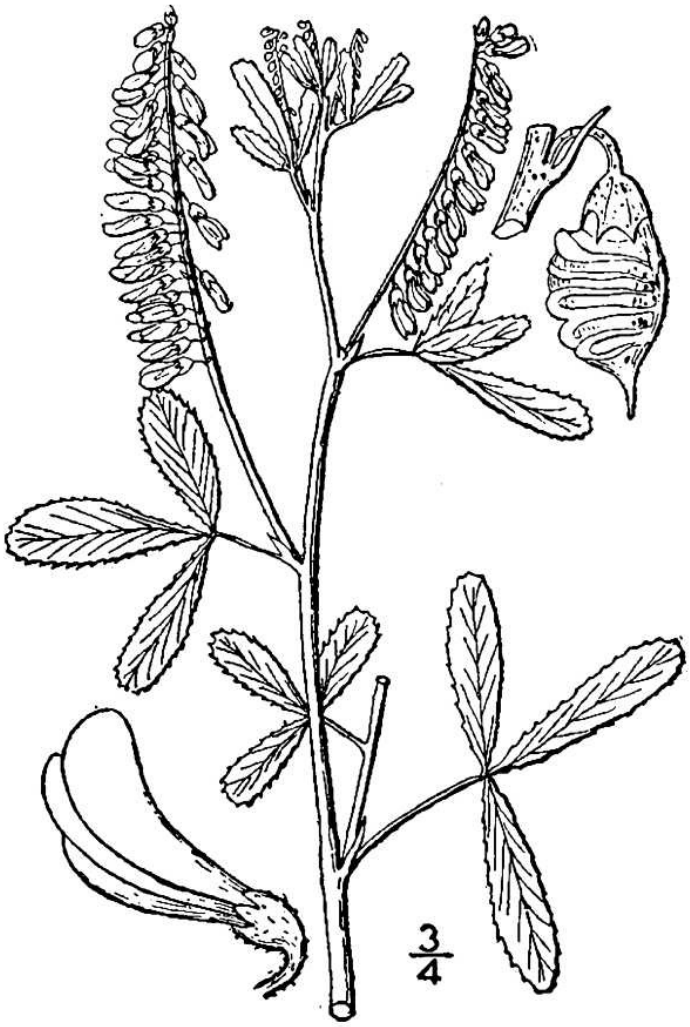
Wheatgrasses (*Agropyron* species, also some *Elymus* species are sometimes referred to as wheatgrasses): Several species of wheatgrasses are used as forage crops in Western USA and Western Canada. Most are considered very winter hardy and many are drought tolerant. Limited testing in Alaska has indicated these species to be not well adapted here. Several wheatgrass species are native to Alaska, but have received limited tests as forage crops. So far, we have tested only Alaska wheatgrass (*Agropyron macrorum* [Turcz.] Drobov) in our trials.

Wildryes (*Elymus* and *Leymus* species): Wildryes (not to be confused with cereal rye or ryegrass) are used in pastures in the western US and Canada. The two most commonly used species, Russian wildrye (*Elymus junceus* Fisch.) (now called *Psathyrostachys junea* [Fisch.] Nerski by some grass taxonomists) and Altai wildrye (*Elymus angustus* [Trin.] *Pilger* or *Leymus angustus* [Trin.] Pilger), produce most of their growth in the form of basal leaves, making them difficult to harvest, thus they are seldom grown for hay. They are generally considered to be winter hardy but usually have not performed well in limited tests in Alaska. Several wildrye species are native to Alaska but have received little testing for their potential as forage crops. Altai wildrye is the only species we tested in these trials.

We have also tested **fountaingrass** (*Pennisetum setaceum* [Forsk.] Chio.), and red and prairie **switchgrass** (*Panicum virgatum* L.) in limited trials but found them unsuitable for our conditions.

LEGUMES:

(family Leguminosaea): The legume family is a large plant family and various species are grown for livestock forage or for their seed, which are used for both human and animal consumption (such as beans, peas, fababeans, chickpeas and many others). Most species of legumes form root associations with bacteria which can fix atmospheric nitrogen into plant available forms and transport them to the legume plant. Thus, legumes often need little or no



Yellow sweetclover.
—USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 2:353.

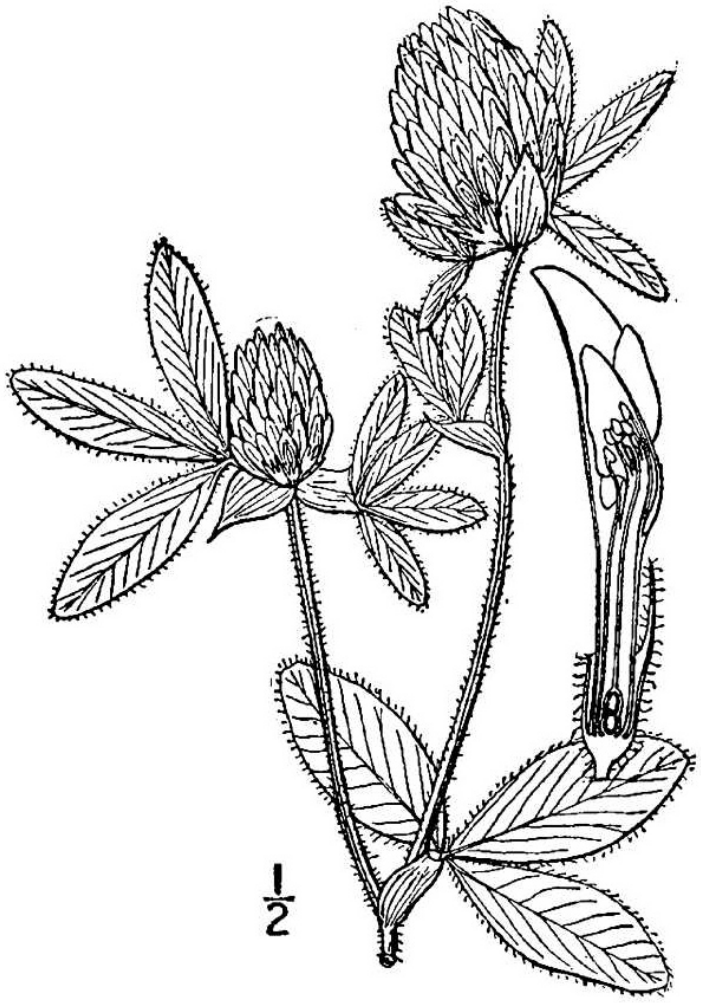
nitrogen fertilizer. There are many native Alaskan legume species, some of which have been tested for their forage potential, but all of them so far tested have been found to be unsuitable (Klebesadel 1971).

Alfalfa (common or purple alfalfa, *Medicago sativa* L.; yellow-flowered alfalfa, *M. falcata* L., sometimes considered a subspecies of *M. sativa*). Alfalfa has been referred to as the "Queen of Forages" because when managed properly under optimum conditions, it produces high yields of very high quality forage. It is intolerant of acidic soils, and requires soils with pH 6 or above for best production. Yellow-flowered alfalfa is generally more winter hardy than common alfalfa, but is usually much less productive. Many alfalfa varieties are crosses of *M. sativa* with *M. falcata* and are often called variegated alfalfa (sometimes referred to as *Medicago media* Pers.).

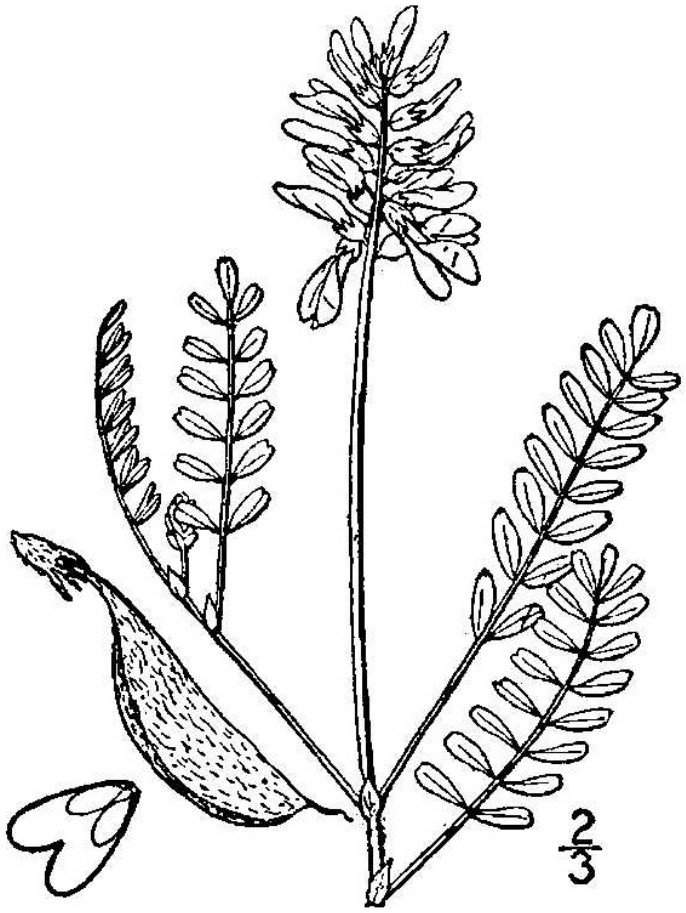
Annual medics (*Medicago* species): Annual medics are closely related to alfalfa and are sometimes grown as winter annuals in warm climate regions. We thought they might perform well in interior Alaska as summer annuals and tested several species including barrel medic (*M. truncatula* Gaertn.), black medic (*M. lupulina* L.), and snail medic (*M. scutellata* [L.] Mill) but we found them to not perform well under our conditions.

Sweetclover (yellow sweetclover, *Melilotus officinalis* L. [Lam.]; white sweetclover, *M. alba* Desrousseaux). Sweetclover is not actually a clover and is more closely related to alfalfa than to the true clovers. Most sweetclover varieties are biennials, but some annual varieties exist. At high latitudes, such as Alaska, biennial sweetclovers act much like annual plants by flowering in the seeding year. Sweetclovers are highly sensitive to acid soils and do not tolerate flooding well, but can be very productive under optimum conditions. Sweetclover is sometimes considered an invasive weed.

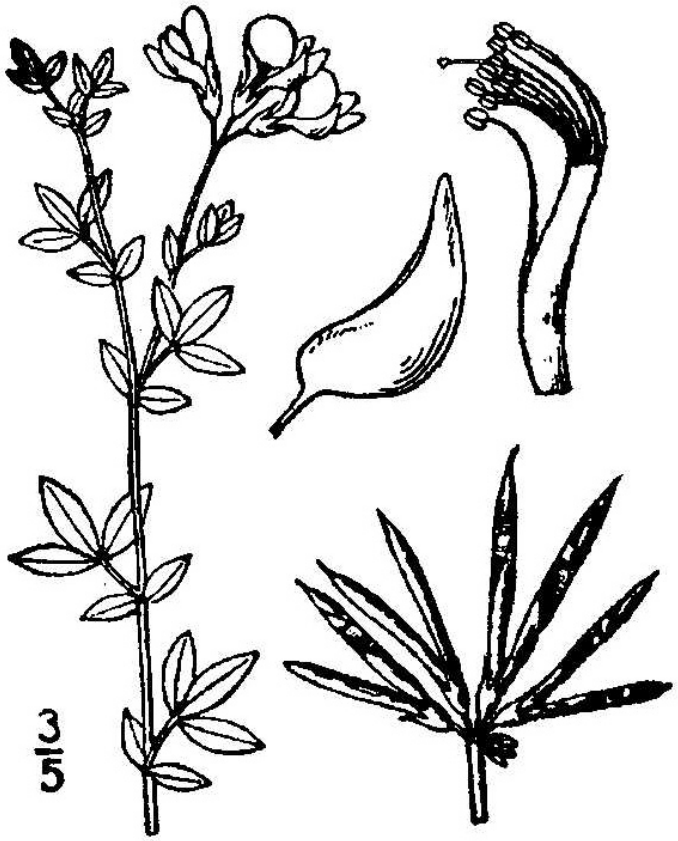
Perennial Clovers (*Trifolium* species): There are numerous species of true clovers, some are perennials and others are annuals. Of the perennials, the most commonly used for forage crops are alsike clover (*T. hybridum* L.), red clover (*T. pratense* L.), and white clover (*T. repens* L.). All are fairly tolerant of acid soils, but do not tolerate salinity or drought well. They are used both as hay and pasture crops. Red clovers are often divided into two types, the so-called mammoth red clover, which is suitable



Red clover.
—USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 2:355.



Alpine milkvetch.
—USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 2:382.



Birdsfoot trefoil.
—USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 2:359.

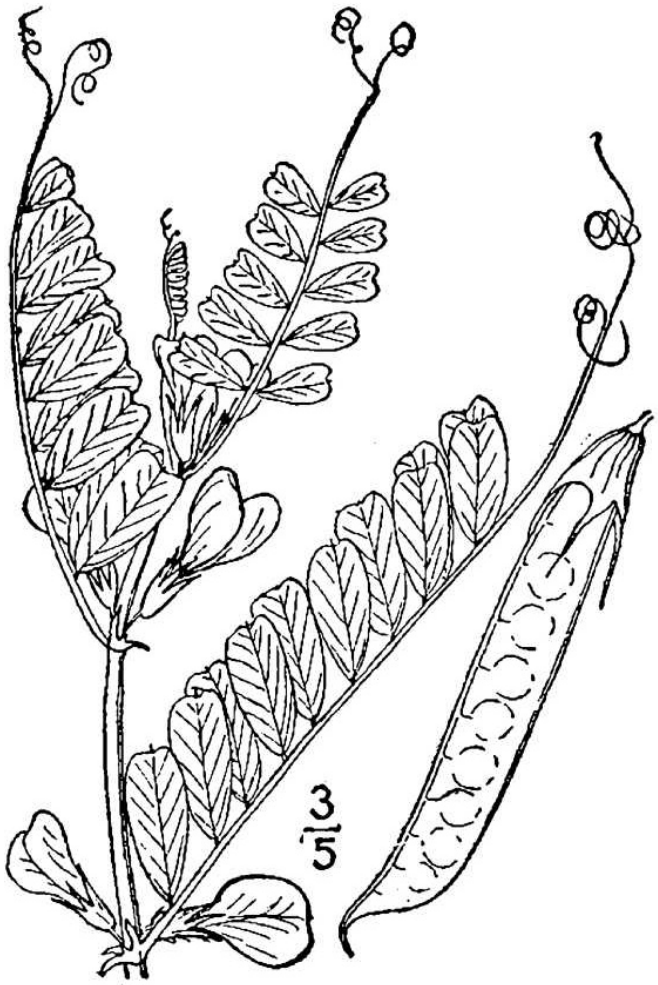
for only one cut per season, and the double-cut type. Double-cut red clover varieties reach cutting stage earlier in the season and recover quicker from harvest than the mammoth type, but are generally less winter hardy. White clover consists of three types, ladino or large white clover, White Dutch or intermediate white clover, and small white clover. Ladino is the only type used for hay because it is much taller than the other types. It is more tolerant of heat but much less winter hardy than intermediate white clover. The small type is not usually grown as a crop. The perennial clovers have generally not shown good long-term persistence in interior Alaska, but red clover has been found to produce well for several years in some areas of southcentral Alaska. Kura clover (*T. ambigium* Bieb.) has been touted as a long-lived, winter-hardy clover for use in the northern Midwestern states, but has received little testing in high-latitude regions. If managed properly, clovers can produce forage with excellent quality.

Annual clovers (*Trifolium* species): Several annual clovers are grown as hay or pasture crops. They are usually grown as winter annuals in warm climate regions. In our trials, we tested arrowleaf clover (*T. vesiculosum* Savi), balansa clover (*T. balansae* Boiss. or *T. michelianum* Savi), ball clover (*T. nigrescens* Viv.), berseem clover (*T. alexandrinum* L.), crimson clover (*T. incarnatum* L.), Persian clover (*T. resupinatum* L.), rose clover (*T. hirtum* All.), strawberry clover (*T. fragiferum* L.), and subterranean clover (*T. subterraneum* L.).

Cicer milkvetch (*Astragalus cicer* L.) and other milkvetches: Cicer milkvetch is considered to be a long-lived, winter-hardy legume with fair drought tolerance. Hard seeds often result in poor germination and seedlings are weak, making it slow and difficult to establish. It is usually lower yielding than alfalfa but is resistant to many alfalfa pests. Several milkvetches are native to Alaska. We have done small tests on a few including *Astragalus alpinus* [L.] Lam. and *A. eucosmus* Robins., but found them to all have very poor and slow seed germination. We therefore did not do any extensive trials on them.

Trefoils (*Lotus* species): Birdsfoot trefoil (*L. corniculatus* L.) and big trefoil (*L. pendunculatus* Cav.) are both grown as forage crops, although birdsfoot trefoil is more common. Birdsfoot trefoil has weak roots in the seedling stage, but produces a strong, deep root system when mature and is considered to be very winter hardy once established. It is used as both a hay and pasture crop. We tested a few varieties of both species in our trials.

Vetches (*Vicia* species): The *Vicia* genus consists mostly of vine like annuals, but a few perennial species exist. At least one species (*V. faba* L.) is a tall-growing, large-seeded annual. Several species are used as forage and cover crops. We tested bigflower



Common or garden vetch.
USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 2:411.

vetch (*V. grandiflora* Scop.), common vetch (*V. sativa* L.), hairy vetch (*V. villosa* Roth), purple vetch (*V. benghalensis* L.), and bird vetch (*V. cracca* L.). The latter is a perennial. It is very slow to establish, but once established is very aggressive. It is often considered a weed in pastures, lawns, and along roadsides and has been suggested for the invasive weeds list in Alaska.

Fababean (*Vicia faba* L.): This crop is also known as bellbean, broadbean, fava bean, horsebean or Windsor bean. It is a tall-growing, upright, large-seeded annual. The seeds are used for human consumption and in animal feeds but the species is also sometimes grown as an annual forage crop. It is fairly expensive to grow as a forage crop.

Lentil (*Lens culinaris* Medik): Lentil, which is an annual crop, is usually grown for its seed for human consumption, but varieties have been developed for use as green manure crops and have been tested as potential forage crops in the northwestern United States and western Canada.

Tingapea (*Lathyrus tingitanus* L.): Also known as Tangier pea, this is an annual legume often used as an ornamental but is sometimes used in the western US and Canada as a green manure crop and occasionally as a forage crop.

Field pea (*Pisum sativum* L.): Peas are usually grown for their seeds for human consumption, but the vines, if harvested at the proper growth stage, make an excellent forage. Peas are sometimes planted in mixtures with forage oats or other cereals. They are fairly expensive to grow for forage uses.

Lupines (*Lupinus* species): Both annual and perennial lupine species exist, but only the annual types are grown as crops. Lupines are upright, large-seeded plants and are sometimes grown as feed-grain legumes in some regions of the world. Many lupines contain high levels of alkaloids which are toxic and bitter to livestock. Low alkaloid strains, sometimes called sweet lupines, are used for forages. The species we tested were white lupine (*L. albus* L.) and yellow lupine (*L. luteus* L.).

Oxytrope (*Oxytropis* species): Numerous *Oxytropis* species, which are perennial legumes, are native to Alaska. We tested one species, field oxytrope (*O. campestris* L. [DC.]) in our trials. Establishment was so poor that we did not harvest any of the plots.

Sweetvetch (*Hedysarum* species): According to Hultén (1968), there are two sweetvetch species native to Alaska: alpine sweetvetch (*H. alpinum* L.), also known as sweet-broom or Eskimo potato, and *H. Mackenzii* Richards. We tested both, usually as mixtures of both species in our trials. At least one species (*H. coronarium* L.), is grown in some regions as a forage crop. We tested it in one of our trials, but found establishment to be so poor that we abandoned it in our tests.

Other species which have been tested but found to be unsuited to interior Alaska conditions include **crownvetch** (*Securigera varia* [L.] Lassen. or *Coronilla varia* L.), **lespedeza** (several species tested, *Kummerowia* species and *Lespedeza sericea* Miq.), and **sanfoin** (*Onobrychis viciaefolia* Scop.).

Appendix 2. Standard hay grades and forage quality values from different regions of North America.

Linn and Martin, 1991: Hay grades based on neutral detergent fiber (NDF), acid detergent fiber (ADF), and relative feed value (RFV).

Grade	NDF	ADF	RFV
	%		
Prime	<40	<31	>151
1	40-46	31-35	151-125
2	47-53	36-40	124-103
3	54-60	41-42	102-87
4	61-65	43-45	86-75
5	<65	>45	<75

USDA Agricultural Marketing Service alfalfa hay quality guidelines (Cash and Dixon 2002).

Quality designation	Crude Protein	NDF	ADF	RFV
	%			
Supreme	>22	<34	<27	>185
Premium	20 – 22	34 – 36	27 – 29	170 - 185
Good	18 – 20	36 – 40	29 – 32	150 - 170
Fair	16 – 18	40 – 44	32 – 35	130 - 150
Low	<16	>44	>35	<130

USDA Agricultural Marketing Service grass hay quality guidelines (Cash and Dixon 2002).

Quality designation	Crude protein
	%
Premium	>13
Good	9-13
Fair	5-9
Low	<5

Grass hay and grass silage forage quality values reported from British Columbia (Bittman et al. 1999).

	Crude Protein	NDF	ADF
	%		
Grass hay			
Low	9.1	43.9	23.8
Average	17.6	56.3	29.8
High	24.4	65.9	38.1
Grass silage			
Low	8.8	33.3	23.4
Average	17.7	48.9	31.2
High	26.1	65.3	41.7

The Alberta Forage Manual (Alberta Agriculture, Food, and Rural Development, 1981) gives the following data for expected crude protein values for grasses and legumes at different growth stages in Alberta.

Growth stage	Crude Protein	
	%	
	Grass	Legume
Vegetative	15	21
Boot or bud	11	16
Bloom	7	11
Mature	4	7

(tables continued on the next page)

Forage quality values at different maturities for various forages as given by Kellems and Church (1998).

Forage	Crude protein	NDF	ADF
	%		
Alfalfa, pre-bud	23	38	28
Alfalfa, bud	20	40	30
Alfalfa, mid-bloom	17	46	35
Alfalfa, mature	15	53	41
Bromegrass, late vegetative	14	63	35
Bromegrass, late bloom	8	81	49
Orchardgrass, early vegetative	18	55	31
Orchardgrass, early bloom	15	61	34

According to Collins and Fritz (2003), well-cured alfalfa and red clover hays harvested at late bud stage will have CP near 25%, NDF of 30 to 32%, and ADF of 25 to 28%.

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The federal Hatch Act of 1887 authorized establishment of agricultural experiment stations in the U.S. and its territories to provide sicence-based research information to farmers. There are agricultural experiment stations in each of the 50 states, Puerto Rico, and Guam. All are part of the land-grant college system. The Morrill Act established the land-grant colleges in 1862. While the experiment stations perform agricultural research, the land-grant colleges provide education in the science and economics of agriculture.

The first experiment station in Alaska was established in Sitka in 1898. Subsequent stations were opened at Kodiak, Kenai, Rampart, Copper Center, Fairbanks, and Matanuska. The latter two remain. None were originally part of the Alaska land-grant college system. The Alaska Agricultural College and School of Mines was established by the Morrill Act in 1922. It became the University of Alaska in 1935. The Fairbanks and Matanuska stations now form the Agricultural and Forestry Experiment Station of the University of Alaska Fairbanks, which also includes the Palmer Research Center.

Early experiment station researchers developed adapted cultivars of grains, grasses, potatoes, and berries, and introduced many vegetable cultivars appropriate to Alaska. Animal and poultry management was also important. This work continues, as does research in soils and revegetation, forest ecology and management, and rural and economic development. Change has been constant as the Agricultural and Forestry Experiment Station continues to bring state-of-the-art research information to its clientele.