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Annual Forages for the Nebraska Panhandle

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Advantages and disadvantages of various annual forages, results of dryland and irrigated forage trials, tips for achieving quality forage, and issues related to animal health and feeding forages.

Annual forages have value as pasture, green chop, silage, and hay. With adequate soil moisture, these forages grow very rapidly during their appropriate growing seasons.

Summer Annual Forages

Most species of summer annual forages are relatively drought resistant because of efficient water use. Summer annual forage grasses vary greatly in: 1) plant height, 2) regrowth potential, 3) stem diameter, 4) anti-quality and toxic components, 5) yield, and 6) growing season, both between types of grasses and within varieties of a given type. Selecting a species and cultivar most suitable to the system in which it is to be used is important. Nebraska producers have relied primarily on six summer annual forage grasses to meet or supplement forage needs: forage sorghum, sudangrass, sorghum x sudangrass, foxtail millet, proso millet, and pearl millet.

Forage sorghum includes open-pollinated cultivars and hybrids. It is a coarse, erect grass with considerable variability in growth characteristics. Some cultivars tiller early, while others do not tiller until late in the season. Stem diameter varies from 0.25 inch to over 1.0 inch, depending on genotype and planting density. It is frequently referred to as "cane" or "sweet cane" or by the particular cultivar or hybrid name with no mention of type. Forage sorghums usually yield more silage dry matter per acre than dryland corn, but yields of total digestible nutrients (TDN) usually are lower for the forage sorghums, especially under irrigation. Since forage sorghums generally have the potential to form high levels of prussic acid, do not graze regrowth after silage harvest. Forage sorghums often are cut for hay. Stem thickness often delays drying after cutting, but this can be partially offset by using heavier seeding rates and thinner-stemmed cultivars. Harvesting equipment that includes a crimper or conditioner should speed drying.

Sudangrass is a relative of the sorghums and recently has been given the same taxonomic name as sorghum (*Sorghum bicolor*). It is generally differentiated from forage sorghum by its relatively low prussic acid content, fine stems, tillering, and higher regrowth potential. Both open-pollinated cultivars and hybrids are available. The hybrids have more yield potential in a multiple-cut harvest system. Prussic acid content varies among sudangrass varieties and can be influenced by management, especially with hybrids. Always check prussic acid potential of cultivars or hybrids before buying seed if the planned use is for grazing or green chop.

Sorghum x sudangrass is the most commonly used summer annual forage in Nebraska. It is high yielding, but much of this yield is stem material, so mature forage can be low in energy and protein. Rate of regrowth after clipping or grazing generally is lower than in sudangrass, but sorghum x sudangrass can be used for grazing, green chop or multiple-cut hay operations. Depending on characteristics of the sudangrass and sorghum parent lines, there can be large variations in these hybrids. Always check the traits needed for your production system before buying seed.

Foxtail millet is well adapted to western Nebraska because it has a short growing season and drought tolerance. Grazing potential is limited because it is frequently pulled from the ground by grazing animals and regrowth is limited. It dries faster and with fewer mold problems than other summer annuals, which are almost all thicker stemmed. Foxtail millet is used primarily for hay production; however, it can be cut in the fall and left in windrows for fall or winter grazing. This can eliminate many harvesting and utilization costs. Once cows know the hay is in the windrows, they'll find it even with some snow cover. Foxtail millet is a known host for the wheat curl mite, which is the carrier for wheat streak mosaic virus. Caution is

Table I. Production and feed values for annual forages grown in western Nebraska or eastern Wyoming, 1998-1999.[abc]

		Dry Matter		*Protein*		*Nitrate*	*Fiber*			*Energy*				*Digestion*
Forage Crop	*Year*	*DM %*	*DM YLD lb/a*	*CP %*	*UIP %/CP*	*NO_3N ppm*	*NDF %*	*ADF %*	*ADL %*	*NE_m Meal*	*NE_g Meal*	*ND_l Meal*	*TDN %*	*IVDMD %*
DRYLAND														
Spring cereal														
Barley	98, 99	40	4200	8.2	8	220	65	34	5.4	.68	.41	.68	66	69
Oat	98, 99	30	3640	9.5	8	360	65	34	5.1	.68	.51	.67	66	73
Triticale	98, 99	38	4100	9.3	6	130	66	36	5.5	.67	.40	.67	65	70
Legume														
Pea	99	26	2090	17.1	9	—	40	33	—	.65	.38	.65	64	71
Soybean	99	32	2400	12.2	5	100	43	28	6.8	.72	.45	.71	68	77
Vetch	99	29	2180	18.4	8	—	40	32	—	.67	.40	.67	65	72
Summer annual														
Forage sorghum	98, 99	22	5400	9.6	10	960	59	30	3.6	.70	.43	.69	67	78
Sorghum x sudan	98, 99	24	5780	9.0	10	830	61	32	4.2	.69	.42	.68	66	72
Sudangrass	98, 99	30	4530	7.6	11	540	65	36	4.9	.67	.40	.67	65	66
Pearl millet	98	20	3740	15.3	8	2090	60	30	3.5	.70	.43	.69	67	78
Foxtail millet	99	32	2760	8.9	9	320	61	32	3.5	.69	.42	.68	66	73
IRRIGATED														
Summer annual														
Forage sorghum	98, 99	21	12370	9.8	9	1040	61	35	4.9	.68	.41	.67	65	70
Sorghum x sudan	98, 99	24	12760	8.9	9	740	61	36	6.1	.67	.40	.67	65	64
Sudangrass	98, 99	28	10910	9.0	10	1050	66	40	6.5	.65	.39	.66	64	60
Pearl millet	98, 99	20	10670	11.3	10	2340	67	40	5.7	.65	.39	.66	64	64
Mega Mill	98, 99	15	11300	12.5	9	2900	66	40	5.2	.65	.39	.66	64	69
PIOXIM	98, 99	22	10800	10.6	10	2000	67	40	6.1	.65	.39	.66	64	61
HPM	98, 99	23	9900	10.9	10	2150	67	39	5.8	.65	.39	.66	64	62
Foxtail millet	98, 99	25	6490	12.1	6	2010	62	36	4.9	.67	.40	.67	65	70

[a]Dryland spring cereal, pea, vetch and summer annual grass forages were grown at the University of Nebraska High Plains Ag Lab at Sidney; irrigated summer annual grass forages were grown at the Panhandle Research and Extension Center at Scottsbluff; and dryland soybeans were grown at the University of Wyoming Research and Extension Center at Archer. Altitudes are about 4300, 4000, and 6000 feet above sea level for these three locations, respectively. Altitude affects crop maturity development.

[b]Grass forages were harvested after a majority of the cultivars had produced seed heads. Pea and vetch crops were harvested at early bloom and soybeans were harvested at mid pod-fill. Contents are expressed on a dry matter basis. Pearl millet contents are shown as crop averages and as individual variety contents, showing variation in dry matter (maturity) and associated differences in crude protein, nitrates, and digestibility.

[c]Abbreviations are: DM = dry matter; DM YLD = dry matter yield; CP = crude protein; UIP = undegradable intake protein; NO_3N = nitrate nitrogen; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin; NE_m = net energy for maintenance; NE_g = net energy for gain; NE_l = net energy for lactation; TDN = total digestible nutrients; and IVDMD = in vitro dry matter digestibility.

needed when planting it beside fields that will be seeded to wheat in the fall. Always cut or destroy foxtail millet before planting wheat. Planting wheat after the first killing frost will eliminate this disease problem when wheat is seeded next to a foxtail millet field.

Proso millet was not developed as a forage crop, but frequently is used as one. It produces forage similar in quality to other summer annuals, but yield is lower. The variety "Horizon" produces more forage than "Dawn" or "Rise". Most proso grown for grain is swathed prior to full maturity and then combined, resulting in straw of relatively high feed value compared to other grain crops that have lost most of their leaves prior to harvest. Proso straw has been used successfully as part of the feed for wintering dry pregnant beef cattle. It is not a major host of the wheat curl mite.

Pearl millet planted for grazing has increased in Nebraska due to new and better adapted cultivars. It can be grown as a hay crop, but its slow dry-down and coarse stems make some other summer annuals more desirable for this purpose. Stem diameter can be reduced by increasing seeding rates or harvesting earlier. New hybrids may have good potential for green chop because of low levels of prussic acid. Its primary use will be for summer grazing for ruminants.

Cool Season Forages

When harvesting cool season crops for forage, energy and nutrient return is nearly doubled compared with harvesting the crop as grain. Small grains, such as **oats, barley, triticale** and **wheat,** may be harvested for silage in the boot, heading, flower, milk, or dough stages. The forage quantity increases and the quality decreases as the plant matures. Harvesting at the dough stage is usually a good compromise. Small grains produce one to six tons of dry matter per acre with yield varying by year, moisture, fertility management, and species.

Any small grain adapted for grain production in an area will make satisfactory forage yield; however, medium to late maturing taller varieties produce more tonnage, especially when harvested after boot stage, unless growing season or nutrients are limiting. "Russell" and "Settler" oats are good for forage production. Settler can be grown for either grain or forage. Susceptibility to barley yellow dwarf or wheat streak mosaic virus can be a limiting factor with forage production but less so than with grain production.

Barley kernels have either smooth or rough awns in the head stage of development. If barley is made into silage, rough awned cultivars are not too objectionable because ensiling

Table II. Mineral contents of annual forages grown in western Nebraska or eastern Wyoming in 1999.[ab]

Forage Crop	*Ca* %	*P* %	*K* %	*Mg* %	*S* %	*Na* %	*Cl* %	*Si* %	*Mn* ppm	*Fe* ppm	*Cu* ppm	*Zn* ppm	*Ti* ppm	*Ni* ppm
DRYLAND														
Spring cereal														
Barley	.30	.20	2.3	.09	.13	.17	.18	4.3	45	460	5	10	30	25
Oat	.35	.24	3.5	.11	.19	.09	.20	4.7	110	470	6	15	60	30
Triticale	.27	.24	2.7	.09	.16	.07	.14	4.5	70	350	7	16	25	20
Legume														
Pea	1.2	.33	2.8	.26	.19	.06	.06	3.9	105	—	8	23	—	—
Soybean	1.7	.25	1.8	.50	.21	.04	.01	.6	50	220	5	20	25	6
Vetch	1.5	.31	2.9	.26	.20	—	—	—	—	—	—	—	—	—
Summer annual														
Forage sorghum	.49	.13	2.7	.18	.11	.04	.08	4.2	50	220	7	15	20	14
Sorghum x sudan	.44	.12	2.6	.16	.10	.04	.07	4.1	50	160	6	15	16	12
Sudangrass	.41	.10	2.5	.17	.11	.06	.06	3.3	40	180	6	13	17	9
Foxtail millet	.35	.12	3.2	.23	.14	.03	.03	3.8	60	100	6	13	12	7
IRRIGATED														
Summer annual														
Forage sorghum	.44	.22	2.6	.29	.14	.16	.50	4.8	110	140	7	25	10	10
Sorghum x sudan	.44	.20	2.5	.29	.13	.13	.48	4.7	100	110	8	26	9	9
Sudangrass	.47	.19	2.8	.31	.15	.15	.52	4.7	90	110	7	24	9	7
Pearl millet	.51	.24	4.3	.33	.23	.26	.70	4.1	80	150	8	25	9	8
Foxtail millet	.48	.22	4.7	.31	.21	.14	.43	5.1	105	170	9	35	12	8

[a]Mineral contents are expressed on a dry matter basis and correspond to the crops shown in *Table I* that were harvested in 1999 only. Contents were determined with the use of X-ray analysis procedures.

[b]Abbreviations are: Ca = calcium; P = phosphorus; K = potassium; Mg = magnesium; S = sulfur; Na = sodium; Cl = Chlorine; Si = silicon; Mn = manganese; Fe = iron; Cu = copper; Zn = zinc; Ti = titanium; and Ni = nickel.

softens the awns. If barley is to be used as hay, use smooth awn cultivars. Rough awns cause considerable soreness and irritation to the mouth, lips, gums, and lower surface of the tongue in cattle. Barley cultivars included in recent Nebraska tests are similar in height and maturity and all should produce equivalent forage yields of hay or silage. Hard red spring wheat varieties are often awned. Give the same consideration in selecting a spring wheat cultivar for hay or silage as discussed for barley.

Peas have become more frequently used as forage in the region. They are able to fix their own nitrogen and therefore are frequently blended with oats or triticale to reduce fertility cost while maintaining or improving forage protein levels. Most grain pea cultivars make acceptable forages, but cultivars such as "Arvika" and "Forager" are primarily used for forage.

Warm Season Broadleaf Plants

Warm season broadleaf plants, including soybeans, kochia, amaranth, and sunflowers, can be utilized for forage, but are typically used only in emergency situations in this region.

Dryland and Irrigated Annual Forage Trials

Dryland and irrigated annual forage trials were conducted over two years to update forage production and quality characteristics for the Central High Plains region. Spring triticale, barley, oat, vetch, and field pea cultivars were tested at Sidney, Nebraska (elevation 4300 feet above sea level). Soybean cultivars were tested at Archer, Wyoming (elevation 6000 ft). Summer annual forages were tested under dryland at Sidney and/or irrigated management systems at Scottsbluff (elevation 4000 feet), and included as many as nine forage sorghum, six sorghum x sudangrass, one sudangrass, three pearl millet and nine foxtail millet cultivars *(Table I)*. A single cut harvest system was used for both dryland and irrigated forages when legumes had bloomed or produced a seed pod or when most of the grass cultivars had produced a seed head.

Using a combination of near infrared (NIR) and wet lab methods, forage quality tests indicated similar crude protein and energy levels for winter wheat and triticale cultivars as well as for spring triticale, barley and oat cultivars. Irrigated foxtail millets in 1998 and 1999 averaged 12.1 percent crude protein and 65 percent TDN; however, nitrate nitrogen levels for these irrigated foxtail millets as well as for dryland and irrigated pearl millets were near or above 2000 ppm. This is the level often used as a threshold for some toxicity risk for ruminants or at least a signal that such forage should be diluted with low nitrate feed or forage in order to avoid toxicity symptoms. Our data indicates that pearl millet is the most likely to have elevated nitrate levels. These nitrate nitrogen levels were likely a function of the level of nitrogen fertilizer (120 lb of nitrogen per acre) applied as a side-dress to all irrigated summer annual forages. Nitrate nitrogen levels in the other summer annual forages seldom approached 2000 ppm in dryland or irrigated trials. Nitrogen application rates for warm season annual forages will need to be managed carefully along with maturity stage at harvest to achieve satisfactory production levels without raising nitrates to levels posing toxicity risks for ruminants.

Mineral contents were determined on most 1999 samples by using an X-ray fluorescence spectrometer from the Agronomy and Horticulture Department Analytical Laboratory, University of Nebraska-Lincoln. There were some differences due to location and management (dryland vs. irrigation plus fertilization and cropping system history for each site);

however, means are provided for important major and trace minerals to help evaluate mineral contributions from these annual forages to animal diets.

The choice of an annual forage crop and cultivar may depend more on the time forage is critically needed rather than the differences in yield potential. For example, the spring seeded forages can produce grazing or hay in May or June, and the foxtail millets can produce a good quality hay during the warm season in about 60 days. Also, the harvesting equipment required for small grain or foxtail millet forages may be a better fit with existing hay equipment on an operation, such as a swather rather than the row equipment that may be required for the taller growing forages. If tonnage is the critical need and the equipment is available for harvest, there are forage sorghum, sorghum x sudangrass, and pearl millet cultivars that can produce forage dry matter yields similar to those for corn silage when moisture and soil fertility are not limiting.

Pearl millet does not produce prussic acid like some of the forage sorghums do, and thus would be a good option for grazing, as would those sorghum x sudangrass hybrids that have low prussic acid forming potential. Finally, the emergence of summer forages with increased digestibility, such as the brown midrib (BMR) cultivars in forage sorghum, sorghum x sudangrass, pearl millet, and corn hybrids, brings new opportunities for improved animal performance through grazing or feeding of these forages. The reduced lignin fiber content of these forages allows for greater digestibility, but also may allow lodging to occur more easily. Management systems involving grazing or harvesting sooner or more often than usual may minimize lodging problems that could occur with tall growth and strong winds. In both our irrigated and dryland trials, the highest digestibility values were associated with lowest acid detergent lignin (ADL) percentages which were typical for many brown midrib hybrids.

Forage Quality

Quality is negatively correlated with maturity in annual forages. As maturity increases, quality declines rapidly. This includes decreases in protein content, energy value and intake, which can drop considerably with the coarser stemmed types. High forage protein and digestible energy levels can be obtained by harvesting prior to heading, preferably at the late boot stage with grasses or pre-bloom with broadleaf forages. The optimum compromise between quality and yield generally occurs shortly after seed heads have emerged. Yield (dry matter per acre) may increase by 10 percent to 20 percent from the boot to the early heading stages. Forage must be harvested prior to the soft dough stage of seed development if anything more than roughage is required. Foxtail and proso millet maintain forage quality slightly longer than the sorghums, but still need to be harvested when most of the seed heads have emerged to maximize quality. Foxtail millet harvested after flowering may develop stiff awns that can cause mouth injuries to animals eating the hay.

Grazing should be initiated at an earlier plant stage than that used for haying because advanced maturity will reduce harvest efficiency and decrease regrowth potential. Intensive grazing with pasture rotation maximizes harvest efficiency and beef production per acre. The grazing season can be lengthened and forage quality maintained if planting dates are staggered. Trampling can be reduced by using wider row spacing and higher seeding per row.

Winter grazing of summer annuals is more practical in western Nebraska than in areas where higher precipitation and humidity levels cause forage deterioration. Forage quality can be maximized by delaying planting so that the crop is killed by frost before flowering. This also will improve forage standability during winter storms.

Animal Health

Exercise caution when grazing or feeding annual grasses. Monitor nitrate levels closely with all of these crops before feeding. Ensiling high nitrate annual forages can help reduce nitrate problems. As nitrate nitrogen levels increase above 2000 ppm, there would be increased risk for nitrate toxicity in animals. High nitrate forages should be fed or grazed along with low nitrate forage and they should not be fed to pregnant animals. Cattle grazing high nitrate forage tend to selectively graze the plant leaves which are lower in nitrate than the lower parts of the plant. If they are forced to graze stem bases that are high in nitrate, the risk of nitrate toxicity will increase.

The potential for formation of prussic acid (also called hydrocyanic acid) is high in most sorghums, high at times in sudangrass (especially in regrowth following a frost, grazing or haying), and high at times in sorghum-sudangrass crosses (especially some particular hybrids). Prussic acid is not present with foxtail, proso or pearl millet. Prussic acid interferes with oxygen utilization, with mild cases causing labored breathing, frothing at the mouth, or staggering, and severe cases causing death.

Horses should not eat large quantities of forage sorghums, sorghum x sudangrass hybrids, or foxtail millet. Horses consuming these forages as a major component of their diet frequently develop urinary, liver or bone problems due to a specific glucoside component of the forage that is not a problem for cattle. However, horses can effectively use pearl millet because it does not have this component. Inadequately curing or drying annual forages can lead to molds that can increase the risk of respiratory reactions in horses.

Change livestock rations carefully. Animals should not be hungry when first exposed to annuals and supplemental nutrients and water should be adequate. Observe animals closely for signs of distress during the first few days and switch to other feed if necessary.

Grass tetany can be a problem with cool-season grass forages early in the spring, especially with lactating animals. Magnesium supplements should be used to help prevent this when using these forages.

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