ALTERNATIVE FORAGE OPTIONS

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ABSTRACT

Annual forages, both warm- and cool-season types, occupy significant space in the hay, silage, and grazing landscapes of the western US. This paper reviews some of the more commonly utilized annual forages grown throughout much of the region as alternatives to alfalfa, perennial grasses, or corn. While many other "alternative" crop options exist, the ones reviewed here represent the broadest utilization potential based on factors such as: adaptation, hardiness, flexibility of harvest, market options, and seed availability. Warm-season forages presented are: sorghums, millets, teff, and cowpeas. Cool-season species presented are: wheat, triticale, barley, oats, rye, berseem clover, and Austrian winter pea.

Key Words: alternative forages, summer annuals, small grains, teff, sorghum, millets, peas

INTRODUCTION

In recent years, water shortages have threatened the sustainability of irrigated agriculture in the dry environments of the western US. Hay producers across the West have experienced reduced irrigation allocations, increased pumping costs, and subsequently lower yields and profitability in their operations. As declining water availability continues to threaten irrigated agriculture sustainability, alternative forage sources can be utilized that reduce water inputs and allow for flexibility in extreme climatic conditions (e.g., drought) and inconsistent water allocations. Annual forages can be such an alternative. Oftentimes, annuals provide a quick emergency forage or fill a forage gap or slumps in perennial crop production. In general, annual species are high in nutritive value and several produce considerable amounts of dry matter in a short amount of time. In addition, annual crops provide valuable forage during perennial crop rotation periods, help to break disease and pest cycles, and allow for alternative weed control strategies. A third advantage of annuals is that they help to diversify farming operations and allow for opportunities to take advantage of a broader array of markets. This article summarizes various annual, warm- and cool-season crops and specific management considerations for each.

SUMMER ANNUAL FORAGES

SORGHUM FORAGES

Sorghums (*Sorghum bicolor*) include forage sorghum, grain sorghum, Sudangrass, and sorghum-sudangrass hybrids. All of these sorghum types can provide valuable summer pasture, hay, and silage and can be grown throughout the West. They are not tolerant of cool climates and will winterkill at first frost regardless of location. Aside from corn, they are one of the most

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extensively grown warm-season annuals because they are easy to establish, are very drought-tolerant, and lend themselves to multiple harvest options. In areas of year-round livestock grazing, sorghums can provide nutritious forage during hot, dry summer months when cool-season perennial grasses have gone dormant and warm-season perennial pastures are lacking nutrition. In addition, they make excellent hay and silage for supplemental feeding during times of inadequate forage production. Another advantage of sorghums is that they can be used as an emergency, late-planted crop to replace a primary crop that has been damaged by wind, hail, or drought early in the growing season. Sorghums can tolerate significant moisture stress and will resume vegetative growth after drought-induced dormancy. This characteristic makes them desirable for use in situations with inconsistent or very intermittent watering and dryland operations. The ability of some varieties to tiller and regrow after cutting or defoliation makes them ideal for multiple cut or grazing situations. These forages respond well to nitrogen fertilization and irrigation, producing high yields of nutritious forage.

As with most forages, nutritive value declines with maturity; however, total digestible nutrients (TDN) as high as 70% and crude protein levels over 15% can be achieved when harvested prior to heading. Sorghum forage quality has been improved by the inclusion of the brown midrib (BMR) trait, and harvest flexibility has been improved by the photoperiod sensitivity trait. The BMR varieties have a lower lignin concentration that increases available energy and digestibility. Heading in photoperiod sensitive varieties is not initiated until approximately mid- to late-September when day length decreases. This broadens the harvest window, allowing for higher yields of high-quality vegetative forage. Seeding rate can also affect quality. Plants seeded at higher rates have finer stems than those seeded at lower rates, which can speed drying time of hay. Due to the typically large stems, hay will need to be conditioned during mowing for proper curing. Lower seeding rates are recommended for BMR varieties because their finer stems, coupled with lower lignin concentrations, increase the likelihood of lodging (falling over). Sorghums should not be sown until the soil temperature reaches 60°F.

Antiquality Factors Associated with Sorghums

While sorghums have many benefits and make excellent-quality forage, there are a few toxicity concerns producers should be aware of. The two main toxicities associated with sorghum are nitrate and prussic acid (cyanogenic glycoside) poisoning in ruminants. Additionally, sorghums can cause a cystitis-ataxia (urinary incontinence and staggering) syndrome in horses.
Nitrates and prussic acid potential increase with environmental or management stresses, such as cool weather, frost, drought, cloudy days, high nitrogen fertility, and herbicide or other injury. Historically, prussic acid was thought to only be of concern when grazing or feeding fresh, green forage. However, new information has surfaced that indicates that prussic acid potential can persist after plants have dried. Nitrate poisoning can occur with both pasture and when feeding hay. Because nitrates accumulate in the lower stem, if grazing animals are not forced to consume low on the plant, the likelihood of poisoning is greatly reduced. Suspect forage should be tested, and if toxic levels are found, animals should be removed from pasture. Toxic hay should be diluted with low-nitrate hay and/or a concentrated energy supplement, such as grain, should be fed. Initial grazing should be avoided until plants reach 24–30 inches of growth, and regrowth grazing deferred until plants reach 18 inches. While toxicities in ruminants can be avoided with careful management, sorghums are not recommended for horse pasture or hay.

TEFF

Teff [*Eragrostis tef* (Zucc.) Trotter], a warm-season, annual grass originally utilized as a cereal grain crop in Africa, has developed a reputation as a rapidly growing, drought-tolerant, high-quality forage crop in the US. Multiple studies in several western states and extensive promotion among companies in the hay industry have touted the benefits of teff for several classes of livestock and for use in challenging growing conditions. The forage is suited to a broad range of environments, can be cut multiple times, and offers flexibility to the hay producer. The primary utilization potential for teff is in the small-bale horse market, and in areas where other suitable annual grass hays are not available to feed to horses. Teff has gained popularity among horse owners and hay producers looking for alternative hay crops to improve marketing opportunities and to fit into low-water situations. Teff offers a high-quality hay option that fits well into alfalfa rotations, while maximizing limited water and fertilizer resources. Research and producer observations have mixed results; however, enough consistencies exist that make choosing teff a viable alternative under certain conditions. As with any crop, both positive and negative opinions have emerged from the varied experiences of farmers with teff. Poor establishment and weed challenges are the most often cited complaints among producers in the region.

Yields, Management, and Quality

Teff has been reported to produce anywhere from 1.5 to over 8.5 tons/ac of total seasonal yield in the western states, depending on location, length of growing season, cutting schedule, and irrigation and fertilizer inputs. Higher yields can be achieved in cooler regions and may exceed 7 tons/ac. Yields tend to be more modest (3 to 4 tons/ac/season) in hotter, drier areas of the West. About 1.0 to 2.0 tons/ac are common per cutting. Teff should not be grazed until after the final hay harvest as it has a weak root system and is easily uprooted.

Water requirement appears to be more than that reported for sorghum forages (e.g., *Sorghum* sp.; haygrazer or forage sorghums), but water use is often lower than typical alfalfa usage, based on producer reports and researcher observations. Sorghum-sudangrass has been shown to yield more than teff with similar water and fertilizer applied. In other locations, teff has exhibited similar irrigation efficiency to sorghums, at about 3-4 inches of water to produce 1 ton of hay.

Recommendations for fertilizing teff with nitrogen are quite variable and are to add anywhere from 50 to 120 lbs of N/ac for the year, but most sources agree that about 30 to 60 lb N/ac at-plant and in between cuttings is optimum. Little yield advantage has been observed with nitrogen applications greater than 50 lb N/ac per cutting. If following alfalfa, enough residual nitrogen may remain in the soil to meet the relatively low nitrogen requirements of teff, even for multiple cuts in a season. This is especially true if the last topgrowth of the alfalfa was incorporated into the soil and not harvested for hay.

Weed control early is critical to good stand establishment and yield of quality hay. Small teff seedlings simply do not compete well with weeds, and stands can easily become overrun and outcompeted. Very few herbicides are labeled for use in teff. Only 2,4-D and Dicamba products (or combination) are labeled. No herbicides are labeled for grassy weed control in teff, so it is important to know the weed history of the field prior to planting.

Teff nutritive value has been described as similar to timothy (*Phleum pratense* L.) and orchardgrass (*Dactylis glomerata* L.) hay and full-bloom alfalfa. Studies and producer experiences have shown mixed results when determining horse and other livestock preference of the different hays. However, many horse owners report improved preference and less waste of teff when feeding it. Teff is marketed as a fine-stemmed, palatable, low starch and soluble carbohydrate hay compared to other forages, and this trait may make it a suitable component in the diet of horses with equine metabolic syndrome or related disorders. Bale sampling at Los Lunas, NM, as well as research at Tucumcari, NM reveal that teff soluble sugars (non-fiber carbohydrates; NFC) are lower than most alfalfa hays, but can be higher than other grasses (>18% NFC).

Crude protein (CP) of teff is dependent upon available nitrogen and improves with additional N fertilizer applications. Crude protein ranges from 7 to 17%, but CP is usually between 10 and 15% with N fertility of 30 to 100 lbs/ac that is commonly applied. High nitrates have been observed in teff under high nitrogen fertility and drought conditions.

MILLETS

PEARL MILLET

Pearl millet (*Pennisetum glaucum*), also known as "cattail millet," is a warm-season annual grass similar to sorghum that exhibits rapid summer growth. It is generally more leafy and higher quality than sorghum. It is another choice for lower elevations and southerly regions since it does not perform well in cooler environments. Pearl millet is tall, growing from 3–8 feet in height, and it has the ability to tiller profusely. Generally, this species is shorter and will not yield as much as the forage-type sorghums; but it tolerates high pH, caliche, and sandy soils better than sorghum. Typical dry forage yields of pearl millet range from 3–6 tons/acre under irrigation. Like sorghum, it can be grazed rotationally or cut for hay multiple times as the season allows. Grazing should be deferred until plants reach 18–24 inches. Grazing and hay cutting height should not go below 4–6 inches to ensure adequate regrowth. Nutritive value declines quickly after heading. Pearl millet is considered safe for horses and does not cause prussic acid poisoning. Nitrates, however, can accumulate to toxic levels in pearl millet under the same environmental conditions described above for sorghum. All millets respond very well to nitrogen and phosphorus fertilizers. Seed size is small and must be planted shallowly after soil temperatures reach 65°F.

FOXTAIL MILLET

Foxtail millet (*Setaria italica*) is another commonly grown millet in annual forage systems. Although it is best suited to the warmer growing regions, it can provide temporary summer pasture in some of the West's higher elevations. Foxtail millet is less productive than pearl millet, but its rapid maturity (65–70 days) allows it to be used in late-planted or emergency short-season situations. It is not very drought-tolerant due to its shallow root system, and it matures quickly in the hot summer months. Although some cool-season hay crops are superior in quality, foxtail millet makes good hay for cattle and sheep, but it has generally been displaced by

sorghum-sudangrass hybrids or pearl millet as a late-sown summer hay crop. Due to its fine stems and lower biomass, hay drying time is considerably less than pearl millet and the sorghums. However, foxtail millet will not grow much, if at all, after the first harvest. Its shallow root system makes it easy for grazing animals to uproot. As plants mature, they can accumulate setarian, a compound that acts as a diuretic in horses, causing excessive urination. This compound can lead to kidney problems and has been implicated in liver, bone, and joint damage, especially if foxtail millet is the only hay source for horses. In addition, high nitrates can be a problem with foxtail millet.

COWPEA

Warm-season annual legumes have not been utilized as broadly as cool-season legumes in the West in irrigated pastures or other forage systems. However, a few, such as cowpea (*Vigna unguiculata*), lablab (*Lablab purpureus*), and tepary bean (*Phaseolus acutifolius*), have high heat and drought tolerance, and have been shown to improve forage nutritive value (crude protein) when mixed with a warm-season annual grass, such as sorghum forages or millets. This complementary mixture (with sorghum or millet) is common in other parts of the country for hay or silage. Cowpea is grown as a grain or fresh vegetable crop (e.g., black-eyed peas) in the southern US and other tropical and subtropical parts of the world. Cowpea, in general, is more tolerant of sandy and droughty conditions than soybeans and is well adapted to hot, dry, semi-arid regions. It is generally ready for forage harvest in less than 50 days. Tall, viny, climbing-type varieties should be utilized for mixing with tall annual grasses. The variety 'Iron Clay' is one of the most popular varieties for this purpose. Nutritive value is high, with these legumes being characterized by high protein (>20%), low fiber, and high digestible dry matter. Hay quality can be excellent; however, drydown can be challenging due to the viny nature and high moisture content of the plant and pods. As such, ensiling may be a more acceptable alternative, particularly if mixed with grasses to limit the buffering capacity of high-protein cowpeas. Cowpea can also be utilized in intensively, rotationally-stocked pastures, which is necessary to maximize productivity and allow for adequate regrowth. However, other legumes such as lablab exhibit greater palatability and regrowth potential, and tolerate trampling better than cowpea. Cowpea can make an excellent cover crop, providing quick growth for weed suppression, up to 3 tons/ac of dry matter (1 to 2 tons/ac more common), and potentially 150 lb/ac of nitrogen to the soil. Of the warm-season legume species, cowpea seed is the most readily available in the region.

WINTER & SPRING ANNUAL FORAGES

SMALL GRAINS (WHEAT, TRITICALE, BARLEY, OATS)

Winter and spring small grain crops are used extensively in the West for various types of forage production and animal feeding situations. Due to the large presence of beef and dairy cattle operations, as well as a significant horse industry and the extent to which these operations utilize baled and ensiled feeds, small grains grown for forage are often in high demand. Small grains used to the greatest extent in the southern states of the western USA are wheat (*Triticum aestivum* L.) and triticale (x *Triticosecale*); however, rye (*Secale cereale* L.), barley (*Hordeum vulgare* L.), and oats (*Avena sativa* L.) are used to a lesser degree while the opposite is true for the northern region of the western states. All of these species have the potential to fill gaps

between summer crops to supply year-round, high-quality forage to meet the varying nutritional demands of all classes of livestock. Wheat and oat hays are popular options in the horse and cow hay markets. In addition, growing small grains for silage with the intent to sell to local dairies gives farmers another potentially profitable alternative. Small grains also serve as excellent cover crops that help prevent soil erosion and that take up significant amounts of soil nitrogen. Nitrogen uptake is particularly important in conjunction with the green water land application practices common with dairies.

WHEAT

Wheat is perhaps the best dual-purpose small grain crop and gives growers the greatest amount of flexibility with harvest and marketing options. Because there are established markets for wheat grain and storage facilities are readily accessible in the major wheat growing regions of the US, high market prices and good weather conditions have the potential to produce profits in any given year. On the other hand, if grain market prices are low, growers can decide whether it is more advantageous to sell their crop as hay or as silage for dairy consumption. By harvesting early for forage, disastrous weather conditions such as hail, drought, or high winds can be avoided, and double cropping becomes a possibility.

Wheat has excellent cold hardiness and can be planted during a large time window in the fall. The majority of forage production occurs in the spring (winter wheat) as the plant begins reproductive stages of growth. Although late plantings into October are possible, earlier plantings (e.g., mid-August/early September) usually result in higher yields and allow for greater productivity for fall grazing if that is part of the producer's program. Spring wheats can produce successful hay or silage crops when planted in the spring (or late winter at the southerly locations), and have been shown to yield from 3 to 6 tons/acre of dry matter. Winter wheat fails to head when planted in the spring unless it is planted early enough that temperatures are cold enough for adequate vernalization. Wheat does not tolerate poorly drained conditions; for best productivity it should be grown on well-drained, loamy soils, although it can do well on sandy and clay soils.

In general, wheat yields more dry matter than winter barley, similar amounts to oats, and slightly less than triticale and rye. In recent years, blends of wheat and triticale have performed better than wheat alone and are available at some seed dealers. Oftentimes, variation from one variety to the next is greater than that of the variation between species, and it is important to know which varieties are best adapted to a particular area. Typical yields of wheat cut for silage range from 10 to 15 tons/acre (65% moisture). Wheat harvested as hay at the boot stage of maturity generally yields on average 5 tons/acre (range: 3–6 tons/acre), but this depends greatly on inputs such as water and fertilizer.

TRITICALE

Triticale is a small grain cereal that was developed by crossing wheat and rye. Until relatively recently, triticale was not grown extensively, mostly because of its inferior grain qualities for baking compared to wheat. In the last 15-20 years, however, triticale has increased in popularity among forage growers looking for alternatives to wheat that may provide higher yields, more

winter growth for grazing, increased nitrogen uptake, and better disease and insect resistance. It is now established that triticale can produce greater amounts of digestible dry matter while maintaining a nutritive value similar to that of wheat. As such, it is often the go-to winter forage for silage operations.

Triticale has a similar growth pattern to wheat. Because it is a cross between wheat and cereal rye, there is a slight reduction of feeding value associated with triticale (rye influence). However, varietal differences may have a greater effect than species selection on forage quality, and certainly in-season management (e.g., fertility, harvest stage) affects nutritive parameters more than anything.Recent releases of triticale have exhibited yields much greater than those of wheat in certain locations of the Southern High Plains under irrigation. Irrigated triticale typically yields greater than 13 tons/acre (65% moisture), and some varieties can produce as much as 20–22 tons/acre.

Triticale has larger leaves, stems, and heads than wheat and usually grows taller. As a result, triticale may require more wilting time at harvest, and lodging can be a problem. Triticale is later-maturing and remains green longer than wheat. Like wheat, both winter and spring triticales are available; however, spring types have not been as extensively tested. Limited testing and producer observations indicate that spring triticales can also be grown successfully with high yields across the West. Likewise, both awned and awnless (or awnletted, short awns) triticales are available. Certain varieties of triticale may exhibit improved resistance to diseases over wheat, such as leaf and stripe rusts and viral diseases.

RYE

Of all the small grains, rye is the most winterhardy and gives the most uniform growth throughout fall and winter. This makes it best suited for fall, winter, and early spring grazing where consistent forage production is required. Rye matures earlier than the other small grains, and quality declines rapidly in spring; hence, rye is not recommended for hay or ensiling unless it is harvested very early. Contamination of nearby fields that will subsequently be planted to wheat (grain) is always a concern with volunteer rye (potential dockage at the elevator); however, if it is grazed out or cut prior to heading for silage, the possibility of contamination is greatly reduced. Triticale is less prone to becoming “weedy” than rye. In general, rye has higher fiber content and lower digestibility and palatability than wheat, triticale, barley, and oat hay or silage due to a higher proportion of stems.

BARLEY

Historically, winter barley has been an inferior producer (hay/silage yield) of forage when compared to wheat and triticale, although newer releases are higher-yielding than in years past. On the other hand, barley produces the most nutritious forage of all the small grain cereals. It is lower in fiber and lignin and is characterized by higher crude protein and total digestible nutrients (TDN). This is likely a result of lower yields. Feed value is 90–100% that of corn. Relative forage quality (RFQ) values of over 200 are achievable with barley when harvested at boot stage. Although it produces high-quality hay and silage, barley is often lower in TDN per acre compared to wheat and triticale due to its low tonnage. Because barley has such high

quality, harvest can be pushed later in order to increase yields while maintaining adequate nutritive value. As a result, barley is often harvested at the soft dough stage of grain fill. Barley matures earlier than wheat and triticale, but later than rye. Consequently, it provides more early growth than wheat and triticale and can be grazed sooner. Also, barley is a very salt-tolerant crop (most tolerant of all cereal crops) and is recommended in situations where soil salinity is of concern (soil ECe greater than 4 dS/m) and on marginal soils that may not be suitable for most other crops. Barley use will likely increase as more marginal land is put into production and as more alternative and potentially saline irrigation waters are used. Both winter and spring types are available. Spring types are not winterhardy, and even some winter barleys may exhibit winter injury in severely cold conditions.

OATS

While winter oats are a good option in the southern states of the US West, spring oats are a good option throughout the West for situations that require rapidly maturing forage production or when wheat productivity is low in spring. Spring oats have the potential to thicken up weak stands of wheat and will produce more forage than late-planted wheat. Quality of oats is similar to or greater than that of wheat at all growth stages. At boot stage, oat TDN can be 65% or greater. As with most forages, quality declines with maturity; however, many growers prefer to allow oats to reach the heading or grain fill stages of maturity before harvesting. While this increases yields, it dramatically reduces nutritive value, particularly crude protein and energy levels. This may be of little concern if the hay is directed toward the horse or cow hay markets. Typical yields of spring-planted oats range from 2 to 2.5 tons/ac although yields greater than 3 tons/ac are not uncommon under high-input scenarios. Forage growers should choose medium-long to very-long maturity varieties since these produce the most amount of dry matter. Oats often are one of the earliest planted crops in the late-winter or very early spring. Otherwise, late summer planted spring oats often provide greater forage yield for autumn grazing than winter cereals and some spring oat varieties will survive the winter in the Southwestern USA.

AUSTRIAN WINTER PEA

Austrian winter pea (AWP, *Pisum sativum*) is a low-growing, viny, winter annual occasionally utilized as forage. The legume tends to do best when mixed with grasses, such as wheat, triticale, or oats (silage or hay). In pure stands, AWP is not well suited for grazing because it can be damaged by hoof traffic and close grazing. Quality of winter pea is very good (high crude protein, low fiber), and it complements lower-quality grasses well. Matching maturity of the peas vs. the small grain grass will be important to meet nutritional goals of the blend. Consequently, AWP should be grown with later maturing winter cereals (wheat, triticale, or oats) because rye and barley mature too early. Peas optimize yield and nutritive value at full bloom stage. Hay of AWP grown as a monoculture can be difficult to dry properly due to its succulent nature. This is exacerbated once the peas start to set pods. Regrowth of AWP is generally considered poor. It is often a preferred species that is common in wildlife and cover crop blends, and it makes a good green manure crop. While it is relatively cold-tolerant, extreme and persistent cold without snow cover (<10-15°F), and/or large temperature swings can kill AWP. It is most commonly grown as a fall-seeded crop, but can be sown in the spring in areas with milder spring and summer temperatures. Growth is maximized with daily average temperatures between 55 and 65°F. Early

season growth after planting of AWP tends to be slow. Yields range from 1 to 3 tons/ac, but may be less in some of the drier, higher-pH soils of the western US. As a cover crop, AWP is a heavy nitrogen accumulator and can produce 50-200 lbs of nitrogen per acre. A certain percentage of the seed may be "hard seed" and germination can be delayed, presenting a problem in subsequent years.

BERSEEM CLOVER

Berseem clover (*Trifolium alexandrinum*) is a winter annual that resembles alfalfa in appearance and is similar in forage quality. Flowers resemble those of white clover. Cold tolerance is questionable with this species, and it often winterkills in other states at more northerly latitudes. Newer varieties have been bred for more cold tolerance surviving temperatures as low as 10°F (e.g., 'Frosty'). Berseem clover has an erect growth habit, making it suitable for hay production. It is very tolerant of alkalinity, salinity, and poor drainage, but it also grows in well-drained soils. Berseem clover produces high-quality forage that is non-bloating. It can be grazed when it reaches 10 inches and will continue producing new growth if a 3- to 4-inch stubble is maintained. Although berseem clover is known as a poor reseeder, newer varieties have been managed for natural reseeding by removing animals during the bud stage. Once seed is produced, grazing can resume to remove standing residue and to trample seed to obtain good seed-to-soil contact for late-summer germination. Berseem clover can be used to temporarily complement or thicken up weakening stands of alfalfa since its growth and hay management are similar (e.g., multiple cuts). Alfalfa allelopathy is not an issue with this clover. It is generally seeded in the fall and growth is then maximized the following spring; however, it can be seeded in spring for a short-season crop in the more northern reaches. Yields as high as 8 tons/ac have been achieved under optimal, high moisture conditions in regions with long growing seasons (e.g., southern CA). Biomass declines significantly with the onset of high summer temperatures.

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