



Teff Grass

Crop Overview and Forage Production Guide

Third Edition



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Crop Overview and Forage Production Guide

A guide for producers, extension, educators and seed marketers.

Cal/West Seeds supports the largest commercial forage Teff grass breeding program in the U.S. In addition to variety improvement, Cal/West and its marketing subsidiary, Producer's Choice, have championed the development and advancement of the best management practices for forage Teff at its research stations and in collaboration with public universities and extension agencies all around the U.S.

This guide, authored by Dr. Don Miller, the Producer's Choice Director of Product Development, has combined the experience and accumulated knowledge of public and private

researchers into a practical, easy-to-read, game plan for growers. Dr. Miller was one of the first private breeders to become interested in Teff and he has been working with the species since 1995. He has bred several leading varieties, authored the first Teff Management Guide, addressed hundreds of producer groups across the U.S. and Canada, and coordinates Cal/West's joint Teff projects with public universities and extension agencies.

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Dr. Don Miller
Teff Breeder/Researcher

INTRODUCTION

Teff is a self-pollinated, warm season annual grass which can be harvested multiple times during the growing season as dry hay, silage or pasture. As a fast-growing crop, Teff combines excellent forage quality with high yield during a relatively short growing season.

CROP ORIGIN

Teff's origin is thought to be Ethiopia, where it emerged as a grain crop for human consumption sometime between 4000 B.C. and 1000 B.C. Distribution of the crop around the world was initially based on its use as a food grain. Following its North American introduction, Teff production centered around its use by ethnic groups familiar with the grain and the niche market for gluten free flour. Teff grain is gluten free, and is a good flour source for segments of the population suffering from gluten intolerance or Celiac's Disease.

Following its initial introduction in the U.S., researchers began evaluating the world collection of Teff lines for their forage potential. As a result of the initial work in South Dakota and later at Oregon State, Teff's potential as forage was identified. Over the last 10 years Teff has gained momentum as a forage crop and several new, improved types have been developed and commercialized.

TAXONOMY

The word "tef" is derived from the Ethio-Semitic root "tff", which means "lost", possibly a reference to its extremely small seed size.



Teff seed heads showing the genetic diversity of the crop worldwide

Taxon:	Eragrostis tef
Family:	Graminae (Poaceae)
Sub Family:	Eragrostideae
Tribe:	Eragrosteae
Genus:	Eragrostis
Species:	Tef

Common Names: Tef, Teff, Lovegrass, Annual Bunch Grass Teff, Annual Bunch Grass (Australia), Warm Season Annual Bunch Grass, Williams Lovegrass, Abyssinian Lovegrass, Teff grass

EMERGENCE AS A FORAGE

Teff's recent popularity is based on the U.S. farmers' increasing demand for a summer forage crop that produces high yields with low inputs, without compromising quality.

Researchers have known for years of Teff's forage potential. Seyfu Ketema reports "According to Burt-Davy (1913), the chief value of Teff as a hay crop lies in its palatability, high nutritive value, narrow albumin ratio (for a grass hay), high yield, rapid growth, drought resistance and ability to smother weeds (in Seyfu Ketema Tef Eragrostis tef (Zucc.) Trotter 1997)."

As described by early researchers, the interest in Teff as a forage crop is due to:

1. **Palatability** - Teff is fine stemmed, leafy and "soft" which is very palatable to livestock. Farmers often report that their livestock prefer Teff hay over other traditional grass hays.
2. **Fast Growth** - Under optimal growing temperatures and moisture, Teff germinates quickly and is ready for early boot stage harvest 45 to 55 days after seeding.
3. **High Yield Coupled with High Quality** - Single cut yields are often in the 1 1/2 to 2 1/2 ton range with quality comparable to other high quality forages such as timothy. In multiple cut areas, summer production of 4 to 7 tons is often obtainable.
4. **Summer Production** - Teff can be planted in late spring and be cut multiple times during the hot summer months. This summer production can provide a source of stored forage for the winter months or fed to bridge the summer slump period of other cool season grass species.
5. **Drought Tolerance** - In areas without supplemental irrigation, Teff can provide forage during times of water deficit.
6. **Wide Adaptation** - Teff has the ability to thrive in moisture-stressed and waterlogged soils.
7. **Anti-quality Compounds** - Teff does not have the anti-quality compounds (nitrate toxicity and prussic acid) that sometimes occur in sorghum-related annuals (Ketema, 1997, Ketema, et al., 1993).
8. **Versatility of Harvest** - Although in most instances Teff forage is harvested as baled dry hay, it can in some operations be grazed, or ensiled.

It is estimated that in 2010 there were approximately 250,000 acres of Teff forage production in the U.S., with the largest concentration of acres being in California, the midwestern and southeastern states. Research and demonstration plots by leading institutions all across the U.S. have demonstrated Teff's high yield and high quality potential and acreage is expected to continue to expand.

Early examples of forage Teff varieties developed in the U.S. were Dessie Summer Love Grass (Carlson, Idaho), S.D. 100 (Boe et al. 1986), and Bridger (Eckhoff et al. 1997). Newer forage types such as Corvallis, CW0604 (Cal/West Seeds) and most recently Tiffany Teff Grass (PVP) (Cal/West Seeds) are gaining popularity in the marketplace.

MORPHOLOGICAL DESCRIPTION and GROWTH HABIT

Teff is a self-pollinated warm season annual grass with the advantage of a C4 photosynthetic pathway. The Teff plant is highly susceptible to frost at all growth stages, and will not survive at temperatures below freezing. Optimal yields are obtained in locations with minimum soil temperatures of 65 degrees Fahrenheit or warmer at planting, and subsequent growing temperatures above 80 degrees. Forage cultivars can be harvested multiple times in a growing season, barring frost. Teff is classified as intermediate between tropical and temperate grasses, day-length sensitive, and optimal flowering occurs at 12 hour day-length. Plant height at maturity ranges from 2 1/2 to 3 1/2 feet. It is fine stemmed and similar in appearance to bunch grasses. It has a massive, fibrous, shallow diverse root system with small-stemmed tillers originating from one crown. Stems are mostly erect with some cultivars having bending or elbowing plant types. The sheaths of Teff are smooth, glabrous, open and distinctly shorter than the internodes. Its ligule is very short and ciliated while its lamina is slender, narrow and nearly linear with elongated acute tips. It has a panicle type of inflorescence (seed head) showing different forms – from loose to compact; its spikelets have 2 to 12 florets. Each floret has a lemma, palea, three stamens, an ovary and mostly two, in exceptional cases three, feathery stigmas. Floret colors vary from white to dark brown, to red.

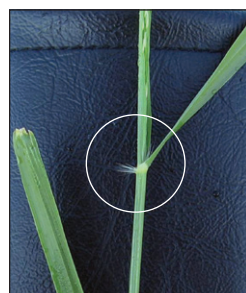
Grain maturity varies from 90 to 130 days. The seed is very small, and its color varies from white to dark brown. Number of seeds per pound is approximately 1.3 million.



Fine stems



Dense fibrous roots



Teff grass stem showing species identifying ligule in the circle



Teff grass panicles

GEOGRAPHIC ADAPTATION

Teff is adapted to environments ranging from drought stress to water logged soil conditions and diverse soil types. Teff production has been reported at altitudes from sea level up to 9,186 feet above sea level. Teff is classified as a C4 plant which is genetically adapted for growth in hot dry climates. Teff and other C4 species such as maize, sorghum and millet, have an evolutionary advantage of a photosynthetic pathway over C3 species such as wheat and cool season grasses. This C4 pathway results in efficient water use and allows plants to photosynthesize faster under high heat and light conditions than C3 species. Following its introduction into North America, Teff has been evaluated in public and private trials in the following states and provinces: Arizona, California, Georgia, Idaho, Indiana, Iowa, Kentucky, Kansas, Michigan, Mississippi, Montana, Nevada, New Mexico, New York, Nebraska, North Carolina, Ohio, Oregon, Pennsylvania, Texas, Utah, Virginia, Washington, Wisconsin and Ontario, Canada. Teff's performance in these trials indicates a wide range of adaptation.

CROP UTILIZATION

EMERGENCY FORAGE

Teff is an excellent choice as an emergency crop when weather delays the timely planting of grain crops or as a rescue crop, when perennials have failed. It can also be used in years when extreme winterkill has occurred on existing perennial forage crops such as alfalfa or when irrigation water supplies are limited. Under optimal summer growing conditions, Teff can produce 1-1/2 to 2-1/2 tons of forage material 45 to 55 days after planting.

"SUMMER SLUMP" PRODUCTION

The majority of grass hay production in the U.S. and Canada is from cool season perennial grasses such as bluegrass, timothy, orchardgrass and to some extent fescues. These grasses provide the majority of their production during cooler weather of spring or fall but perform poorly during the hot summer months. This summer slump may require the live-stock producer to use his hay reserves during these periods or rely on supplemental forage production. In the past, crop choices for those low production months have been mainly limited to high yielding but low quality crop alternatives. Teff can provide both high forage yield and quality during this traditional "summer slump" period.

DOUBLE CROPPING

Because Teff can be planted from late spring to mid-summer, it is a good double cropping option following cereal grain crops such as wheat. When double cropping Teff after wheat on the Central and Southern Plains, growers should avoid no-tilling into overly tall stubble or over-working dry soils. Teff must be planted no deeper than 1/4 inch and can not be "planted to moisture". Grower reports indicate poor stand establishment when Teff follows triticale due to a possible allelopathic interaction. Teff hay has a higher profit potential than many alternatives due to its high yield and high quality.



Teff seedlings in wheat stubble

ROTATION CROP

Teff is an excellent rotation break crop when renovating a perennial grass pasture or older alfalfa stand. Alfalfa growers must rotate out of alfalfa for one year (due to autotoxicity) before replanting alfalfa. Historically rotation choices have been hybrid sorghum x sudangrass or grain species that were cut early for hay such as wheat or oats, all of which produced high yields, but the hay or silage was not very marketable due to low quality.

SPECIAL USES

Unfortunately each planting season usually has an area in the U.S. where rain delays the planting of row crops past a critical date. Teff with its quick germination, fast growth and low seeding rates can be aerial applied to potentially produce a forage crop, cover for habitat and meet crop insurance/soil conservation requirements. Teff's fast growth and high tonnage make it a good choice as a green manure crop. It is not uncommon for Teff fields to produce 1 1/2 to 2 1/2 tons of forage in 45 to 55 days, facilitating its use as a green manure crop.

Due to its fast germination (3 to 5 days) and fibrous root system, Teff is an excellent choice for erosion control.

Farmers in irrigated areas using center pivots have been successful in utilizing Teff to obtain some production in the dryland corners. These plantings can be successful if there is adequate soil moisture at planting time for germination and establishment. Once established, Teff's low water requirement and subsequent drought tolerance has the potential of providing growers with additional hay production for on farm use or hay sales.



Windrows of Teff in corners of irrigated field

The best use of Teff in a forage system appears to be as an annual forage grass in monoculture. It is generally not recommended to use Teff as a companion crop or in a forage mix in new plantings. However it can be used to extend the forage production life of older alfalfa stands for a single season. Teff has been successfully interseeded in thin older stands of alfalfa to extend the life of the stand and increase forage production for a single season. Best results have been seen when the grower delays interseeding into the thin alfalfa stand until after the first spring cut. This will allow the interseeding to occur at a more optimal time, when the soil temps are warmer. Work is currently being done by researchers at Virginia Tech to explore the possibility of interseeding of Teff into tall fescue pastures to enhance summer production. Preliminary data looks promising.

CROP MANAGEMENT

TEMPERATURE REQUIREMENTS

Teff doesn't establish well in soil temperatures below 65 degrees Fahrenheit. Early season planting in cool soils reduces Teff's competitiveness and may result in weed problems on the first cut. Teff is a warm season annual and should be planted under similar conditions required for other warm season crops such as hybrid sorghum x sudangrass.

Teff is day length sensitive and forage growth will slow as days become shorter in the fall. Teff doesn't tolerate frost, and temperatures below freezing may damage or kill it. Some researchers have observed some Teff fields surviving 28 degrees but none have survived at lower temperatures. Despite its sensitivity to frost, it must be noted that Teff has had no reports of prussic acid accumulation.

SEED BED PREPARATION

Proper seed bed preparation can't be stressed enough when it comes to planting Teff.

Dr. Bruce Anderson (University of Nebraska) illustrates this point to his Teff growers by saying that the seed bed must be firm enough to bounce a basketball on it. Other researchers compare the proper seedbed to that needed to plant alfalfa. Another method of gauging the correct firmness is if you can walk across the field without sinking below the soles of your shoes. Seed bed firmness is especially important if grain drills are used to plant the Teff. Brillion planters are useful in conditioning the fields and are the preferred planter for Teff.

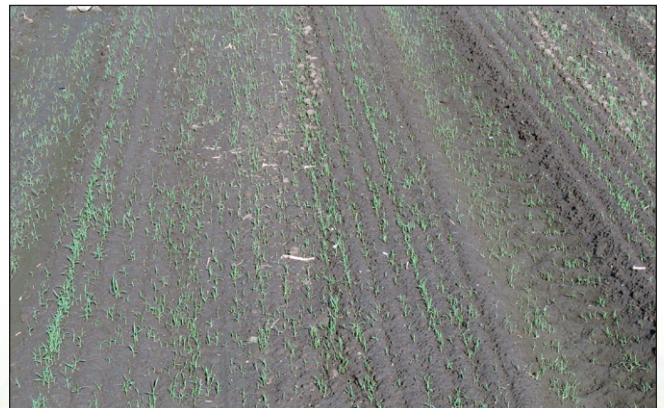


Proper seed bed preparation



Improper seed bed preparation

Planting Teff in a firm seed bed helps in proper seed placement and reduces the chance of burying the seed too deeply with loose soil. It also provides good seed to soil contact allowing for better soil moisture movement to the seed. Teff plantings in loose seed beds can often be identified by quicker seedling emergence in the wheel tracks of the planter, than in the rest of the field.



Uneven emergence due to a loose seed bed at planting

FERTILITY REQUIREMENTS

Teff is considered a low input crop, requiring minimal fertilization. Plantings following alfalfa, legumes, or sod may not need any additional nitrogen fertilization on the first cutting. The total seasonal nitrogen needs of Teff are relatively low, generally in the range of 50 to 90 pounds of available nitrogen. Excessive single applications of nitrogen above 100 pounds per acre may result in lodging. In multiple cut regions, split applications of nitrogen (30 to 50 pounds) following each cut throughout the growing season will enhance forage production. Nitrate toxicity problems associated with other warm season grasses have not been reported in Teff. Moderate amounts of phosphorous and in some cases sulfur may be required. Teff can be a good fit as a forage crop for dairy operations trying to utilize their manure. Mike Hunter, Cornell University Extension Dairy Specialist says, "It looks like it will be a great crop to grow in complement with manure. That's one of the reasons we think it could be a good fit as an emergency forage crop for dairy farmers in this area. It's also one of the only annual forage crops that is suitable for making dry bales from rather than having to ensile it."

SEED SELECTION

If the crop use goal is forage production, be sure the variety selected was bred for forage production and not grain. Grain types tend to reach maturity early and as a result often yield less and the forage quality is less than optimal.

Teff is a very small seeded annual grass with an average of 1.3 million seeds per raw pound. For this reason coated seed is usually preferred by growers so most planting equipment can handle Teff seed. Some seed coatings are now colored, which aids growers to visually check for coverage and depth of planting.



Raw Teff seed on the left at 1.3 million seeds per pound and alfalfa seed on the right with 220,000 seeds per pound.

PLANTERS AND PLANTING RATES

The recommended seeding rate is usually 5 to 7 pounds per acre for raw seed, and 8 to 10 pounds per acre for coated seed. Broadcast planting using a Brillion grass seeder and cultipacker combination, or a spinner type grass seeder is often used. Brillion planters are considered the optimal planter for Teff. However a conventional or no-till grain drill equipped with a small seed box attachment, can be used. Broadcast seeders have also been used as well as aerial plantings. When aerial seeding, coated seed should be used and the seeding rate increased to 10-14 pounds per acre. Sprinkler irrigation has been beneficial in broadcast plantings to aid emergence in the West, if the seed is not rolled or packed after planting.

Teff is a relatively new crop, and many planter manufacturers haven't published planter settings for Teff. The Brillion seed planter settings (raw and coated) can be found for most models on the web site (<http://www.teffgrass.com>).

If row planters are used, row-spacing should be very narrow (< 6 inches) to minimize weed establishment. Planting in two directions can be used if row spacing adjustments are not possible.

SEEDING DEPTH

Seeding depth is critical; plant 1/8 to 1/4 inch deep into a very firm seed bed. Good seed to soil contact is required. Planting deeper than 1/2 inch is likely to result in a complete stand failure. If planted at the right depth, and at optimal temperatures, Teff usually emerges in 4 to 5 days.

SEEDING DATE

Teff is a warm season annual grass that requires a frost free growing season. Seed must be planted in the spring after the risk of frost has passed. Soil temperatures at planting should be at least 65° F and warming.

WEED CONTROL

Teff germinates fast under warm conditions; however most of the plant growth during the first two weeks is devoted to establishing its root system and not top growth. Therefore some precautions should be taken to prevent weed competition during that 2 week period until Teff starts to produce top-growth that will compete with germinating weeds. Early season planting in cool temperatures may result in weed problems on the first cut. Later planting dates are recommended to reduce weed pressure.



Seeding with no herbicide applied

If weed control is needed during stand establishment, several management practices can be useful. A pre-plant cultivation can be effective, especially if Teff is planted immediately after cultivation.

A second weed control method is to minimize open ground for weed establishment. Planting in narrow row spacings is recommended, or using higher seeding rates to provide more plant density and competition.

Herbicide options are limited but herbicides are being evaluated by researchers and chemical companies are currently registering products for broadleaf and grass weed control for Teff forage production. Growers should check with their local suppliers for approved herbicides and follow all label instructions. Generally, if a broadleaf herbicide is applied, it should not be applied to teff until the plant has at least 5 to 7 leaves.

Following the initial root growth period, Teff is very aggressive in its growth, and can out-compete many weeds. In its native country Ethiopia, Teff's competitive nature is often used to reduce weed pressure for successive crops.

WATER REQUIREMENTS

Due to its small seed size, Teff cannot be planted deep into moisture as some crops. Therefore like most grasses, keeping Teff seed exposed to adequate moisture during the germination period can often be challenging. Good seed to soil contact, with proper placement (seed depth <1/4 inch), in a very firm seedbed can't be over emphasized.

Water requirements vary depending on the climate and length of growing season (number of cuts). In its native country, it has been reported that Teff needs at least 17 inches of rainfall for grain production. However Teff appears to be most productive in regions having at least 24 inches of rainfall, or supplemental irrigation. In Ethiopia its native country, it is said that a farmer can typically expect to get one to two tons per acre per cutting if they get three inches of rain per month. Preliminary reports from U.S. researchers indicate

that Teff requires less irrigation water than alfalfa for comparable forage yields, however conclusive numbers are not available at this time. Jay Davison, Alternative Crops and Forage Specialist for the University of Nevada Reno Cooperative Extension, has researched Teff for over seven years. Jay estimates that Teff "requires approximately 50 to 70% as much water as alfalfa to produce an economic crop."



Teff under irrigation

Numerous reports indicate that Teff is relatively drought tolerant once established, and will remain green when other summer crops have turned brown. Larry Zibilske, Integrated Farming and Natural Resources Research Soil Scientist with the USDA Agricultural Research Service in Weslaco, Texas, reports that during 75 continuous days of 100+ degree temperatures and no rain, Teff stayed green and grew to about 3 feet tall with just two waterings (a total of about 4.5"). During the same period, ARS plowed under the sorghum at the Weslaco farm as yields were projected to be too low to be worthwhile.

Teff is reported to grow in a wide range of environments ranging from dry to waterlogged conditions. It is also reported to be relatively salt tolerant with a tolerance level similar to or greater than alfalfa, and significantly better than sudangrass. Teff is known to grow well in a wide range of soil types with pHs ranging from acid to alkaline; however tolerance levels in extreme acid or alkaline environments are still being determined.

DISEASE AND INSECTS

Forage and seed production of *Eragrostis tef* in the United States has been relatively free of serious disease and insect problems since its introduction in the 1970-1980's. Insect infestations by the larvae of a stem-boring wasp, *Eurytomocharis eragrostidis* was reported in the 1970's by South Dakota State University in the northwestern U.S. This occurred only one time in the five years of testing. (Boe, A.J. 1986) This wasp has also been reported in parts of Arizona in research plots. A sporadic report of rust was also reported in the central U.S. in 2007.

HARVEST OPTIONS

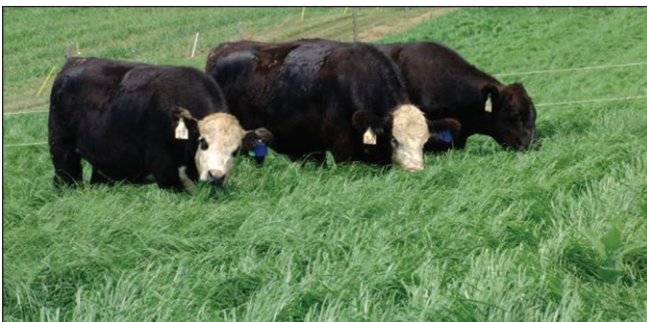
Harvest as dry hay will maximize forage production and return per acre. Hay making can be accomplished using normal harvest equipment for grass hay, however rotary mowers are preferred. Due to the fineness of its stems, Teff is one of the few annual forage crops that is suitable for making dry bales rather than having to ensile it. Windrows should not be left in the field for extended times since plants under the windrow may be damaged by delayed harvest.



Windrows of Teff and note fast recovery after cutting

Although best suited for haying operations, Teff can be grazed by cattle, horses and sheep. Avoid pasturing until the root system has developed, excess stocking rates and over-grazing. As with hay harvest, a 4-inch stubble is a must for quick regrowth.

Grazing Teff planted in sandy soils may be more difficult than in heavier soils since plants are easier to pull out of sandy ground. In those cases, harvesting for hay might be advised in the early season and grazing after the last cutting. Prussic acid or nitrate toxicity in Teff forage has not been observed on late season grazing or after a frost.



Cattle grazing in Teff

HARVEST TIMING AND CUTTING MANAGEMENT

For optimum forage quality, Teff should be harvested prior to seed head appearance in the late vegetative stages (pre-boot to early-boot stage). Don't be fooled by Teff's 2 1/2 to 3 foot height at the sight of first heads and delay harvest. The canopy is thick, dense, and carries a deceptive

yield. Delaying harvest only hurts quality, harvest recovery, and total seasonal yield.

Cutting at the proper time (prior to seed head appearance) ensures adequate plant reserves for regrowth in subsequent cuts. Harvesting after Teff has headed out will cause delays in regrowth and may severely reduce subsequent forage production. Cutting interval is generally 45 to 50 days for first cut and approximately 30 days for subsequent cuts; however this may vary by location. In the event of lodging due to weather, harvest immediately to prevent potential stand loss from plant smothering. A stubble cutting height of no less than 4 inches is recommended to promote vigorous regrowth. Plant food reserves that fuel regrowth are stored in the bottom 4 inches of the plant stem. Therefore cutting heights lower than 4 inches will severely reduce subsequent forage production. Windrows should not be left in field for extended times, or stand loss will occur under the windrows.



Proper cutting height

MANAGEMENT CHECKLIST

- Firm seed bed at planting is absolutely critical.
- Seeding depth should not exceed 1/4 inch.
- Soil temperatures at planting should be at least 65° F and warming.
- Teff will not tolerate a frost. Planting dates should be well beyond historic first spring frost date.
- Select a forage seed variety with seed coating.
- Teff grows best when air and soil temperature are warm. Early spring plantings during cool periods may result in slow growth and crop stunting.
- Optimal cutting stubble height is 4 inches.
- Harvest should occur in early boot stage for optimal forage quality.
- Multiple cut systems may require split applications of nitrogen (30 to 40 units per cut) for maximum production.
- Delaying harvest until heading may adversely affect the production of subsequent cuts and total seasonal yield.

YIELD

Depending on the length of the growing season Teff's dry matter yields can range from 4 to 7 tons for the season. Teff yields across the country usually average 1 1/2 to 2 tons per acre per cut. Yields may vary by location; however one researcher out of New York reported "High-quality Teff forage can be grown in New York in 2- or 3-cut systems with dry matter yields ranging from 3.3 to 4.9 ton per acre, depending mostly on rainfall late summer."

TABLE 1:
TEFF YIELD PERFORMANCE

	Number of Cuts	Number of Entries	Average Yield (tons/acre)
2007 Crop Year			
Wisconsin	3	8	6.61
California	4	9	6.38
2008 Crop Year			
Wisconsin	3	8	5.87
California	4	9	5.34
2009 Crop Year			
Wisconsin	4	24	7.17
California	4	24	8.94
2010 Crop Year			
Wisconsin	3	24	4.29
California	4	24	8.88
4 Year Average			
Wisconsin			5.99
California			7.39

Cal/West Seeds @ West Salem, WI and Woodland, CA

LIVESTOCK USES AND NUTRITIONAL VALUE

Teff is a premium hay alternative for a wide range of livestock including dairy, beef, sheep, and horses. Its quality comparison to timothy hay has made it a popular choice for horse owners. Recent horse feeding studies conducted by Pennsylvania State has demonstrated that Tiffany Teff would be a good choice for horse owners looking for relatively low non-structural carbohydrate hay. Staniar et al stated that under their testing conditions the following was found "The intake and nutrient composition of the boot and early -heading maturities (of teff) was sufficient to meet 90 to 97% of the average DE of the horses and most other nutrient requirements." "For all maturities of teff hay, the NSC intake was below 10% of the total intake. In conclusion, the low NSC and DE of teff hay grown in central Pennsylvania under the conditions in this study make it an appropriate forage source for obese horses and those at risk for laminitis or other metabolic disorders." (W.B. Staniar et al., Penn State Univ.)



Nutritive value of Teff is comparable to timothy, making it excellent forage for horses and other livestock.

TABLE 2:
FORAGE QUALITY ANALYSIS, TEFF VS TIMOTHY

Quality Analysis	Average Timothy Hay	Teff Hay
% Crude Protein	8 – 14	9-14
Acid Detergent Fiber (ADF)	32 – 36	32 – 38
Neutral Detergent Fiber (NDF)	53 – 59	53 – 65
Total Digestible Nutrients (TDN)	57 – 65	55 - 64

"Teff's crude protein content appears to be heavily influenced by nitrogen," observes Mike Hunter, Cornell University Extension Dairy Specialist. Protein content of Teff hay ranges from 12 to 17% depending on the growth stage or maturity. RFV values have been reported in the range of 80 to 120. Oregon State University trials reported ADF and NDF values at 3 locations ranging from 32 to 40 and 53 to 70 respectively. Teff hay is high in calcium as well as phosphorus, iron, copper, aluminum, barium, and thiamine. Potassium levels have been reported in some hays in the 2.5 to 3.0% range. Nitrate and nitrite content is low under normal fertility conditions. As with most forage crops, quality and digestibility decreases with maturity and fiber content increases. For optimal nutritional value, a crop cutting interval avoiding seed head formation is recommended. Teff also has higher ratings in several key forage quality factors when compared to other summer annual forage alternatives. If harvested at optimal maturity, Teff's Relative Feed Value (RFV, a measure of the forage's intake and energy value) has been reported to be as much as 15 percent greater; pounds of milk produced per acre, 8 percent greater; pounds of milk produced per ton of hay feed, 7 percent greater; and crude protein, 9 percent greater.

Preliminary testing has indicated that Teff may also be an excellent choice for dairy and/or beef producers. One dairy producer in Idaho, Harmon Tobler, commented that he was very surprised by the apparent high palatability of Teff. The preference of his animals for Teff over other high quality hays including alfalfa was often dramatic. They will eat Teff whenever you put it in front of them even if they are full from their normal feed ration. He commented that dairymen are missing the boat if they don't try and utilize Teff in their feed ration. During the crop year of 2010, several Teff forage production and feeding studies on dairy farms are planned across the U.S. to substantiate these positive claims.



Forage quality analysis has shown that under normal growing conditions, Teff forage can be produced with a relatively low copper content, making it a viable option for sheep operations.

THE FUTURE

Teff is a relatively new crop for farmers in the U.S. and its popularity is growing. Continued public and private research will lead to further genetic improvements in forage yield and quality. Research programs are further examining the USDA world collection of Teff in an attempt to identify new beneficial agronomic traits to expand its range of use and enhance crop performance in diverse environments.

Teff was originally marketed as premium hay for horse owners; mainly because its hay quality was comparable to timothy. In the future, Teff forage use will undoubtedly continue to expand to include the dairy, beef, and sheep industries.

REFERENCES

- ANON. 1887. I. Teff (*Eragrostis*, Abyssinia), "Royal Gardens", Kew *Bul. of Miscellaneous Information* 1:2-6.
- Boe, A., J. Sommerfeldt, R. Wynia, and N. Thiex. 1986. A Preliminary Evaluation of the Forage Potential of Teff. *Proc. South Dakota Acad. Sci.* 65:75-82.
- Curtis, K. R., C. Bishop, and J. Davison 2008. Northwestern Nevada Teff Production Costs and Returns, 2008. Univ of Nevada Cooperative Extension. Special Publication-08-13.
- Ebba, T. 1969. *Tief (Eragrostis tef) the Cultivation, Usage, and Some of the Known Diseases and Insect Pests*. Haile Selassie Univ. College Agr., Dire Dawa Ethiopia Exp. Sta. Bul. 60. Part I.
- Ebba, T. 1975. *Tief (Eragrostis tef) Cultivars: Morphology and Classification*. Addis Ababa Univ. College Agr., Dire Dawa, Ethiopia, Expt. Sta. Bul. 69. Part II.
- Eckhoff, J. L. A., D. M. Wichman, J. Scheetz, M. Majerus, L.E. Welty, G.F. Stallknecht, R.L. Ditterline, R.L. Dunn, and D.C. Sands. *Registration of Bridger Teff*. Accepted Crop Sci.
- Eckhoff, J.L.A., D.M. Wichman, J. Scheetz, M. Majerus, L.E. Welty, G.F. Stallknecht, R.L. Ditterline, R.L. Dunn, and D.C. Sands, 1993. *Teff: a potential forage and grain crop for Montana*. *Montana AgResearch* 10:38-41.
- Ketema, S. 1997. Tef. *Eragrostis tef* (Zucc.) Trotter. *Promoting the Conservation and Use of Underutilized and Neglected Crops*. 12. Institute of plant genetics and crop plant research, Gatersleben/Int. plant genetic resources institute, (IPGRI) Rome Italy.
- Miller, D.R. 2007. *Management Guide for Tiffany Teff Forage Grass*. <http://www.targetseed.com>
- In: *Proceedings, 2009 California Alfalfa & Forage Symposium and Western Seed Conference*, Reno, NV, 2-4 December, 2009. UC Cooperative Extension, Plant Sciences Department, University of California, Davis, CA 95616.
- W.B. Staniar, M.H. Hall, and A. L. Burk. 2010 *Voluntary Intake and Digestibility of Three Cuttings of Teff Hay Fed to Horses*. Penn State University. *J. Animal Sci.* 2010. 88:3296-3303.



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