Plant & Soil Sciences Extension Newsletter

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White teff crop. (courtesy of EIAR and Mercur)

TEFF: A Potential Alternative Crop for Oklahoma

Today's agricultural enterprise selection is derived by several factors including the conventional demand-supply dogma plus cultural and social forces. Unique to the US is immigrant population from different corners of the globe. With the immigrants came their favorite crops for food, herbal medicine and other purposes. Some of these crops and herbs are also well accepted by local population for alternative uses creating a common interest and demand. One of such crop is teff [*Eragrostis tef* (Zucc.) Trotter]. Teff is an annual grass indigenous to Ethiopia.

The crop has small grains that can be used for human consumption in many forms. Teff seed contains 11% protein, 80% complex carbohydrate and 3% fat. As food for human consumption, teff has unique qualities in that it contains high level of several minerals such as iron, magnesium, calcium, phosphorus, and thiamine. It is an excellent source of essential amino acids, especially lysine, the amino acid that is most often deficient in common grain foods including wheat and millet.

The grain of teff can be mixed with baking supplies or substituted for part of seeds or nuts. It can be consumed by non-Ethiopians in a variety of forms and there are ranges of recipes available for Pancakes, Teff-Carob Cookies, Teff-Peanut Butter Muffins, Pudding, Teff Burger, and bran Muffins. There is growing interest in teff within the health food sector because the grain is gluten-free, making it an alternative to wheat, rye and barley for persons with gluten intolerance. In the baby food industry teff is used in mixtures with soybean, chickpea and other grains mainly due to its high mineral content.

The crop is also excellent quality hay comparable to timothy and better than other grasses. Researchers from Montana, South Dakota and New York found that the protein content of teff forage ranged from about 9% when the plant is at maturity to 20% when the plant is young. Forage yields of teff ranges from 2 to 6 t/ac. The performance of the crop improves as growing conditions and inputs are optimized.

Teff grain is sold on the market at $3.2-4.0/lb. Flour generally fetches more dollars than other cereals such as rice due to its quality. Price of teff flour is about $4.00 -6.00 on the market. Given the low input costs per acre, teff could be a very competitive alternative crop in Oklahoma. At least one farm in Oklahoma is reported to produce teff. The following table shows a rough net return determined by inputting variable costs considering the current worst case scenario (input purchase at high price and output sale at low price).

Input	$/ac
Fertilizer: 50 lbs/ac urea + 100 lbs/ac DAP†	110.00
Fuel: land preparation, planting, & harvesting	200.00
Cropland rental rate $50.00/ac	50.00
Weed control: herbicide and applicator‡	65.00
Machinery rental€	150.00
Seed, $3/lb, 7 lbs/ac	21.00
Labor for different activities, 30 hrs, $20.00/hr	600.00
Grain price 2.2/lb, yield of teff 1091 lbs/ac	2400.00
Net benefit	**1204.00**

† Urea at $900.00/ton; DAP at $1200.00/ton

‡ Includes dicamba at 1.5 qrt/ac, and sprayer rental from Coop at $6.00/ac

€ Includes tractor and combine rental at $45.00/hr

"There is growing interest in teff within the health food sector because the grain is gluten-free, making it an alternative to wheat, rye and barley for persons with gluten intolerance."

Seven Reasons for Growing Teff in Oklahoma as an Alternative Crop

1. **Fast growth:** Teff grows and completes its life cycle very fast. As tropical crop, the long photoperiod of the summer months facilitate its fast growth. It takes teff about 90 to 100 days from emergence to maturity in normal years. Like many crops it hastens its growth and development if growing conditions are suboptimal, especially if moisture is deficient.
2. **Seasonal water logging tolerance:** Teff unlike common cereals grown in Oklahoma have the ability to tolerate seasonal water logging conditions. The crop grows well in Veritsols such as Osage clays that have a water logging condition when precipitation is high.
3. **Produce grain on residual moisture:** Attributed to its fast growth and hastened physiological maturity plus effective use of residual moisture, teff gives reasonable yield when other cereals yield is depressed significantly in low moisture conditions. If not for grain it can be grazed to cattle or horses; harvested for hay any time. It is a reliable and low-risk crop as it can be planted as rescue or catch crop in moisture-stress areas.
4. **Low input crop:** Teff is generally low input crop. It requires modest amount of fertilizer. Not many insect and disease problems on this crop even in its native land, Ethiopia thus no cost associated with pesticides.
5. **Suitable for double and relay cropping**: Oklahoma, specially central and south western parts are constrained by lack of relay or double crops especially when the months of July and August are dry.
6. **High price for grain encourage small farmers:** Teff's high grain price and niche market encourages small farmers to include it in their overall farming strategy. In a way, it adds to their crop diversification scheme.
7. **Extended storage:** Teff grain is free of bugs due to its tiny seeds and reduced movement within the stored grain. No post-harvest or storage pests are reported on teff. This allows producers to keep the crop until that time price is high. For food it can be stored for five or more years. The extended storage is also applicable to seed supply. Teff seed is viable after three years in storage

Some Issues

While teff has several advantages as an alternative crop, there are apparent Issues that need to be addressed.

1. Extended daylight length of the summer months has some impact on flowering. In Michigan and Idaho researchers are working to address this problem. With more research this problem can go away.
2. Lodging in fertile or over fertilized soils and heavy wind conditions that occurs in Oklahoma can pose a problem to successful and sustainable teff production in the state. Selection for traits resistance to lodging through different crop improvement methods is necessary.
3. Yield of teff in the US and in its native country Ethiopia is generally low despite the high grain or flour price. Given the demand for this crop for consumption by immigrant population and competing market for health food, the yield potential of the crop need to be improved through breeding and molecular level manipulation. Along this, it is important to optimize management practices to exploit the full potential of the crop.
4. Teff in the US is on the hands of private entrepreneurs. While this is absolutely acceptable and should be encouraged, as an alternative crop it needs to be introduced to different segments of farming including small farmers for both its economic and environmental contribution for sustainability.

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Red teff seeds.
(courtesy of EIAR and
Mercur)

Things to Remember about pH in No-till Soils

Soil pH is influenced by both environmental and production factors. High rainfall and subsequent leaching of basic cationic nutrients such as Ca, Mg, Na and K is a natural, relatively slow cause of soil acidity. This is why there are more acidic soils naturally in Eastern Oklahoma compared to those found in central and western Oklahoma. Formation of soils from acidic parent materials also results in naturally acidic soils. Decomposition of organic matter in soils produces organic acids that can slowly acidify soils. Lastly, production and removal of high yielding crops contribute to the acidification of soils. This acidification results from the removal of basic cations in the harvested crop biomass and from the addition of N containing fertilizers. All of these processes mentioned previosuly are minor compared to addition of nitrogen fertilizers.

"...it is important to monitor the pH of no-till soils with soil samples every 2-4 years to prevent the acidification of the lower rooting zone."

These processes of soil acidification occur in both conventionally tilled and no-till soils. In fact, when the whole soil is considered, the accumulation of acidity (a lowering of pH) will occur at the same rate in both production systems. However, in no-till production, because the soil surface is not mixed, soil pH can become stratified. These stratified soils can have determinately low pH near the surface (0-2 inches) and the rooting layer (2-6 inches) is less acidified. Soil pH stratification will occur most readily when N fertilizers are surface applied. Therefore, when N fertilizers are continuously applied to the soil surface, it is advantageous to collect samples from the 0-2 inch depth to assess soil pH in addition to the 0-6 inch sample for routine analysis. When soil pH at 0-2 inches is below optimum, lime should be applied even if the pH of the 6 inch sample is sufficient. In this case, a lesser amount of lime, such as 0.5 tons of ECCE per acre, can be applied. If the pH of the 6 inch sample is below optimum, the standard liming recommendations from your soil test report.

Another thing to remember is that lime is exceptionally immobile in soil. The neutralization of soil acidity shortly after lime application will be limited to near the soil surface in a no-till system. In Eastern Oklahoma where rainfall totals are higher, this effect will be less dramatic compared to Western Oklahoma. However, even in the east, neutralization of soil acidity to 6 inches below the surface by lime will take a long time. Therefore, it is important to monitor the pH of no-till soils with soil samples every 2-4 years to prevent the acidification of the lower rooting zone. Also, because of this immobility, it is very important to correct soil pH problems prior to adoption of no-till. Application and incorporation of lime into the plow layer of acidic soils prior to adoption of no-till is an important step toward successful transition to no-till production.

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Hailin Zhang, Brian Arnall, and Chad Godsey also contributed to this article.

Know when to dig!

The early signs of fall have begun producers thinking of digging this year's peanut crop. From looking at several fields, it appears that this years crop had an excellent early set and a good early August set. The early set appears to be a little larger than the last couple of years. Even with a large early set delaying digging can result in increased yield and grade. Often peanuts are dug to early which reduces yield and grade. Information from harvest management tests has shown the importance of allowing the peanut crop to reach optimum maturity (Table 1). Peanut yields can be increased by several hundred pounds per acre and grades by several percentage points during the last weeks of the growing season. This is shown in Table 1 were yields and grades increase later in the season regardless of market type.

"To determine optimum digging time the "Hull Scrape Method" is the simplest and most accurate."

Table 1. Effect of digging date on peanut yield and grade at Fort Cobb, OK. Spanco and Okrun data is an average from 3 years and Tamrun OL02 data is from 2008.

	Spanco		Okrun		Tamrun OL02	
Days after Planting	Yield (lb/ac)	TSMK (%)	Yield (lb/ac)	TSMK (%)	Yield (lb/ac)	TSMK (%)
115	2200	60	na	na	na	na
125	2750	61	na	na	na	na
135	3000	64	2782	63	3369	62
145	3055	65	3232	65	3173	61
155	3384	67	3322	68	na	na
165	na	na	3441	71	4298	70
175	na	na	3192	73	3282	65

To determine optimum digging time the "Hull Scrape Method" is the simplest and most accurate. Follow these steps:

Hull Scrape Maturity Testing Method:

1. Approximately 110 days after planting, collect three to five adjacent plants from three locations in the field or area of a field that can be dug in one day. For early maturing varieties, pull a sample at 95 days after planting.
2. Remove all pods from the plants from each area to obtain 180 to 220 pods. Complete picking of one plant once started. Repeat for each sample.
3. Determine the color of the middle hull by scraping or sandblasting away the outer hull.
4. Examine the middle hull color at the attachment point of the basal seed, the indented or saddle area of the pod when the beak is turned downward.
5. Place pods on the peanut profile board (if available), which is based on middle hull color. Keep pods wet. If a profile board is not available start digging when 65 to 70 percent of the peanuts are mature.

6. Determine when to dig on the basis of slope line and harvest projection line. Find the point at which the leading edge (slope) of the sample profile crosses the projection line. Read the days until digging directly below the first column from the right that contains three pods.
7. A second sample should be taken about 10 days before the predicted date to verify maturity progression.

Over-anxiousness to get the crop harvested can result in severe economic loss. Of course, other factors need to be considered such as vine health and weather outlook. If you have lost a significant amount (>50%) of leaves from foliar disease it would be a good idea to dig ASAP because plant health is poor and yields will start to decrease from pod loss. Table 2 indicates the various pod colors and the days between the major color changes.


Peanut crop just after digging.

Table 2. Color of peanut pods and days to move to the next color.

Major color	Characteristics	Development period (days)
white	soft, watery, poorly defined kernel, between the size of a match head and a full size pod	14-16
yellow	spongy texture, pod is full size, kernel is somewhat defined	10-14
dark yellow	coarser pod texture then yellow, well-defined kernel	10-14
orange	pink seed coat developing	12-14
brown	rough pod texture, dark pink seed coat	10-12
black	completely developed kernel, extremely rough pod texture	19-21

We will be offering hull blasting at the two fall field days so bring samples from each of your fields (see Up-coming events for more information).

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Upcoming Events

- Fall Peanut Field Tours
  - September 23—Erick, OK
    Will meet at 5:00pm at the plots northeast of Erick. Call County Office for more information.
  - September 30—Ft. Cobb, OK
    The tour will start at the Caddo County Research Station at 5:00pm.

- Fuel From the Field—Oklahoma Grown Biofuels Field Day
  - South Central Research Station Chickasha, OK
    1105 E. Iowa, ½ mi. South of Hwy 62, East Edge of City

- Enhancing the Adoption of Organic Production Workshop
  - Tuesday and Wednesday, October 14th and 15th, 2008
  - OSU/OKC Agriculture Technology Center
  - Please contact Ag Conferencing or janelle.malone@okstate.edu for registration information
  - Registration is $35.00 before September 15, 2008

- • Sensors for crop management / OSU winter crop school
  - December 16 & 17
  - Wes Watkins Center—OSU Stillwater
  - More details to come

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Subscription information

The Plant and Soil Sciences Extension Newsletter is published in electronic format on an as needed basis throughout the year.
To receive an electronic copy in pdf format, email Janelle Malone at Janelle.malone@okstate.edu. Be sure to include the word Subscribe in the message title and include your name and where you are from.

FUEL FROM THE FIELD – OKLAHOMA GROWN

Biofuels Field Day

South Central Research Station
Chickasha, OK

1105 E. Iowa, ½ mi. South of Hwy 62, East Edge of City

OCTOBER 13, 2008

8:30 – 9:00 am	***Sign-in with coffee & donuts***
9:00 – 9:15 am	***Welcome from Dr. Whitson & Secretary of Energy Fleischaker and Others***
9:15 – 9:30 am	***Load trailers and travel to Tour Stops***
12:15 pm	***Lunch***

TOUR STOPS

Storage Techniques for Forage Crops and Lignocellulosic Biofeedstock
Carol Jones, PhD.
Biosystems and Agricultural Engineering

In-field Production for Ethanol from Sweet Sorghum
Dani Bellmer, PhD.
Food and Agricultural Products Center/Biosystems & Ag Engineering

Converting Biomass to Ethanol – Bales to Barrels
Ray Huhnke, PhD.
Biobased Products and Energy Center/Biosystems & Ag Engineering

Agronomic Considerations for Sorghum Production
Chad, Godsey, PhD.
Plant and Soil Sciences

Equipment Needs for the Future: An Industry Perspective
Brent Westerman, PhD.
Oklahoma Agricultural Experiment Station, Field and Research Service Unit
Along with a panel of Industry Representatives from John Deere, Livingston Machinery, Case IH and New Holland

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