# TEF
## Post-harvest Operations

INPhO - Post-harvest Compendium

Food and Agriculture Organization
of the United Nations

# TEF: Post-harvest Operations

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**Last reviewed:** 14/05/2001

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## Preface

A large amount of time and effort is required to produce a crop until it is harvested.
The importance of post production operations is as important as pre-production operations. The utilization of certain crops in different ways as one component and storage and handling of the product as a second component should be given due consideration especially in developing and underdeveloped countries. In a few developing and underdeveloped countries, certain crops are especially produced and consumed, which are not known or totally neglected by the developed countries. Excellent examples are Tef, *Eragrostis tef* (Zucc.) Trotter and Niger (locally known as *Noog*), *Guizotia abyssinica* (L. f.) *Cass*, which is produced in Ethiopia and India consisting about 50 percent of Ethiopian and 3 percent of Indian oilseed production. These crops amongst others have a stable system of pre-and post harvest operations and utilization. However, no or little emphasis is given to these crops by developed countries. Both the production and research for the improvements of these crops are borne by underdeveloped nations. It is essential that the pre- and post production systems and problems encountered be brought to the attention of developed countries. In this way, system problems attached to post production systems can be solved.
By reducing losses due to post harvest handling problems, it can be possible to feed more people in the world. Apparently, it is possible to reduce loss of the produce during harvesting, threshing, cleaning, transporting, storage and preparation as human consumption and as animal feed.

## *1. Introduction*

Tef, *Eragrostis tef (*Zucc.) Trotter is a staple food crop of Ethiopia. It has existed in Ethiopia since recorded history of the country and some authorities believed that the pre-Semitic inhabitants might have domesticated it in BC. Tef originated and has diversified in Ethiopia. Ethiopian farmers grew it for centuries because of its various merits. Otherwise it would not have existed after the introduction of other cereals such as maize, wheat, barley and others. Tef accounts for about two-third of the daily protein intake in the diet of the population (Ethiopian Nutrition Survey, 1959). Its grain is mainly used for making different kinds of *Enjera* (pancake-like flat bread), porridge and feed. It is also used in making a local alcoholic drink called *Arak'e* or *katikalla* and a native beer called *T'ella* or *Fersso*. The straw is used mainly for reinforcing mud for plastering wooden walls of buildings and for livestock feed. It is also used as mulch. Tef has a high economic value as its grain can be kept for many years in practically any kind of storage facilities without being seriously damaged by common storage insect pests (Tadesse, 1969). The area under cultivation is over one million hectares of land each year. During the 1994/95 cropping season, **tef** occupied 32 percent of the cultivated land under cereals, while **maize** occupied 19 percent, **sorghum** 16 percent, **barley** 15 percent, **wheat** 13 percent, **millet** 4 percent and **oats** 1 percent [Central Statistical Authority (CSA), 1995]. This is similar to previous production years and clearly shows the importance of tef in Ethiopia. During the *Belg* season, which is the autumn season in Ethiopian (from February to the end of May) tef, is grown in very limited areas and occupies less land. According to the Central Statistical Office, 1996, the share of tef against cereals was 6.40 percent and the total production share is 4.33 percent, indicating that tef is predominately a main season crop. Tef is also an export crop. The crop was exported to the Middle East, North America and to many European countries, mainly for Ethiopians or of Ethiopian origin that have immigrated to these countries. Outside Ethiopia, there is a growing interest in using tef. For example, small-scale commercial production of tef has begun in a few areas of the wheat belts of the USA, Canada and Australia. Tef has been introduced to South Africa and is cultivated as a forage

crop and in recent years, it has been cultivated as a cereal crop in Northern Kenya (Seyfu, 1997).

**Origin and Centre of Diversity**

Vavilov (1951) identified Ethiopia as the centre and origin of tef. Hence, Ethiopia is the appropriate and most important centre for the collection of tef germplasm. Tef belongs to the genus *Eragrostis*. This genus contains about 300 species. Within the genus *Eragrostis,* 43 percent of the species seem to have originated in Africa, 18 percent in South America, 12 percent in Asia, 10 percent in Australia, 9 percent in Central America, 6 percent in North America, and 2 percent in Europe (Costanza, 1974). Of the 54 *Eragrostis* species listed in Ethiopia, 14 (or 26 percent) are endemic (Cufodontis, 1974).

Tef is endemic to Ethiopia and its major diversity is found only in that country. As with several other crops, the exact date and location for the domestication of tef is unknown. However, there is no doubt that it is a very ancient crop in Ethiopia, where domestication took place before the birth of Christ (Seyfu, 1997). According to Ponti (1978) tef was introduced to Ethiopia well before the Semitic invasion of 1000 to 4000 BC. It was probably cultivated in Ethiopia even before the ancient introduction of emmer and barley.

**Names of the species and taxonomy**

Tef, *Eragrostis tef* (Zucc.) Trotter belongs to the family Poaceae, subfamily Eragrostoideae, Tribe Eragrostae and genus *Eragrostis*. The genus contains about 300 species (Costanza 1974). Accepted synonyms of *Eragrostis tef* (Zucc.) Trotter, are *E. pilosa* (L.), *P. Beauv* sub-sp. a*byssinica* (Jacq.) Aschers et Garebn., *E. abyssinica* (Jacq.) Link, *Cynodon abyssincus* (Jacq.) Rasp, *Poa cerealis* Salisb, *P. abyssinica* Jacquin, *P. tef* Zuccagni,

The common vernacular name of the crop in Ethiopia is *Tef*. It is also known by the vernacular name *Tafi* in Oromigna another main language of the Ethiopian people and *Taf* in Tigrigna, which is also another language of the Ethiopian people.

**Brief Description of the Crop**

Tef is a $C_4^*$, self-pollinated, chasmogamous annual cereal. It has a fibrous roots system with mostly erect stems, although some cultivars are bending or elbowing types. The sheaths of tef 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 showing different forms, from very loose, loose, semi loose, semi-compact to compact. The semi-compact to compact types appearing like a spike. Its spikelets have 2-12 florets. Each floret has lemma, palea, three stamens, an ovary and mostly two, in exceptional cases three, feathery stigmas (Figure 1).

**Figure 1: Tef plant white and red (brown).**

*$C_4$ plants are plants whose primary product is a 4-carbon molecule. Oxaloacetate is the first stable product in Hatch and Slack cycle. $C_3$ plants whose first stable primary is a 3-carbon molecule, which is Phosphoglyceric acid in Calvin cycle. $C_4$ plants are $CO_2$ and water efficient while $C_3$ plants are light efficient. $C_4$ plants are basically adapted to warmer regions and the $C_3$ plants are mostly adapted to the temperate regions (Pandey and Sinha, 1972).
The caryopsis is 0.9-1.7mm in length, and 0.7-1.0mm in diameter, which is very small and its colour varies from white to dark brown (Figure 2) (Tadesse, 1975). Tef is an allotetraploid plant with a chromosome number of 2n=40 (Assefa, 1976). The basic chromosome number of the genus *Eragrostis* is X=10. When two accessions of tef were observed, measurements of the largest chromosome were 1.6-2.9μ m and of the smallest were 0.8-1.1μ m. The range within each measurement was attributed to differences in condensation (Tavassoli, 1986). According to Melake Hail and Guad (1966), the extent of out-crossing in tef is very low, 0.2-1.0 percent.


**Figure 2: White, mixed and red (brown) seeds.**

Most of the Ethiopian farmers use traditional landraces of tef and these are distributed all over the country. (Seyfu, 1997). Tef has been introduced to different parts of the world through diverse institutions and individuals. The Royal Botanic Gardens, Kew, London, United Kingdom, obtained tef seeds from Ethiopia in 1866 and 1886 and distributed it to some countries in the then British colonies, i.e. India, Australia, the United States of America, South Africa and British Guyana. According to Tadesse, (1975), Burt Davy in 1916 introduced tef to California (USA), Malawi, Zaire, India, Sri Lanka, Australia, New Zealand and Argentina. Skyes in 1911 introduced it to Zimbabwe, Mozambique, Kenya, Uganda, and Tanzania. In 1940 Horuitz introduced tef to Palestine. It has been reported that tef made excellent hay in all these places.
Tef plants cannot compete with weeds especially during the young growing stage. It is best to start with a weed-free, clean field that has been ploughed frequently during the appropriate season, in order to kill the weeds. The work should also start with clean tef seeds that are free of weed seeds (Seyfu, 1997).

## *Genetic resources*

Existing genetic variation

Studies made at the Institute of Bio-diversity and Research, Ethiopia, Seyfu, (1993) characterized 2 255 pure line varieties of tef germplasm for 15 morphological and agronomic traits. All the traits studied showed a wide magnitude of variation and had statistically significant differences. This elucidates the existence of a great wealth of genetic diversity in tef, which could be utilized in the improvement programme of the crop (Table 1). Out of the 15 traits studied, maximum genetic diversity was observed in the flag leaf area, grain yield per plant and straw yield per plant.

## *Properties*

The composition of tef is similar to that of millet, although it generally contains a higher amount of essential amino acids, including lysine, the most limiting amino acid (Jansen *et al.* 1962). The amino acid composition of tef is excellent, its lysine content is higher than that of all cereals except rice and oats, it has good mineral content and its straw is nutritious (Table 2, 3, and 4). The fractional composition of the protein in tef indicated that glutelins and albumins were the major protein storage components and their order of fractional importance was glutelins 44.55 percent, albumins 36.6 percent, prolamin 11.8 percent and globulins 6.7 percent. In tef seed the distribution of protein, percentage of ash and mineral elements is higher in the pericarp than in the endosperm (Mulugeta, 1978). According to Assefa (1979), the protein concentrations in the grain varied significantly between cultivars, ranging from 8.8 to 15 percent.

According to Besrat *et. al* (1980), the iron content of 35 samples of acid washed white and red tef (also known as brown tef) grain, was 3.6 to 7.8 mg/100 g DM. The relatively high values reported for tef as consumed were caused by contamination, probably with soil. Tadesse (1969), Molineaux and Biru (1965) reported that non-tef consumers have a lower level of hemoglobin, and hookworm anaemia develops in non-tef eaters if they are infested with hookworm. On the other hand, since tef eaters have higher levels of hemoglobin in their blood, they do not suffer from hookworm anaemia even when infested.

**Table 1. Descriptive statistical values for phenological traits, components of height, shoot biomass, harvest index, flag leaf area and culm thickness for 2 255 pure line accessions of tef (Seyfu, 1993)**

| Character | Min | Max | Mean | SD | SE | CV (%) |
|---|---|---|---|---|---|---|
| Days to germination | 4 | 12 | 5 | 0.70 | 0.01 | 13 |
| Days to heading | 26 | 54 | 37 | 3.80 | 0.08 | 10 |
| Days to maturity | 62 | 123 | 93 | 7.36 | 0.16 | 8 |
| Days heading to maturity | 29 | 76 | 56 | 6.23 | 0.13 | 11 |
| Culm length (cm) | 11 | 82 | 38 | 7.57 | 0.16 | 20 |
| Peduncle length (cm) | 7 | 42 | 19 | 4.54 | 0.09 | 23 |
| Panicle length (cm) | 14 | 65 | 41 | 6.99 | 0.15 | 17 |
| Plant height (cm) | 31 | 155 | 98 | 12.97 | 0.27 | 13 |
| Grain yield/panicle (g) | 0.3 | 3.0 | 0.9 | 0.34 | 0.01 | 38 |
| Grain yield/plant (g) | 4 | 22 | 8 | 4.01 | 0.08 | 48 |
| Straw yield/plant (g) | 20 | 90 | 41 | 15.83 | 0.33 | 39 |
| Total shoot biomass per plant (g) | 26 | 105 | 49 | 18.58 | 0.39 | 38 |
| Harvest index (%) | 7.0 | 38.0 | 17 | 5.51 | 0.12 | 33 |
| Flag leaf area ($cm^2$) * | 2.0 | 26.0 | 12 | 6.22 | 0.62 | 52 |
| Culm of first internod (mm)** | 1.2 | 5.0 | 3 | 1.12 | 0.17 | 37 |
| Culm of second internod (mm)** | 1.2 | 5.0 | 3 | 1.10 | 0.16 | 38 |

* Data taken from 100 germplasm accessions.

** Data taken from 45 germplasm accessions.

In addition, according to the same study, malaria is frequently found in groups with lower hemoglobin levels. Moreover, consuming tef is reported to prevent anaemia related to pregnancy. Tef contains more calcium, copper, zinc, aluminium and barium than winter wheat, barley and sorghum (Melak Hail, 1966).

Other grains such as wheat, corn, sorghum, or a mixture of these, can be used for making *Enjera*. However, tef alone is preferred. Compared to other cereals, *Enjera* made out of tef grain has a better odour, flavour, texture and long-keeping quality. *Enjera* made from tef is traditionally consumed with *Wot*, a sauce made of meat or ground pulses like lentil, faba bean, field pea, broad bean and chickpea. Generally there are two kinds of *Wot*: *kayy wot* is red *Wot* highly seasoned with ground dry pepper and other spices. This also gives it the red colour. The second type is called *Alecha* .

Taddesse (1969) and Beyene (1965) suggested that fenugreek *(Trigonella foenumgraecum*) seeds, which is reach in protein, is a good supplement if used with tef. In some regions of Ethiopia, e.g. Welo, women usually prepare *Enjera* by adding some fenugreek flour to tef to improve its baking quality. Because of this, the *Enjera* becomes softer and has a shiny appearance. Thus women are encouraged to continue this traditional practice and should be made aware that this will not only improve the baking quality of the *Enjera* but also supplement its protein content, especially lysine. The grains give higher returns both in flour upon milling (i.e. 99 percent compared to 60-80 percent from that of wheat) and in *Enjera* upon baking. The flour is also used for the preparation of tef porridge and not raised bread called *Kitta*. Sometimes, the grain is also brewed into a native beer called *Tella*, *Fersso* and a more alcoholic traditional liquor, locally known as *Arak'e*, or *Katikalla*. Alternate tef dishes such as tef breakfast cereal, tef waffles, tef banana bread and the like, are appearing in the Western world particularly in the United States of America. Tef is found to be a very nutritious cereal grain. Tef seed is especially high in iron and calcium but lacks glutelin, which makes it unfit for making raised bread (Seyfu, 1997).

## 1.1 Economic and Social Impact of Tef

Tef is the major staple cereal of Ethiopia. According to data collected over a six-year period (1992/93-1997/98) from the Central Statistics Authority, tef is annually cultivated on about 1.8 million hectares of land (Table 2), thereby covering about 29.4 of the total average of cereals. Its area has been expanding over time and shows a respective increase of 2.8 percent, 33.3 percent, 13.9 percent and 3.5 percent, from 1993/94 up to 1996/97 when compared to each preceding year. The highest acreage was recorded in 1996/97 (2.2 million hectares), which was a favourable year with a record harvest in the country. A slight decline in area under all cereal crops decreased by 15 percent in 1997/98 owing to shortage of rainfall in some agro-ecologies both in the *Belg* and main season. With an average of 1.6 million tons of grain per year, tef constitutes about 23 percent (second to maize, which is about 29 percent) of the gross yearly grain production of cereals (EARO, 1999).

**Table 2. Area under cultivation, yield and production of tef from 1992/93 to 1997/98.**

| Year | Area (000 ha) | Yield (Q/ha)* | Production (000Q) |
|---|---|---|---|
| 1992/93 | 1 385.7 | 9.8 | 13 559.7 |
| 1993/94 | 1 425.1 | 8.8 | 12 546.2 |
| 1994/95 | 1 899.0 | 9.8 | 18 582.0 |
| 1995/96 | 2 162.9 | 8.3 | 17 926.3 |
| 1996/97 | 2 238.7 | 9.1 | 20 371.7 |
| 1997/98 | 1 807.1 | 7.4 | 13 287.8 |
| Average | 1 819.7 | 8.9 | 16 045.6 |

*1 Q = 100kg (Source: Central Statistical Authority, 1997 and 1999).

On the whole the area devoted to tef cultivation is on the increase owing to the versatile merits of tef to the Ethiopia farmers. Firstly, both the grain and straw fetch a relatively high price in the market compared to other cereal crops. Secondly, tef is a crop, which adapts itself excellently to changing environments in the country, and, therefore, is considered a low risk for farmers. In some environments where farmers face a complete crop failure due to moisture stress, tef is their choice in order to obtain a harvest (EARO, 1999).

**Price and contribution to the GDP**

Based on DZARC price data (unpublished) for grain and straw collected from different district markets of East and North Shewa from 1992/93-1997/98, the prices of both the grain and the straw have increased steadily. The prices were collected from markets where farmers sell their produce directly to consumers. The grain price is an average of harvesting and planting time data of white, mixed locally called *Sergagna* and red (brown) seeds. At the harvesting time, average prices of the three classes of tef rose from 200 Birr per quintal in 1992/93 to 212 Birr per quintal in 1997/98. Likewise, the straw price increased from 19 Birr to 38 Birr per quintal. Based on an average of four years the Debre Zeit Agricultural Research Centre (DZARC) price data the grain of tef contributed 3.3 billion Birr and the straw 1.7 billion Birr to the Gross Domestic Product (GDP) of the country. The total contribution is estimated to reach five billion Birr (Table 3)

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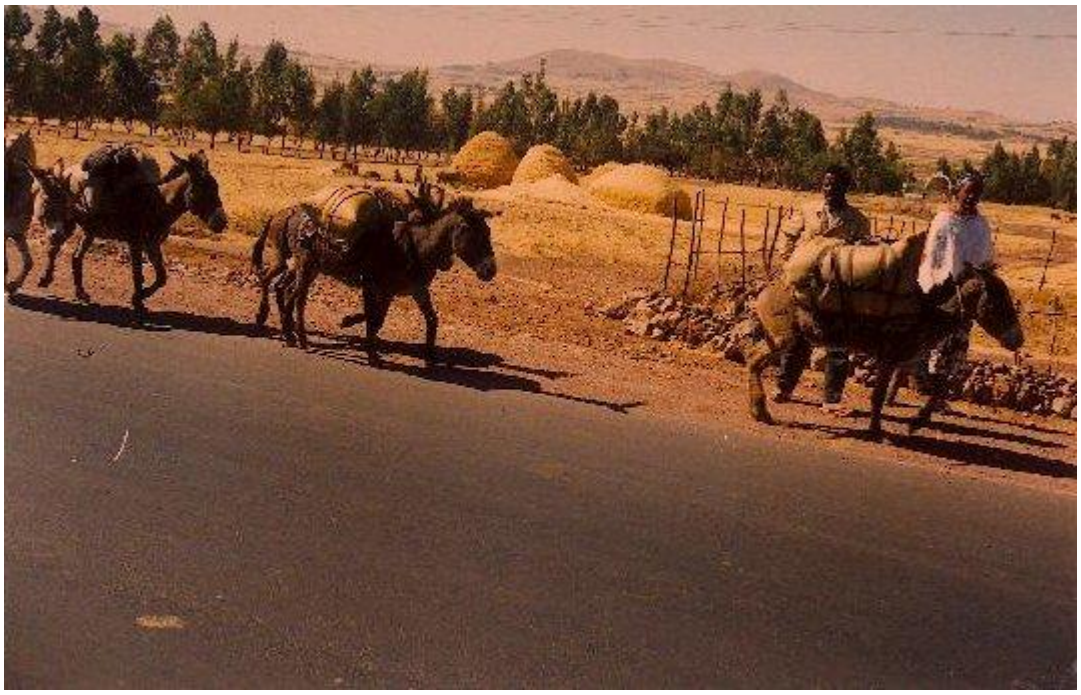

**Figure 3: Tef produce transported to the market by donkey.**

In many parts of Ethiopia such as Showa and Gojam, tef is used as a principal cash crop while in other parts it is used as a secondary cash crop. Tef is marketed throughout the year. Poor farmers who cannot wait for a better price sell their tef just after the harvesting season. This enables them to buy clothing for the family, to pay taxes and to pay other debts. The grain is taken to the market in sacks, bags, or an *Akomada* (goatskin bag) on donkeys (Figure 3), mules or horses. Sometimes the farmer will carry the seed on his head or shoulders, or his wife may carry it on her back. Traders and farmers with a lot of produce use modern transport methods that start from the farm gate to the trains. Ships and aeroplanes are used for export of the product.

At the market place, tef is sold at a special location called the *tef-tara*, which means a place where only tef is sold. Often in the market places, more standardized measuring units are used, called *Tassa*. These are usually about a kilogram or *Kubbayya* for about half a kilogram. In many parts of the country they have begun selling tef seed by weight, i.e. by using modern weighing systems.

## 1.2 World Trade

Official figures on the export status of tef have appeared during the past two years (Table 4). Almost equal amounts (1.8 thousand quintals) of tef grain were exported in 1997/98 and 1998/99, but the value obtained differs remarkably. About nine million Birr was obtained in 1997/98 (493.37 Birr/Q) whilst 14.6 million Birr was obtained 1998/99 (791.83 Birr/Q). The trend indicates that there is a good export market for this crop in the Middle East, North America and Europe and others mainly for Ethiopians who immigrated to the above mentioned regions (Customs Authority, 1999).

**Table 3. Value (Birr)* of tef grain and straw at the national level from 1992/93 to 1997/98.**

| Year | Grain Production (000 Q) | Straw Production 1 (000 Q) | Value from Grain (Million Birr)2 | Value from Straw (million Birr) | Total Value from Grain & Straw based in DZARC price (Million Birr)3 |
|---|---|---|---|---|---|
| 1992/93 | 13 559.7 | 42 012.8 | 2 711.94 | 798.24 | 3 510.18 |
| 1995/96 | 17 926.3 | 55 542.1 | 3 746.60 | 2 017.85 | 5 764.45 |
| 1996/97 | 20 371.7 | 63 118.9 | 3 952.11 | 2 261.55 | 6 213.66 |
| 1997/98 | 13 287.8 | 41 170.4 | 2 817.01 | 1 569.83 | 4 386.84 |
| Average | 16 286.4 | 50 461.1 | 3 306.92 | 1 661.87 | 4 968.78 |

Tef straw was estimated based on an average of 24.4 percent harvest index (Seyfu, 1997).
DZARC (Debre Zeit Agricultural Centre) price data (unpublished) for grain and straw were collected from different district markets of east Shewa and North Shewa where farmers sell their produce directly to consumers. The figures for the grains are an average of white, mixed (Sergagena) and brown seeds and the average of harvesting time and planting time prices were taken.
The current exchange rate for the month of January 2000 is 1USD = 8.141 Ethiopian Birr.
The major requirement for export of white and brown tef is its cleanliness. The seeds must be the same colour and free of inert materials such as dust, soil particles and weed seeds. Among other requirements for export, the amount of mixture of brown seeds inside the white tef is also given due consideration. Pure white seeds are exported more than the mixed or the pure brown tef.

## 1.3 Primary Product

Tef if a very fruitful plant, yielding from 1 000 to 10 000 seeds per plant. From this data one can state that tef produces more grains per square unit of area as compared to other food grains. But due to its minute seeds (2 500-3 000 seeds in a gram), there is a great loss of seeds in the field during harvesting, carrying the bundles to the threshing field, and in the threshing field itself. During threshing it is not possible to get all the grains out of the straw (Seyfu, 1997).

During a six-year period (1992/93 to 1997/98), the average national yield of tef was estimated to be 8.9 q/ha. However, farmers who use improved varieties and their management practices can easily get 17 to 25 q/ha (Table 2), which is a little more than two fold. Yields higher than 25 q/ha have been reported from several regions in recent extension package activities. The production had increased due to increased productivity. At the experimental plot level tef yields up to 34 q/ha in the presence of lodging that reduces yield by 17 to 25 percent. Study conducted under non-lodging condition has demonstrated that yield can further be increased up to 46 q/ha (Table 4). A record of 50 q/ha in some research plots has also been noted in the past. Some researchers of tef believe that tef yield can be increased to 6 tonnes/ha through an intensive research programme Seyfu (1993).

**Table 4. Yielding ability of three different tef varieties under different growthconditions.**

| Variety | Farmers' Condition (kg/ha) | Experimental Lodged Condition (kg/ha) | Experimental Non-lodging Condition (kg/ha) |
|---|---|---|---|
| DZ-01-94 | 2 000-2 500 | 2 400-3 400 | 4 600 |
| DZ-01-354 | 1 700-2 200 | 2 400-3 200 | 4 100 |
| DZ-Cr-37 | 1 700-2 200 | 1 800-2 800 | 4 200 |
| National Average | 890 | | |

Source: EARO 1999.

## 1.4 Secondary & Derived Products

Tef is predominantly grown in Ethiopia as a cereal crop and not as forage crop. However, the straw after the grain is threshed, is used as fodder. Farmers highly value the straw of tef and it is stored and used as a very important source of animal feed, especially during the dry season. Tef straw is called *Ch'ed* (Figure 4). Farmers feed tef straw preferentially to milking cows and working oxen. Cattle prefer tef straw than the straw of any other cereals and its price is also higher than that of other cereals. According to Lulseged and Jamal (1989), the quantity and quality of residues from various cereal crops vary greatly depending on the crop species. Wheat and barley give high straw yields, though these are of inferior quality. Among cereals, the straw of tef is relatively the best and is comparable to a good natural pasture. The same source indicated that the performance of animals on residue diets is also known to vary depending on the crop species.

**Figure 4: Tef straw called Ch'ed.**

**Table 5. Amount of tef grain exported and values (Birr) obtained in 1997/98 and 1998/99**

| Year | Amount Exported (quintals) | Value (Birr)* |
|---|---|---|
| 1997/98 (1990 E.C.)<br>1998/99 (1991 E.C.) | 17 976.8<br>18 402.8 | 8 869 168<br>14 571 827 |

Source: Custom Authority, 1999

* 1USD = 8.141 Ethiopian Birr (January 2000 Exchange rate).

The highest daily weight gain was obtained using tef straw. Table 8 shows the weight gains of steers fed for 116 days on a ration composed of 50 percent residue, 20 percent molasses, 25 percent Niger cake (*Guizotia abyssinica*), 4 percent bonemeal and 1 percent salt. Dry-matter intake and daily weight gain were lowest for wheat straw, 5.0kg and 352g/head, respectively. For tef straw it was 6.9kg and 628g for dry-matter intake and daily weight gain, respectively. Daily feed intake was the highest for tef (IAR, 1975). It was also reported that a tef plant produced an average of 12 899 lbs. of green material per acre within three months (The Agriculture of Ethiopia, 1956).

Tef has been used for many years in the Republic of South Africa for hay. Here extensive studies have been conducted for some years. According to the experiments carried out in other countries, tef has proved to be good forage grass. Some of its greatest advantages are the ease with which it is harvested, the way it can be dried in summer rain and its high nutrition quality. Burt-Davy (1913), cited by Seyfu (1997) had also indicated that the chief value of tef 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. According to Taddesse (1969), tef produces more than twice as much forage as weeping Lovegrass (*Eragrostis curvula*), producing an average of 14.5t/ha of green material in three months. This again shows that tef has a great potential to serve as a forage crop. Hence it can be used as a dual or multipurpose crop, i.e. for both cereal and forage. Tef is grown as a forage crop in various parts of the world.

*Milling of Tef*

The preparation of tef grain for making *Enjera* is as follows: Ordinarily, the grain is first cleaned by sifting and then ground into flour on *Wefcho* in households in very remote areas or in modern flour millings. In the homes of the wealthy, after the grain is cleaned by sifting, it is soaked or moistened for a few hours, and then pounded lightly in a *Mukachcha* (a mortar with a pestle) to remove the thin seed coat. Soon after, it is dried in the sun on a finely woven mat, and then ground into flour on *Wefcho*, which is placed in the house. The *Wefcho* is made of two hard pieces of stone, which are hand hewn. The bottom stone, about 45-50 cm long and 20-30 cm wide has a flat slightly cupped surface. This stone is set in a slightly inclined or elevated position and the edges are usually cemented with mud reinforced with tef straw. The edges are smooth or curved upward so that the grains will not roll off on the ground. The upper part is round and smooth. At the lower end, mud is made in a form of a pot called a *Kuwat* or *kodakomby* to catch flour. Other utensils may be placed at the lower end to catch the flour. The top stone called a *Megg* is about 10 to 20 cm wide on the flat side and the upper part is curved to fit the woman. s hand. The woman moves it forward and backward when grinding. While grinding the woman is in a kneeling position, behind the *Wefecho* with the weight of her body on her forearms. Then she adds small amount of grain on the upper side and rolls the grain to the centre with her fingers and grinds it by crushing it between the two stones. After some use, the *Wefecho* becomes slippery and fails to grind well. Beating with a round or oval stone called a *Mawkariya* or a hammer roughens the *Wefecho*.

People living in and around towns, take their grain to the gristmill. In some villages they now have gristmills which are run by waterpower. Diesel engine milling facilities are available in areas where electric power is unavailable. (Figure 5). In towns and cities electrical powered milling machines are used for milling. These are much more efficient than any of above mentioned milling facilities.

**Figure 5:** ***Diesel engine operated milling machine.***

Studies have shown that in milling, tef gives a 99 percent return in flour, whereas wheat yields 60-80 percent (Ciferri and Bakdrati, 1939). Analytical Data physical characteristics of the grain or flours from tef or a combination of tef seeds, grain flour and ash are given in Tables 6 and 7, respectively.

**Table 6. Analytical Data physical characteristics of tef grain or flour**

| | As by Visco (1936) Flour %(mg/100g) | As by Borasio(1937) Flour %(mg/100g) | As by Camis (1930) | |
|---|---|---|---|---|
| | | | % whole seed (mg/100g) | Flour % **(mg/100g)** |
| Water | 10.360 | 8.64 | 8.84 | 2.85 |
| Nitrogen | 1.550 | - | - | - |
| Protein matter | 9.725 | 9.93 | 10.43 | 8.56 |
| Fatty matter | 3.470 | 2.00 | 2.20 | 3.22 |
| Soluble sugars | 1.440 | - | - | - |
| Starch | 64.920 | - | - | - |
| Cellulose | 6.540 | 4.07 | 4.32 | 4.30 |
| Pentosans | 3.478 | - | - | - |
| Ash | 2.396 | 2.53 | 2.65 | 2.94 |
| N-free extract | - | 72.83 | 71.56 | - |

Source: (Ciferri *et al,* 1939 and Baldrati, 1950)

**Table 7. Composition of tef grain flour and ash according to Visco (1936)**

| | % of the flour (g/100g) | % of the ash (g/100g) |
|---|---|---|
| Sodium | .050 | 2.089 |
| Potassium | .244 | 10.193 |
| Calcium | .149 | 4.528 |
| Magnesium | .175 | 7.327 |
| Iron | .033 | 1.382 |
| Sulphur | .127 | 5.050 |
| Phosphorus | 2.277 | 11.572 |
| Chlorine | .082 | 3.480 |

**Making Different Kinds of Tef Enjera**

The main use of tef is for making Ethiopian bread, called *Enjera* of which there are many kinds. *Enjera* is the most popular type of bread, which is circular, thin, porous and pancake-like with numerous eyes. It has a sour taste. The average thickness is about 5mm and the diameter is 35 to 50cm. To make this kind of *Enjera* the flour is mixed with warm water and

then worked by hand until the dough becomes hard. The water should not be either boiled or cold as this can result in an *Enjera* of very poor quality. The numerous eyes are the indication of good quality *Enjera* (Taddesse, 1969; Seyfu, 1993).
Making *Enjera* is mostly work for women. *Enjera* is prepared both in the rural areas, villages, towns and cities. *Enjera* is baked in a circular; almost flat earthenware pan called a *Metad* or *Elle chabetta*. This is a baking oven made from local materials, which is about 60cm in diameter. It is put on the open fire and heated gently. The *Metad* is raised slightly on three small stones at the corners called *Gulecha*. Then it is polished or greased by rubbing with ground *Gommanzar* (*Brassica integrifolia*) seed; or *kalawa* (*Maesa lanceolata*) seed; or *Gullo* (*Ricinus communis*) seed, cotton seed, or animal fat in a piece of cloth. People living in rural areas where electricity is unavailable or even in towns and cities where the electrical powered *Mitad* is too expensive, use the one which is heated by burning wood, animal dung, shrubs, etc. (Figure 6). Nowadays the *Mitad* is heated by electrical power in areas where electricity is available. Most of the families living in cities, towns and villages use an electrical powered *Mitad* (Figure 7).


**Figure 6: Mitad,** an oven like used for baking Enjera, which is heated by wood, animal dung, shrubs etc. Please note that the concave shape lid of the Mitad called Akambalo, grey in colour.


**Figure 7: Mitad which is heated by electric power.**

***Below is the procedure and recipe for preparing tef Enjera (Ethiopian Nutrition Institute, 1980). The flow chart is shown in Annex 2a.***

1. Procedure and recipe for preparing tef *Enjera*
Ingredients Weight
Tef flour 3 kg
*Ersho** (local yeast) 480 g
Water for dough 6 litres
* *Ersho* is starter, which is dough, saved from a previous fermentation and used as a starting fermentation in every new dough preparation.
Cooked product
Number of *Enjera* 18
Weight of one *Enjera* 450g
Preparation of the Dough
Sift the flour into a container that is large enough to hold the entire recipe,
Add the *Ersho* to the dough and then using a large wooden ladle or the hands stir the whole content,
Add three litres of water and mix the dough well. Add three more litres of water gradually along with frequent stirring all the time. Use either a wooden ladle or the hands until it is mixed well,
Cover the dough and allow it to ferment for three days.
Baking the *Enjera*
Pour away the water that has settled on top of the dough,
Add a half-litre of dough to a litre of water and then boil it,
Mix three litres of cold water into the dough. The hot mixture should be well stirred and allowed to stand for 30 minutes.
After fermentation the batter is thinned again by adding a small amount of water. The fermented batter is then taken in a small can, or a gourd, called *Mazoria* or *Masfiya* from the *Buhaka*, and poured on to the *Metad* with a circular motion beginning at the outer perimeter and working towards the centre. It is covered with a *Metad* cover called an *Akambalo*. This is convex in shape. The edges of the *Akambalo* rest on the *Metad*, on the outer circle of the *Enjera*. Cracks or the openings between the lid and the griddle are covered with a strip of moist cloth. After 3-6 minutes the *Enjera* will be baked depending on its thickness and heat intensity (Figure 8). The *Enjera* comes loose from the *Metad* if the latter is well polished and well greased. Otherwise it may stick to the *Metad*. The baked *Enjera* is lifted up by hand and placed on a *Sefed* or lifted with the help of a *Sefed*, which is a kind of basket made of grass stems. The housewife makes *Enjera* either for one meal or for 2-3 days at one time. *Enjera* is used for all meals especially in the countryside.

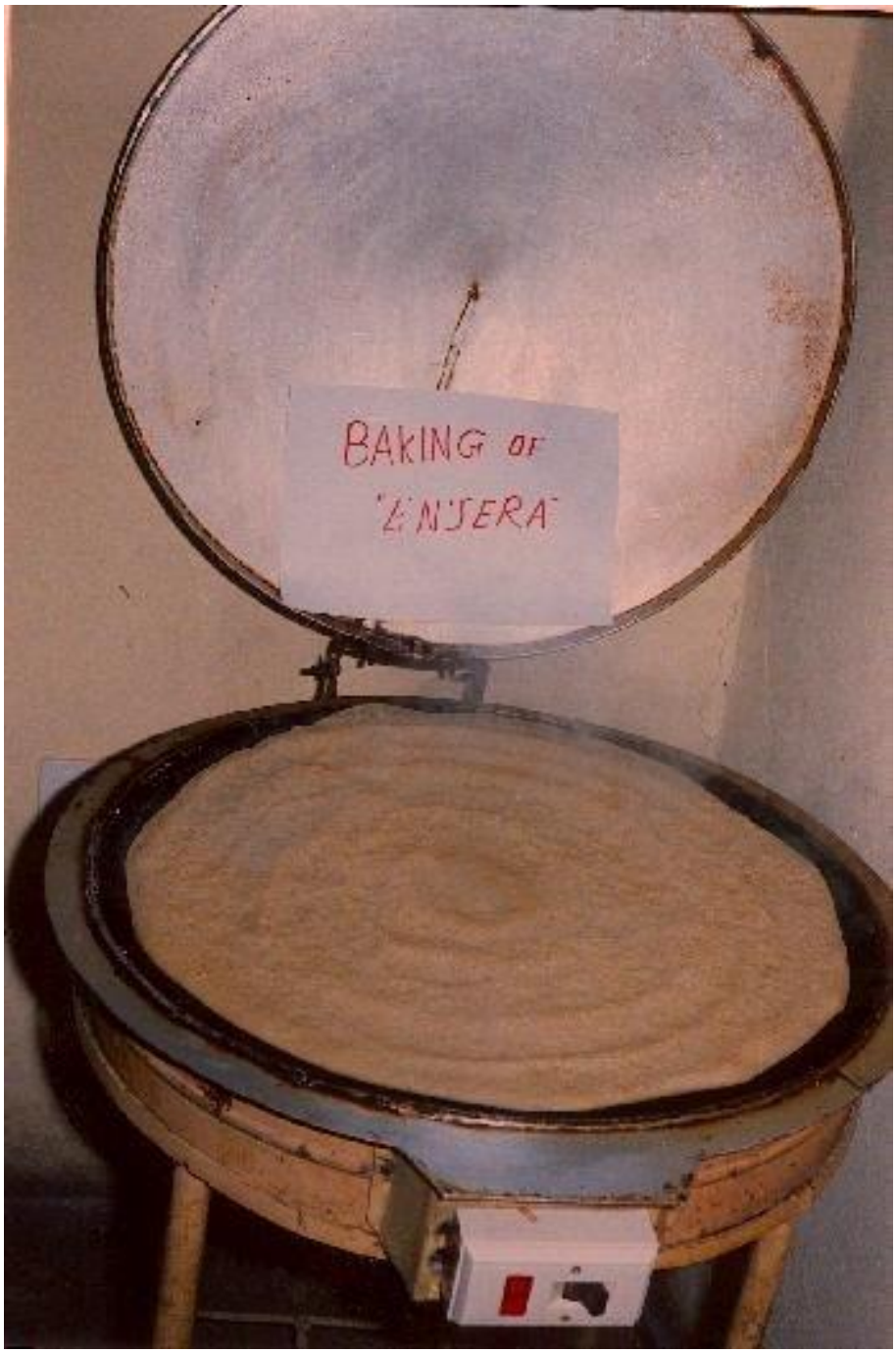


**Figure 8: Baked Enjera on the hot Mitad.**

Other important points to be followed in preparing *Enjera* are:
The *Mitad* should be rubbed with oil or ground oilseed between each baking interval. The process should be repeated until all the dough is used to make *Enjeras*.
Although no longer customary, oil is added to the dough along with the boiled water. Oil improves the appearance of the underside of the *Enjera*. It makes it shinier and gives it a better appearance.
Even though tef flour is most commonly used to make *Enjera*, barley, wheat, corn, finger millet and sorghum flours are also used for the same purpose in some cases.
The duration of fermentation time required depends on the climate: where the climate is hot, the *Enjera* is baked on the same day as the dough is mixed; in cooler climates the dough is left to ferment for a few days (2-3 days).

The dough should never be fermented for more than 3 days, or it will become too sour and might cause gastritis. Besides, the longer the fermentation time the higher the destruction of nutrients.
Traditionally the flour is mixed with water in earthenware, wooden or metal container called *Buhaka*. During mixing, water is added to the flour little by little until the desired thickness or texture is obtained. About three litres of water are added to two kilograms of flour. To this mixture a small amount of yeast which is called *Ersho* is added, and the whole content is thoroughly mixed by hand to form hard dough. The dough is next immersed in water and left for 2-3 days to ferment. The rapidity with which it ferments depends on the altitude of the area and the concentration of *Ersho*, (Stewart and Asnake, 1962). The *Buhaka* is not washed very often or thoroughly, so the fermenting agent is maintained in the container continuously. After baking, the batter on the inside of the *Buhaka* is washed down and left for subsequent use. As the batter ferments a gas is produced and as it rises, a thin yellowish liquid settles over the paste. This yellowish liquid is the *Ersho*. It is poured off and saved for the next batch. Sometimes, to make a clean looking thin *Enjera* with numerous eyes, a small amount of the fermented paste is mixed with water (1 part to 3 parts of water), boiled, and added to the fermented batter, called *Lit*.
The fermented paste is called *Absit*. According to Stewart and Asnake (1962) the primary agent responsible for fermenting flour in making *Enjera* has been identified as *Candida guilliermondii* (Cast) Longeron and Guerra. This yeast is known to occur naturally in the flour and seed of tef.
After baking is over, *Enjera* is placed on a *Messob*, which is a slender splendid basket with a flat top, and a base made from grass stems (Figure 9). Large flat plates may be used on *Messob*. It may also be placed on a *Gebata*, a container with a rather flat top, smooth or curved edge, and flat base made of wood, or on a flat plate. Then some *Wot* is put in a bowl of black clay called a *Wachett*, or in a wooden or metal dish and set in the middle of a *Messob* or a *Gebata* on *Enjera*. *Wot* may also come in a small earthenware bowl called *Dest* in which *Wot* is made. It is scooped out with a wooden or metal dipper, called *Chelfa* and spread over or placed at the centre of the *Enjera* (Figure 10). Then a piece of *Enjera* is broken off with the fingers, dropped on the *Wot* upside down, to absorb the *Wot*, folded and shaped with the fingers and placed in the mouth (Figure 11).

**Figure 9: Baked Enjera transferred on to the Messob.**


**Figure 10:The sausage called Wot spread over Enjera.**

**Figure 11: Eating Enjera with Wot.**

*Enjera* can be broken into very small pieces to make *Fetfet*. Cutting *Enjera* into small pieces and dipping in to *Wot* or other sausages makes *Fetfet*. *Enjera* is eaten with the fingers except when *Fetfet* is prepared. *Fetfet* is eaten with spoon made from cattle horn, wood or silver. Other types of Enjera are called *Aflangna* or *Chumbo*, or *Bekuo*. It is a very heavy cake 3-4cm or thicker near the edge, thinner nearer to the centre, and 40-70cm in diameter. It is baked from relatively unfermented dough, 12-14 hours, on a bigger and heavier *Metad* than that

used for ordinary *Enjera*. This kind of *Enjera* is quite common in rural areas, especially at *Debo*, that is, work projects with neighbours helping each other on the farm, building a house, etc., or for large families where making thin *Enjera* is very time consuming. In baking *Chumbo*, a large *Metad* called an *Elle Chumbo*, small concave *Metad* called a *Bedde*, and the cover called *Akembalo* are used. *Bedde* is placed on the fire upside down and heated until it is very hot. Then the *Elle Chumbo* is turned upright and cleaned by rubbing it with a piece of cloth. *Bedde* is placed in the centre of the *Elle Chumbo* upside down. In baking *Aflangna*, *Bedde* is not used. Then batter somewhat thicker than that is used for *Enjera* is poured onto the back of the *Bedde*. There it spreads out. Next a cover known as *Akembalo* is placed on the *Elle Chumbo* and cemented together along the edge with cloth or mud reinforced with tef straw. This is done to prevent the steam from escaping. It requires 1-3 hours to bake depending on its size. *Chumbo* is eaten with *Wot* made from pulses, other vegetables, and cheese. Meat *Wot* is not usually used with *Chumbo*. *Chumbo* is almost always made from red tef.

*Hongochy*; is heavier and larger than *Chumbo*. It is made from rather unfermented batter, and baked for similar occasions or purposes as *Chumbo*, a small *Metad* called *Bedde*, and an *Akembalo* is needed. These are heated until very hot. Then the bigger *Metad* is turned upright, cleaned by rubbing with a piece of cloth, and the thick batter is poured in the centre. Next the small hot *Metad* is set in the centre upright on the batter and hot coals are added to it. An *Akembalo* is placed on the *Metad* and the two cemented together along the edges with mud reinforced with tef straw. *Hongochy* is baked slowly for 2-4 hours and eaten like *Chumbo*. It is almost always made from red tef. The flow chart is shown in Annex 2b.

*Annababaro* or *Chabetta* or *Hansa*. This type of *Enjera* is made by doubling two ordinary thin *Enjera*. First, one thin *Enjera* is baked and removed from the *Metad* and batter for the second one is poured on the *Metad*. The baked *Enjera* is then placed on it usually upside down and baked for five to ten minutes. It is made from a fermented batter of either red or white tef and eaten like thin *Enjera*. The flow chart for baking *Annababaro* or *Chabetta* or *Hansa* is shown on Annex 2c.

*Eremmto* (or *Bittile* or *Daguwale*) is a small flat bread like loaf baked on hot coals in a fireplace. It is made from a thick unfermented batter. It is wrapped in leaves of kale (*Brassica integrifolia*), banana, *Ensat* (*Ensete ventricosum*), or *Baggi* (*combretum paniculatum*), and placed in a fireplace. Hot coals are added over it. *Ermto* is baked for children to east as snacks. It has a sweet taste and is eaten without *Wot*.

*Kitta* or *Matino* is made from fresh or unfermented dough. It is prepared when the housewife does not have enough time to make fermented batter. It is slightly salted and eaten with milk. Usually *kitta* is baked on an earthenware or metal *Metad*. It is sometimes decorated by making an impression with the fingers in the dough. Usually a red tef, called *Dabi* is used for preparing *kitta*. The flow chart for baking *Kitta* or *Matino* is shown in Annex 2d.

Other types of *enjera* are usually made in rural areas, where farmers and farmers. cooperatives are found. They are not well known in the cities and large towns. Their methods of preparation follow.

*Bedena Balla* means *Enjera* made in a leaf. This is a large loaf, which are about 4-6cm thick, 8-20cm wide and 40-60cm long. This *Enjera* is made from a fermented thick batter with a lot of spices are added. The common spices which are commonly added are chopped onion locally called *kayy Shenkurt*, chopped garlic called *Nach Shenkurt*, ground black cumin called *Tekur Azmud* and ground white cumin called *Nach Azmud* chopped ginger called *Zenjeblle*, *Korarima* or false cardamom, *Afrannum korrarimam* Zingiberacease and salt. It is baked in a large *Metad*; batter is poured on layers of banana, *Ensat*, or *Baggi* (C*omparatum paniculatum*) leaves, which are laid on a *Metad*. Another layer of leaves is put on the top and the hard dough is completely wrapped in a leaf. Usually two pieces are baked at a time.

*Bedena Balla* is characterized by sweet flavour and has an inviting aroma. *Wot* is not used with this *Enjera*. This kind of *Enjera*, made from red tef is baked for special occasions. When a mother visits her married daughter she often takes *Bedena Balla*, a native alcohol, with her. Also a married daughter takes the bread to her parents when she visits them. Relatives living a little distance from each other will usually take it with them during a visit as well. The flow chart for baking *Bedena Balla* is shown in Annex 2e.
*Tibbennya* or *Bedena Galla* or *Luflufo* is a loaf similar to *Bedena Balla* except that this is very small. It is made from dough fermented for one and half days, wrapped in leaves and baked on a *Metad*. It is spiced similarly to *Bedena Balla*, and is used as reserve food called *Senk* by persons going to markets a long distance away, hunting, war or other types of long journeys. It keeps well for two to four weeks. It is usually made from red tef. The flow chart for *Tibbennya* or *Bedena Galla* or *Luflufo* is shown in Annex 2f.

### *Making Tef Porridge*

Porridge, which is locally called *Ganfo,* is made directly from flour or from fermented batter called *Marka Buko* (meaning porridge from batter). To make this porridge the housewife puts the *Tuwe Marka*, (a pot for porridge) onto an open fire. This is raised with three stones at the corners, water is boiled and flour or batter is added. Stirring is done with a piece of wood with a flat end, known as *Bogeto*. The pot is held in place with a piece of *Y* shaped wood that is called *Ejeta*. It takes about 20-40 minutes to cook porridge. Porridge is eaten with cheese or with soup made from thin, well-fermented batter. In eating the porridge women usually use their hands, children use plates, and husbands use spoons. The wife puts pieces of porridge flavoured with cheese or soup on the husband. s spoon. Often porridge is eaten in the morning. It can be prepared either from white or red tef. It is also prepared from maize, sorghum, barley, etc. (The flow chart is shown in Annex 2g).

### *Making Tef Soup Muk*

In some parts of the country, namely Wollega, soup known as *Muk* is made from thin fermented batter. When it is cooked, salt and spices are added and it is eaten with a spoon. *Muk* is prepared when there is very little food available or for a sick person. It can be prepared from red or white tef. The flow chart is shown in Annex 2h.
Making Tef As A Local beverage Called *T'ella*
*T' ella* is a native beer made from grains such as finger millet (*Eleusine coracana*), grain sorghum, corn, barley, etc. Occasionally red tef is used for *kitta*; bread made from unfermented hard dough. This is especially used in brewing a native alcohol called *Katikalla*. *T' ella* prepared from red tef is very strong. It is called *Embushbush* or *Bawuza*.
Making Tef Bread Bolls (Grains) Called *Hunkuro* (*Dabbo Kolo*)
*Hunkuro* also known as *Dabbo Kolo* are bread grains cut with scissors in small sizes. Wheat is preferred for *Dabbo Kolo*, but in areas where wheat is not grown, white tef is used. Warm water is added to the flour to moisten it. The *cereal* is then roasted on a *Metad* over an open fire. It is stirred constantly with a piece of flat wood until small hard bread balls are formed. This is usually seasoned with spices and butter. Because it keeps for a long time without spoiling, travelers use it. White tef is preferred to red tef for the preparation of *Dabo Kolo*. A flow chart for making of *Dabo Kolo* is shown in Annex 2i.

## Fermentation of Tef

Studies conducted using tef as the sole source of microorganisms indicate that a metabolically associated heterogeneous group of fermentative, aerogenic, gram-negative rods, lactic acid bacteria, *Bacillus* spp. and yeasts growing in succession were involved in the fermentation process of tef. This is reported to be unlike the fermentation process in wheat where a single

organism is involved in the breadmaking process (Berhanu *et al.* 1982). The initial fermentation activity is performed by a group of microorganism (gram-negative aerogenic rods) such as *Enterobacter, Hafnia, Citrobacter, Klebsiella, Escherichia and Proteus*. Their population as a group increases substantially during the first 36 hours of fermentation and decreases thereafter. The yeast *Saccharomyces* spp., even though present during the whole of the fermentation process, becomes abundant after the pH level reaches below 5. This yeast become the predominant group of organisms in the liquid layer after 50 hours of fermentation, i.e. after the complete separation of the liquid/solid and is responsible for the . rising of the dough. during the second stage of fermentation (Berhanu, *et al.* 1982).
According to Chaltu and Abreham (1982), out of the 22 identified yeasts isolated. 14 were the type most commonly found during the peak time of fermentation. The dominant yeast flora at the peak of fermentation of tef dough comprises two physiological groups belonging to the general *Saccharomyces* and *Torulopsis*. Yeast of the general *Candida* and *Pichia* become prominent in the yellow fluid that settles on top of the dough in the latter stages of fermentation Table 8.
It is important to note that in studies conducted by Berhan *et al.* (1982) the fermentation of tef, the whole process is done without making use of *Ersho* (yeast) at the beginning . Whereas according to Chaltu and Abreham (1982), *Ersho* was added at the beginning of the fermentation process, since their experimental samples were taken from private homes and food processing enterprises that mass produced tef *Enjera* and where *Ersho* is traditionally practiced. *Ersho* is traditional yeast added to tef dough and used as a starter to enhance fermentation; it is usually obtained from previously fermented tef dough. This may account for the difference in the reports of the two studies cited above, regarding the population density of the various microflora observed at different times during the fermentation process. The studies of both Berhanu *et al.* (1982) and Chaltu and Abreham (1982) agree that the yeast genera *Saccharomyces* are involved in the fermentation process of tef, although their reports vary concerning the population density and prime time of occurrence of these genera during the process of fermentation. Both of these studies also reported that they did not find *Candida guillermondii* as the yeast responsible for the fermentation of tef dough, as earlier reported by Stewart and Asnake (1962).
Enjera showed no aflatoxin contamination when prepared and handled and fermentation of the dough or storage of *Enjera* for prolonged periods did not increase aflatoxin B1 contamination (Besrat and Gebre, 1981).

### *Effect of Fermentation on the Nitrogen of Tef*

During the latter part of the fermentation process of tef this separates into dough that settles down forming a liquid layer at the top. Because of the acidic nature of this liquid that remains at the top, it is discarded just before *Enjera* is baked. In the process of pouring off this liquid layer, other soluble compounds (amino acids, sugars, and minerals) and a large portion of the microorganisms involved in the fermentation process are also removed. Moreover, a significant quantity of tef nitrogen is lost at the end of the fermentation process. The nitrogen loss in tef, which amounts to 4 to 13 percent, can however, be avoided by stopping the fermentation process at about 31 hours, just before the liquid/solid separation. *Enjera* with minimum acidity and no or minimal loss of nitrogen, can be baked before the liquid/solid separation occurs in the fermentation tank for about 31 hours (Berhanu, *et al.* 1982 as cited by Seyfu, 1993). The nitrogen content of the various fractions of fermenting tef flour are presented in Table 9.

### *Effect of Fermentation on the iron, phosphorus and zinc content of tef.*

The effect of fermentation on the bioavailability of iron, phosphorus and zinc was studied, in tef and in wheat. Samples were cleaned and washed in the laboratory using tap water and 25 hydrochloric acid. Fermentation at room temperature was followed by dialysis of the batters. Fermentation of tef and wheat decreased pH of the dough from 6.8 ± 0.1 to 4.5 ± 0.1, with partial breakdown of soluble starch. This also increased the dialyzable portions of their Fe, P and Zn contents from 9.0 percent ± 0.4, 16 percent ± 2.0 and 7.0 percent ± 1.0, respectively, to 24.0 percent ± 0.7, 60.0 percent ± 3.0 and 43.0 percent ± 2.0. The increase in dialyzable Fe may have a positive effect on its bioavailability, and may thus explain the rarity of iron-deficiency anaemia among tef-eating populations in Ethiopia (Ramachandran and Bolodia, 1984).

**Table 8. Yeast flora of fermenting tef dough**

| Source | Type of yeast isolates |
|---|---|
| Fermenting tef dough (22-25hr old) | Saccharomyces exiguus |
| | Saccharomyces dairensis |
| | Torulopsis holmii |
| Yellow fluid (48hr old) | Candida krusei |
| | Candida lambica |
| | Candida sorbosa |
| | Pichia kudriavzevii |

*Source: Chaltu and Abreham, (1982)*

## *Effect of Fermentation on the carbohydrates in tef*

In an experiment carried out by Umeta and Faulks (1988), indicated that the fermentation is generally spontaneous but may also be initiated by the addition of a starter culture from the previous fermentation. The changing pattern of free sugars during fermentation was the same in both varieties. A change in the microbial population dynamics also resulted in changes in the pH of the dough. Fructose was the main free sugar in the fermenting dough and cooked product. After 72 hours of fermentation, the microbial population utilized 9 percent of the starch in both varieties. The non-starch polysaccharides (dietary fibre) were not affected.

## *New Recipes for the Utilization of tef*

Many people are showing great interest in introducing tef into their countries. Hence, efforts are being made to discover and introduce other methods of utilizing tef. Ten new food recipes have been developed and introduced for the utilization of tef in the United States (Wood, N.D., cited by Seyfu, 1993). These recipes are given below.

Tef breakfast cereal
Tef waffles
Whole grain muffins
Moroccan chicken
Jalapeno tef *fillets*
Great chocolate cake
Chocolate mint refrigerator cookies
Tef banana bread
Date cake
Double-tef butter-pecan tea cakes

The recipes for some of the above mentioned new methods of using tef are presented below:

## *Tef Breakfast Cereal*

Yields: 3 cups
Time: 15 minutes
Tef breakfast cereal is a good diversion from oatmeal breakfast. It is quick to cook breakfast cereal that is nutritionally and energetically superior to oatmeal. Most importantly, it is delicious. It takes only 15 minutes to prepare 3 cups of this breakfast cereal.
Tef cooks well in varying amounts of water. For a firm cereal, cook a cup of tef in two cups of water. Cooked tef, regardless of the water proportion sets up firm and lends itself to panfrying.
Ingredients
three cups of water
few grains of salt
a half cup of tef (white, brown, or red)
Boil water and salt in a pan. Add tef, cover the pan, and simmer for 15 to 20 minutes, or until the water is completely absorbed. Towards the end of cooking, stir it intermittently and serve it with milk, maple syrup, or honey.

**Table 9. Nitrogen content of the various fractions of fermenting tef flour Nitrogen content on dry weight basis (percent)**

| Duration of fermentation in hours. | | | | | |
|---|---|---|---|---|---|
| Sample | 0 | 24 | 48 | 72 | 96 |
| Tef | 1.59 | 1.59 | 1.60 | 1.58 | 1.59 |
| Fresh dough | 1.60 | 1.58 | 1.59 | 1.59 | 1.60 |
| Fermented dough | 1.60 | 1.58 | 1.51 | 1.46 | 1.40 |
| Liquid layer | - | - | 0.07 | 0.13 | 0.20 |
| Total loss of starting nitrogen in the liquid layer (%) | - | - | 4.40 | 8.10 | 12.5 |

Source: Berhanu *et al.* (1982)

Variations
Add a quarter cup of raisins and a quarter teaspoon full of cinnamon and cook with the tef.

## *Tef Banana Bread*

Yield: 9-inch tube cake
Time: 50 minutes
It just takes one taste to know how great this tef bread is. Tef's full range of blandly sweet earth flavour gives depth and adds to its unique and tender crumb.
Ingredients
1 ¾ cups of brown tef flour
½ cup of chopped dates
1 cup of currants
½ cup chopped hazelnuts
1 ½ teaspoonful salt
½ teaspoonful of baking soda
½ teaspoonful of baking soda
½ teaspoonful of baking powder
1 teaspoonful of cinnamon

1 cup of natural sugar
½ cup of unsalted butter
1 egg, beaten
¼ teaspoonful of anise extract
1 cup of mashed ripe banana
Preparation
Preheat the oven to 350 degrees.
Toss a few tablespoonful of tef flour over dates, currants and hazelnuts and set the fruits aside. Blend together the baking soda, baking powder, salt and cinnamon with the remaining flour.
Cream together butter and sugar. Mix in an egg, anise and banana and add these to the dry ingredients, including nuts and fruits, and mix well
Spoon into a 9-inch oiled tube pan and bake for 40-45 minutes or until a toothpick inserted in the centre comes out clean
Variations
Grated carrot can be substituted for banana. The anise also can be replaced with cardamom, and raisins can replace dates and currants.
Blueberries can also be substitutes for banana. In this case, the dried fruit is not added;
Substitute applesauce for banana. Replace the anise with ground cloves.

### *Tef Waffles*

Yield: 6 waffles
Time: 30 minutes
Tef waffles are superior to wheat waffles. Tef. s superbly delicate crumb and full flavour offer so much more than wheat (whole or white), which demands sugar to make it palatable. Red tef is used.
**Ingredients:**
1 ¾ cups of red tef flour
2 teaspoonfuls of baking powder
¼ teaspoonful of salt
2 beaten eggs
3 tablespoonfuls of unsalted and melted butter
1 ½ cups of milk
Preparation
Heat a waffle iron
Sift the flour and the baking powder together in a mixing bowl and add salt. Make a hole in the centre of the sifted ingredients.
Pour the liquid ingredients and stir them together with a few quick strokes that are enough only to moisten the dry ingredients. The batter will still have a pebbled look. Then cook in the hot waffle iron.
Variations
Cook the pancakes on a griddle or skillet;
Add a cup of blueberries or sliced bananas;
Working quickly, sprinkle sunflower, poppy, flax or sesame seeds on top of the lower iron. Pour on the batter. Sprinkle the seeds on top of the batter and cook as usual.

### *Chocolate Cake*

Yield: 18-inch round layer cake
Time: 25 minutes
This recipe is a special alternative for people have allergies to the gluten in wheat. Tef's light and tender crumb, plus its full range of subtly sweet earth flavours make a very good chocolate cake.
Ingredients:
2 ¼ cups of brown tef flour
2 teaspoonfuls of baking powder
½ teaspoonfuls of baking soda
teaspoonfuls of cinnamon
½ teaspoonful of salt
1 ½ cups of natural sugar
½ cup of unsalted butter
2 slightly beaten eggs
1 cup of milk
1 teaspoonful of vanilla
2 ounces of melted and cooled chocolate
Icing and filling
1 ½ cups of any chocolate icing
¾ cup of raspberry jam
2 cups of almond slices
Preparation
Preheat the oven to 350 degrees.
Sift the tef flour, baking powder and soda together. Add the cinnamon and salt.
Cream sugar and butter together until fluffy.
Combine the eggs, milk and vanilla. Stir into the sugar mixture. Then gently add the dry ingredients. Pour into 2 oiled and floured 8-inch round cake pans. Bake for 25 minutes or until the toothpick inserted in the centre comes out clean. Cool on racks for 5 minutes and then remove from the pan and leave it to completely cool.
Place one cake layer on a plate. Spread raspberry jam between the two layers of the cake. Spread chocolate icing on top and decorate with almond slices at the sides of cake.
Variations
To make a marble cake, put a cup and two tablespoonfuls of brown tef in bowl and another 1 cup and two tablespoonfuls of white tef in a second bowel Combine the remaining dry ingredients and divide these into the white and brown tef bowls. Do the same for all the other ingredients except for the chocolate. Reduce the chocolate quantity to 1 ounce and add it only to the brown tef mixture. Alternating between the light and dark batter, pour large spoonfuls of batter in well-prepared cake pans.
To make cupcakes, set paper baking cups in a muffin tin, pour in ½ inch of the batter and bake for 20 minutes or until a toothpick inserted in the centre comes out clean.

### *Double-Tef Butter-Pecan Tea Cakes*

Yield: 18, 1 ½ inch cakes
Time: 30 minutes
Rich but not too sweet, small but filling, lavish but nourishing, these dainty shortbread are very delicious. Tef teacakes keep well for a week when thoroughly cooled and then placed into an airtight container.
Ingredients

¼ of unsalted and softened butter
2 tablespoonfuls of cooked white tef
2 tablespoonfuls of maple syrup
¼ teaspoon full of vanilla
2 tablespoonfuls of pecans
few salt grains
½ cup of white tef flour
Preparation
Preheat the oven up to 350 degrees.
Cream butter, cooked tef, maple syrup and vanilla together.
In a blender, grind pecans with salt until fine. Add ground pecans and tef flour to the creamed mixture.
Shape the creamed mixture into 18 balls. Then place each on an oiled baking sheet and flatten them with a cookie press, a candy mould, or with a thumb or moistened fork. Bake for 15 minutes. Allow to cool, before taking them from the baking sheet.
Variations
Substitute the almonds with pecans and the almond extract with vanilla
Substitute honey for maple syrup

### *Whole Grain Muffins*

Yield: 12 muffins
Time: 45 minutes
Three different grains make these nutritious muffins extra tasty. The oat brand and wheat germ add nutty flavours and the tef contributes to the fine texture.
Ingredients
½ cup of ref tef
¼ cup of boiling water
2 cups of whole wheat pastry flour
¼ cup of oat bran
¼ cup of wheat germ
1 ½ teaspoonfuls of baking soda
½ teaspoonfuls of salt
½ teaspoonfuls of cinnamon
½ cup of honey
2 tablespoonfuls of sesame oil or unsalted softened butter
a cup of butter milk or yoghurt
Slightly beaten egg
Tablespoonfuls of grated orange rind
Preparation
Preheat the oven up to 375 degrees, oil or line it with paper baking cups to make 12 muffins tins.
In a medium mixing bowl, pour boiling water onto the tef flour. Stir to moisten all the tef. Cover the bowl and leave for 10 minutes.
In another bowl, mix whole-wheat pastry flour, oat bran, wheat germ, baking soda, salt and cinnamon together.
When the tef mixture cools, add honey, softened butter or oil, buttermilk or yoghurt, egg and grated orange rind and stir together. Add the dry ingredients, mix them with a few quick strokes, spoon into prepared muffin tins, and immediately place them into the preheated oven. Bake for 20 minutes and them cool for 10 minutes before taking them out of the tins.

Variations
Add a ½ cup of chopped nuts either to the batter or on top of the muffins before baking;
Add currants, plumed raisins, fresh or frozen blueberries, or chopped dates to the batter;
Substitute a ½ cup of applesauce or grated vegetables such as carrots, zucchini, yams or pumpkins, or mashed banana for the ½ cup of buttermilk;
Add a ½ cup of wheat bran to the tef before adding the boiling water, thus replacing the oat bran and wheat germ;
Substitute a cup of Soy milk and a teaspoonful of lemon juice for the buttermilk.

### *Jalapeno Tef fillets*

Yield: 4 servings
Time: 30 minutes
For those who enjoy Italian polenta but who do not want to spend 45 minutes standing over a stove stirring it, the *tef potential* is a good change. Polenta is similar to the southern version of fried cornmeal mush.
Tef takes a fraction of the time to cook and requires stirring once or twice. Compared to corn, tef sets quickly and holds together equally as well.
Ingredients
3 tablespoonfuls of unsalted butter
a clove garlic, minced or pressed
3 diced shallots
a small diced onion
a jalapeno chili, broiled, steamed, peeled, seeded and diced
a tablespoonful of red pepper flakes
a quarter teaspoonful of salt
a half teaspoonful of pepper
3 cups of vegetable stock
a cup of white, brown or red tef
Preparation
Heat a tablespoonful of butter briefly in a two-quart pot. Put aside the remaining butter.
Sauté the garlic, shallots, onion and jalapeno together. Add pepper flakes, cumin, salt and pepper, and sauté the mixture together for another minute.
Add stock and bring the mixture to boil. Add tef, and bring to boil again, reduce the heat, put the lid on and allow to simmer for 15 minutes or until the liquid is absorbed. Stir once or twice during the last 5 minutes of cooking.
Rinse an 8 x 8-inch pan with cold water. Spoon the tef mixture into the pan and put it aside for an hour or so until it becomes cold.
Slice the tef into ¾ inch thick and 4 inches long fillets. Heat the remaining two tablespoonfuls of butter in a skillet. Fry the tef fillets in a medium heated pan until they become golden on each side.
Variations
Fry white tef fillets on one side, turn and top with slices of provolone or Dunlop cheese. Serve with tomato sauce.
Slice brown or red tef into finger-sized strips and use them as substitutes for ham on Chef's salad.
Substitute curry, peas, carrots, raisins and pistachio nuts for the jalapeno, pepper flakes and the cumin.

### Utilization for Animal Feed

According to the FAO Production Yearbook of 1985, Ethiopia had an estimated 26 million head of cattle, 17.26 million head of goats and 23.5 million head of sheep. This clearly indicates the heavy requirement of animal feeds as well as its importance to the agricultural economy of the country. However, the production of forage crops is not widely practiced. Hence, crop residues play a significant role as a source of livestock feeds.

Tef is not grown as a forage crop in Ethiopia. However, when grown as a cereal, its straw is stored and used as a very important source of animal feed, especially during the dry season. Cattle prefer tef straw than straw from any other cereal and its price is higher than that of other cereals. For example, tef straw costs about 40-50/100 Birr/kg while the price of wheat is about 30-40/100 Birr/kg in the Ada region (Seyfu, 1993).

The national average grain yield of tef is nearly 1 tonne $ha^{-1}$. With a national average of biomass production of 4.1 $ha^{-1}$ and a harvest index of 24.4 percent on 1.38 million hectares of land currently under production, the country produces on average 4.3 million tonnes of tef straw annually. The price of tef straw varies depending on the region as well as the season. However, taking the price in Ada region as a base, it is possible to roughly estimate that the national price tef straw produced per annum is between 129 million Birr and 172 million Birr. Both the amounts of tef straw produced as well as its price clearly indicates the important role tef straw plays as a crop-residue for livestock feed in Ethiopian agriculture.

According to Lulseged and Jemal (1989), the quantity and quality of residues from various crops vary greatly depending on the crop species. Wheat and barley usually give high straw yields though of inferior quality. Among cereals, straw of tef is relatively the best and is comparable to good natural pasture-hay. Indication of the relative importance of various crop residues is given in the Table 4. According to Lulseged and Jemal (1989), the performance of animals on residue diets is also known to vary depending on the crop species.

According to Burt-Davy (1913), the chief value of tef as a hay crop lies in its palatability, high nutritive value, narrow albumin ration (for a grass hay), high yield, rapid growth, drought resistance and ability to smother weeds. In South Africa tef is grown as a forage crop. According to Taddesse, (1969), tef produces more than twice as much forage as weeping love-grass (*Eragrostis curvual*), producing on average of 14.5t $ha^{-1}$ green material in three months. This again shows that tef has a great potential as a forage crop. Hence it can be used as a dual or multipurpose crop, i.e., both as a cereal and as forage feed (Seyfu, 1993).

## 1.5 Consumer Preference

Consumers prefer white tef followed by mixed tef and red (brown) tef. Poor farmers usually sell the white tef at reasonably higher prices, while buying either the mixed or brown tef for their own consumption. The grain is ground into flour which is mainly used for making a popular pancake-like bread locally called *Enjera.*There are three main commercial classes of tef based on the prevailing colours of the grain. Nach (meaning white) or Manngna is very white or medium white tef and Sergagna is a mixture of white and red or reddish brown tef without any standard proportions from each. Kayy tef is red or brown red tef. Tekur tef also called Taffy Dimma is a deep vivacious or red grained tef. Sometimes there may be as many as five classes of tef. (Taddesse, 1969). White tef is more expensive than the red tef. People who can afford the price usually consume white tef or Manngna tef, while the medium and poor families consume the mixed and/or red tef. Farmers who grow white tef often do not consume it. Instead they sell the white tef and buy the red tef for home consumption.

In the Nach class, usually red grains are found and in the kayy class white grains occur mixed with red. In samples taken from Dire Dawa, Harar, Addis Ababa, Nekemte, Jimma, Asmara and Bahre-Dar markets, it was found that from 0.1-5 percent red caryopsises were mixed in the white class and from 0.1-0.8 percent white caryopsises mixed in the red class. The

principal cause of this mixture is attributed to the common threshing ground, the use of common utensils in handling the grains, run-off water carrying tef seeds from field to field, and possibly to unsatisfactory storage facilities.

**Table 10. Amino acid content of tef (g/16g N) compared with other cereals, the FAO pattern and whole egg**

| Amino acid | Tef | Barley | Maize | Oats | Rice | Sorghum | Wheat | Pearl Millet* | FAO Pattern* | Whole egg*** |
|---|---|---|---|---|---|---|---|---|---|---|
| Lysine | 3.68 | 3.64 | 2.67 | 3.71 | 3.79 | 2.02 | 2.08 | 2.89 | 4.2 | 6.6 |
| Isoleucine | 4.00 | 3.58 | 3.68 | 3.78 | 3.81 | 3.92 | 3.68 | 3.09 | 4.2 | 7.5 |
| Leucine | 8.53 | 6.67 | 12.50 | 7.26 | 8.22 | 13.30 | 7.04 | 7.29 | 4.8 | 9.4 |
| Valine | 5.46 | 5.04 | 4.85 | 5.10 | 5.50 | 5.01 | 4.13 | 4.49 | 4.2 | 7.2 |
| Pheny-lalanine | 5.69 | 5.14 | 4.88 | 5.00 | 5.15 | 4.90 | 4.86 | 3.46 | 2.8 | 5.8 |
| Tyrosine | 3.84 | 3.10 | 3.82 | 3.30 | 3.49 | 2.67 | 2.32 | 1.41 | 2.8 | 4.4 |
| Tryptophan | 1.30* | 1.54 | 0.70 | 1.26 | 1.25 | 1.22 | 1.07 | 1.62 | 1.4 | 1.4 |
| Threonine | 4.32 | 3.31 | 3.60 | 3.31 | 3.90 | 3.02 | 2.69 | 2.50 | 2.8 | 4.2 |
| Histidine | 3.21 | 2.11 | 2.72 | 2.10 | 2.50 | 2.14 | 2.08 | 2.08 | - - | 2.1 |
| Arginine | 5.15 | 4.72 | 4.19 | 6.29 | 8.26 | 3.07 | 3.54 | 3.48 | - - | 6.9 |
| Methionine | 4.06 | 1.66 | 1.92 | 1.68 | 2.32 | 1.39 | 1.46 | 1.35 | 2.2 | 3.8 |
| Cystine* | 2.50 | | | | | | | 3.19 | 2.0 | 2.4 |

* Jansen *et al*. (1962).

** Amount of amino acid content considered adequate by FAO standards.

*** Alemayehu (1990).

**Table 11. Chemical composition of tef seed compared with spring wheat, winter wheat, winter barley and sorghum (Melak Hail, 1966)**

| Chemical Element | Purple tef | White tef | Spring Wheat | Winter Wheat | Winter Barley | Sorghum |
|---|---|---|---|---|---|---|
| K (%) (g/100g) | 0.36 | 0.20 | 0.37 | 0.33 | 0.44 | 0.44 |
| P (%) (g/100g) | 0.44 | 0.46 | 0.51 | 0.40 | 0.48 | 0.52 |
| Ca (%) (g/100g) | 0.18 | 0.17 | <0.10 | <0.10 | <0.10 | <0.10 |
| Mg (%) (g/100g) | 0.18 | 0.19 | 0.15 | 0.12 | 0.13 | 0.18 |
| Mn (ppm) | 21.20 | 30.00 | 53.00 | 36.00 | 12.00 | 29.00 |
| Fe (ppm) | 196.00 | 115.00 | 78.50 | 40.00 | 35.00 | 66.50 |
| B (ppm) | 14.00 | 13.00 | 12.00 | 11.50 | 11.00 | 16.50 |
| Cu (ppm) | 53.00 | 36.00 | 20.00 | 11.00 | 14.00 | 23.50 |
| Zn (ppm) | 67.00 | 67.60 | 60.00 | 39.50 | 45.00 | 44.00 |
| Al (ppm) % | 83.00 | 0.12 | <0.10 | <0.10 | <0.10 | <0.10 |
| Sr (ppm) % | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Mo (ppm) | 0.78 | 0.74 | 0.55 | 0.55 | 0.40 | 0.45 |
| Co (ppm) | 0.52 | 0.64 | 0.55 | 0.55 | 0.30 | 0.30 |
| Na (ppm) | 220.00 | 212.20 | 168.50 | 168.50 | 392.00 | 141.50 |
| Ba (ppm) | 19.00 | 23.50 | 6.00 | 6.00 | 7.00 | <0.10 |
| $SiO_2$ (%)(g/100g) | 0.31 | trace | trace | trace | trace | <0.10 |

**Table 12. Yield and chemical composition of various crop residues on dry matter basis (Lulseged and Jamal, 1989)**

| Crop residue | Yield composition % _____ | | | | | |
|---|---|---|---|---|---|---|
| | (t/ha) | DM | Ash | CP | EE | NDF |
| Barley straw | 10.0 | 92.6 | 8.4 | 4.7 | 2.3 | 71.5 |
| Tef straw | 5.0 | 92.6 | 8.4 | 5.2 | 1.9 | 72.6 |
| Wheat straw | 9.0 | 93.1 | 9.0 | 3.9 | 1.2 | 79.8 |
| Faba bean | 3.8 | 91.7 | 10.4 | 7.2 | 0.8 | 74.3 |
| Field pea | 5.0 | 91.9 | 6.1 | 6.7 | 1.2 | 73.6 |
| Natural pasture(hay) | 4.1 | 92.2 | 9.5 | 6.6 | 1.5 | 73.8 |

* DM = dry matter; CP = crude protein; EE = either extract; NDF = neutral detergent fibre.

## *2. Post-Production Operations*

### 2.1 Harvesting

Tef is harvested when the vegetative parts turn yellowish or straw colour. This depends on the maturity period of varieties, which varies from 60 to 120 days. Drying of the pedicel (straw colour) which holds individual spiklets is a good indicator of maturity of tef (Hailu, 1993). Harvesting before the plant gets too dry helps prevent losses owing to shattering (Seyfu, 1997). The average cutting loss is not known. The moisture content is not specifically determined for tef, but for many cereals it is around 12 percent. Tef does not need artificial drying before harvesting. The seeds are dry when the plant is harvested. Seeds can immediately germinate if moisture is absorbed.

**Table 13. Decrease in nutrient content of tef during storage.**

| | Calcium* | | Iron* | | Vitamin C* | |
|---|---|---|---|---|---|---|
| Crop | Initial | Final | Initial | Final | Initial | Final |
| Tef | 146 | 142 | 27.8 | 13.4 | 0.6 | 0.4 |
| Wheat | 64 | 53 | 29.0 | 7.1 | 0 | 2.0 |
| Emmer wheat | 38 | 7 | 5.9 | 3.9 | 2.0 | 2.0 |
| Horse bean | 117 | 49 | 18.3 | 6.6 | 7.0 | 2.0 |
| Field pea | 92 | 83 | 9.6 | 6.6 | 10.0 | 9.0 |
| Chickpea | 245 | 212 | 31.1 | 6.6 | 1.0 | 1.0 |
| Vetch | 218 | 170 | 31.1 | 11.6 | 13.0 | 1.0 |
| Lentil (clay *Gotera*) | 64 | 40 | 9.7 | 17.8 | 15.0 | 3.0 |
| Lentil (cow dung *Gotera)* | 64 | 40 | 9.7 | 20.8 | 15.0 | 3.0 |

Source: Yemane and Yilma (1989) * Parts per thousands.

Harvesting is carried out by grasping the tef plants in one hand and cutting them with the sickle near the base of the plant. The cut plants are placed in piles on the ground. In some parts of Ethiopia, such as in Showa province, the farmer when harvesting the tef, crouches

and cuts the plants near the soil surface. This is done especially when the tef plants are short. In other parts of the country, the whole plant is pulled out. Eight to twelve people can harvest one *Massa* which is about 2 000-2 500$m^2$ in one working day. Farmers share their human labour and their harvesting equipment during harvesting. Rarely do farmers harvest alone on their farm. After the plant is cut and placed on the ground, other people, usually the elderly, women and young children follow the harvesters and tie the harvested plants in small bundles or sheaves called *Nado*. These are 14 to 18cm in diameter bundled with green tef plants: the sheaves are larger if bundled with green sorghum stalks. Other farmers, instead of tying into sheaves, leave the plants loose on the ground. The sheaves or loose plants are subsequently stacked in the field where they remain until the farmer has finished harvesting all of his crops in other fields.

There is a migration of farmers during harvesting. Farmers, whose tef crop is late for harvesting mostly in highland areas, migrate to middle and lower altitude areas for harvesting. They earn much for their services and return to harvest their own crop. Due to lodging problems and shattering of seeds during harvesting tef is not suitable for mechanized harvesting. Quality consideration during harvesting is not possible. Grass weeds could be harvested along with tef and this could lower the quality of the product. Farmers usually do their best not to harvest grass weeds along with tef during harvesting. The harvested crop is then carried on the women's backs, men's shoulders or heads and/or on a donkey to near the threshing ground in the village where a large stack or pile, called *Kemmer* is situated (Figure 12). Stones are usually the base for *Kemmer* thus eliminating access of termites to the crop.

**Figure 12:Pile of tef called Kemmer.**

In areas where termites are non existent the stacks can be on bare ground. The heads are turned towards the centre of the stack so that rain will not wet them, and animals cannot feed on them. The crop remains in the stack until the farmer is ready to thresh (Taddesse 1969). According to the characterization made on 2 255 tef pure lines the harvest index ranged from 7 percent to 38 percent (Table 1). In the existing varieties mostly 24.4 percent is taken as a harvest index (Seyfu, 1997).

## 2.2 Threshing

Threshing is done after all crops have been gathered from the field. The threshing ground is prepared first. A threshing ground called *Awdemma* is made on nearly level or gently sloping ground by digging out the vegetation inside the soil and smoothing the ground.

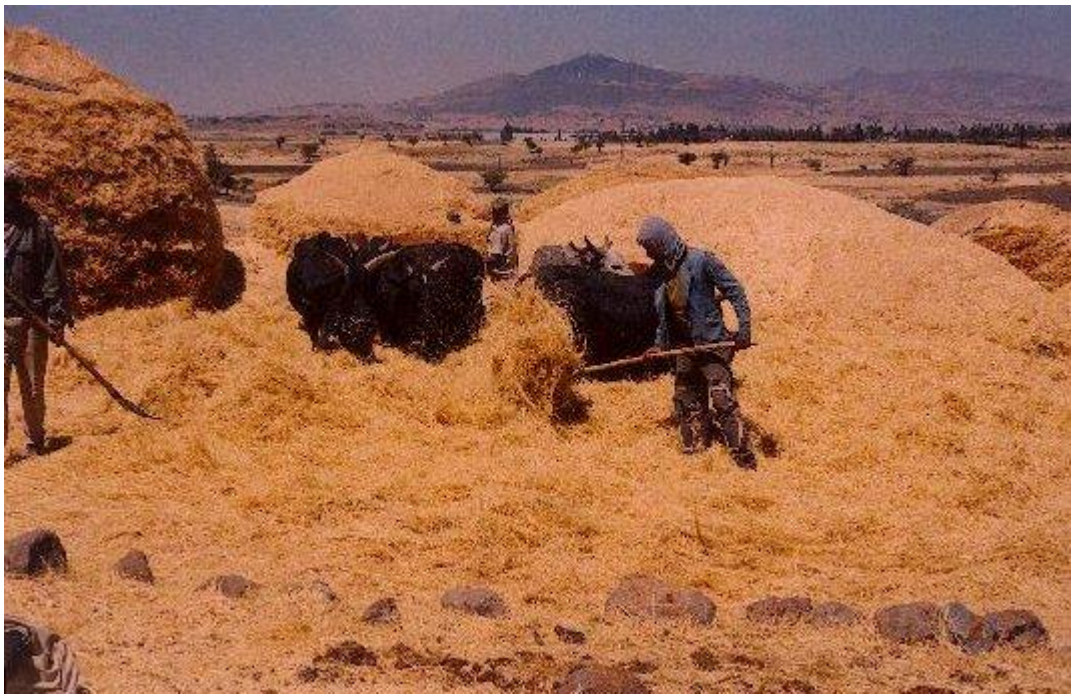

**Figure 13:Threshing of tef.**

Note that the farmers are permanently pushing tef to the centre of the threshing ground with forks that have three or four prongs.

In some parts of the country the ground is made firm by wetting the soil and then driving cattle over it. Then fresh cattle dung is collected from corrals or fields where cattle have grazed and a mixture of manure and water is prepared. This mixture is prepared in a shallow hole dug in the ground called *Bola Obid*, in earthenware jars, and a wooden container is prepared on the so-called *Awdemma*. The loose soil is removed and the bare ground is smeared with this mixture. To some extent, this reduces the mixing of the grain with soil. Pulse and other grain crops are threshed first. Tef is then threshed on the firmed *Awdemma*. Usually the threshing floor is re-smeared after every threshing, since the same floor is used for threshing all crops. The size of the threshing ground varies in different localities and dependent in part on the wealth of the farmer (Taddesse, 1969).

Threshing may be a festive occasion. The farmers whose fields are being worked on is expected to provide *T' ella* a native beer and *Enjera* or roasted parched grains such as barley, maize, etc. for the threshing day. Neighbouring farmers are asked to help with the threshing. In return the farmer helps them when they thresh their grain. Such cpp [eratopm is called a *Debo*. Males mostly do threshing. When threshing begins the farmer and his sons or friends get on the top of the tef stack with sickles and undo the stack by taking out each sheaf, cutting the tie with a sickle and throwing it onto the threshing ground. The untied bundles are spread evenly over the threshing ground with long wooden forks called *Andogo* or *Mansh*. This has two *Andogo* or three to four *Mansh* slightly curved prongs or tines. Nowadays *Mansh* with four prongs made of metal are distributed and widely used in many parts of the country. In many places, oxen are driven over the tef to tread out the grain. In other parts of the country, threshing is done with cows or donkeys. The working animals are driven in a circle round and

round on the threshing by one or two men at a time. Sometimes the working animals. mouths are tied during threshing so that they cannot eat the grain. Men, who push it into the centre with forks, *Andogo* or *Mansh*, keep tef on the threshing floor (Figure 14). After the top part of the tef bundles is broken or trampled out, the animals are driven out and workers start turning the broken tef under, starting from one side. After they have done this several times, the straw with some grain remaining in it is drawn aside with the *Mansh* and put in a long row (Figure 15).

Here it is beaten or flailed with a long, slender stick, usually eucalyptus or with a long curved stick usually made from *Milletia ferruginea*, known locally as *Birberra* or *Maytenus ovatus*, known locally as *Atat* or *Aule taffi* meaning stick for tef. When the *Aule Taffi* is used two men usually stand opposite each other along the row of straw and beat it in rhythm. Then the chaff with seeds is thrown up against the wind to separate the seeds from the chaff (Figure 16). Then the straw is pulled to the lower side of the *Awdemma* with the *Mansh* are removed with bundles of a branch of shrub called *Matoya* or *Abachara*.

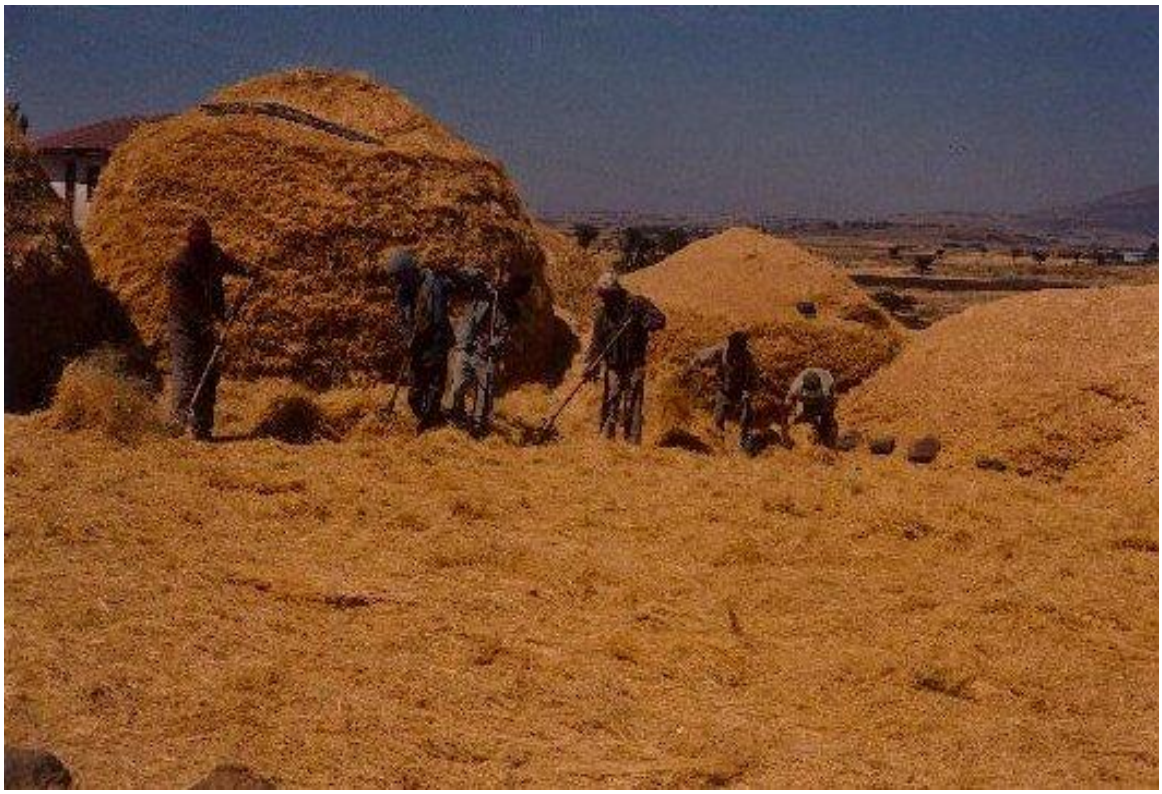

**Figure 14:Separation of the tef chaff from the seeds after threshing on the ground.**

The grain, with a lot of chaff called *Galaba* is then swept to the centre or to one side of the *Awdemma* with dried kale heads tied into a small bunch *Matragiya* or with wooden shovels, *Layada* or *Lahada*.


**Figure 15:Separation of the tef chaff from the seeds using the air current.**

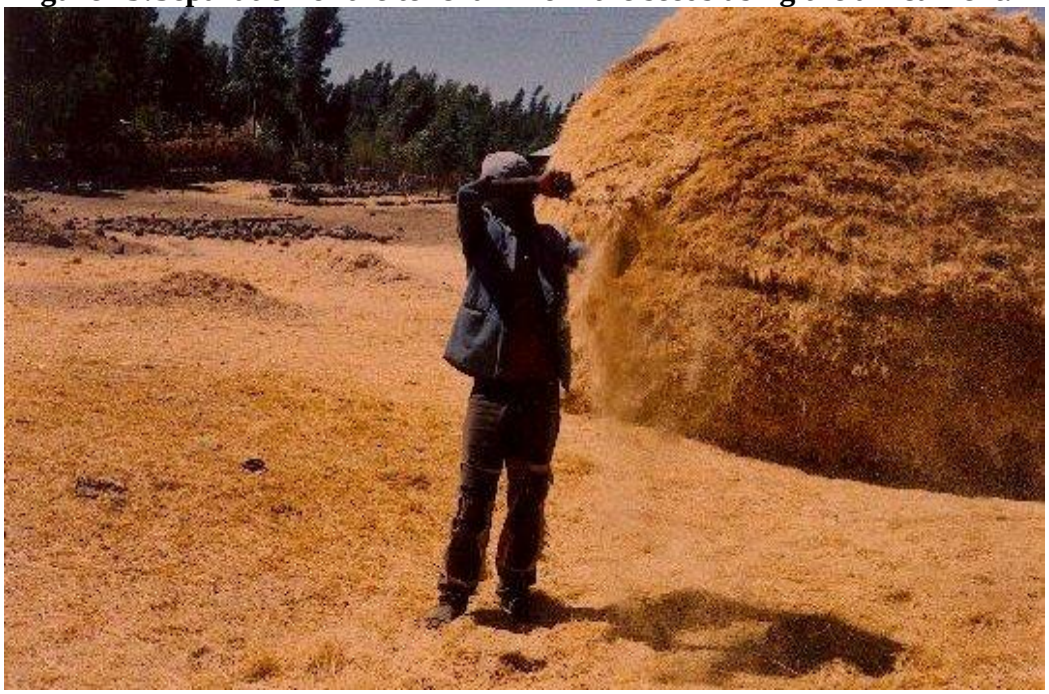

**Figure 16:Separation of the tef chaff from the seeds using the wind.**

The remaining chaff is then separated from the grain by wind. In this work a farmer will put a small amount of tef seeds together with small sized chaffs inside a *Sefed*. A *Sefed* is a kind of a fan woven from grass stems (Figure 17). This fan is used for a lot of post harvest operations. This operation is carried out by raising the fan above the farmers height and letting it drop smoothly so that the blowing wind will separate the seeds from the chaff. Winnowing (Figure 18) will then separate the chaff that cannot be removed by the above-mentioned work. The remaining inert materials are removed by fanning with an *Afarssa* or *Maragabiya* or small *Sefed*. The *Maragabiya* is a small piece of stiff skin from a wild hog or the head of oxen with semi-circular wooden handle (Taddesse, 1969).

In some areas thresher machines are used to thresh tef. However due to the incompatibility of the sieves which are specifically made for other crops, small sized tef seeds escape along the chaffs. Work to improve and evaluate the thresher for tef indicated that increasing the number of bars on the drum from six to twelve and replacing the rasp bars with 40 by 40 angle iron reduced threshing losses from 31.5 percent to 2 percent (IAR Annual Report, 1996). Hence, rethreshing tef could be avoided and threshing losses can be minimized with the right modifications and a proper workshop to assemble the drum-concave. During testing, it was observed that rethreshing was easier with the new modifications than with previous threshing units. However, economic analysis as well as economic loss due to different threshing, cost and equipment maintenance, as well as labour inputs has not been well determined.

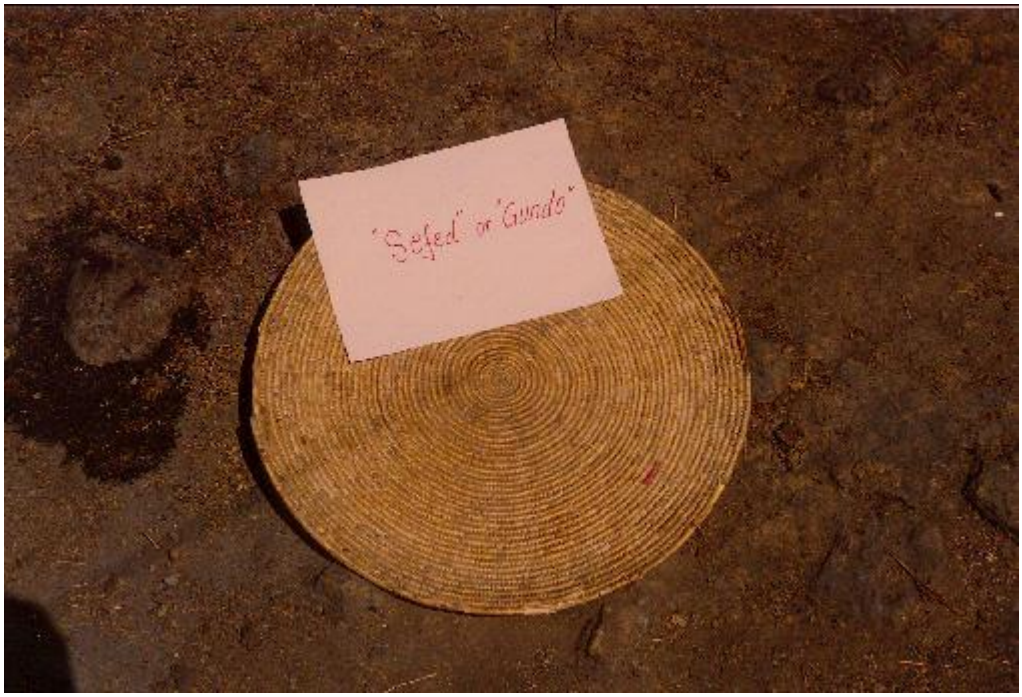


**Figure 17:Sefed also called Gundo.**

## 2.3 Cleaning

Women usually separate chaff from grain. The woman usually takes a container full of grain and chaff and winnows it from a long strip. When she reaches the end of the row another person using a *Maragabiya* starts fanning away the chaff that is too heavy for the wind by swinging the *Maragabiya* to and throws over the grain. The woman then takes another container of grain and winnows it by adding another layer over the previous one. It is fanned again and again with a Maragabiya. This process is repeated until the cleaning is finished. Sieves remove the heavy particles and dirt. If sieves are not available a bundle of kale heads is tied together right at the bottom and the grain is poured over it so that the grains pass through this bundle while the dirt remain in the bundle. More cleaning work is done by women through sieving many times in their homes (Taddesse, 1969).

A farmer grades his tef into two grades while it is on the *Awdemma*. When winnowing, the light grains fall away from the centre of the windrows. These grains are considered to be of low quality and are called *Gerd* while the heavy ones fall in the centre of the windrow. These are high in quality. The *Gerd* that contains dirt and chaff is used for poultry and cattle feed (Taddesse, 1969).

**Figure 18:Separation of tef seeds and chaff by winnowing.**

## 2.4 Utensils for measurement

After cleaning, the grain is measured and stored in different types of storage facilities. There are many different kinds of measuring devices or utensils used. These differ in different communities, but the ones most commonly used are *kunna* and *Enkeb* (Figure 19), which vary slightly from one village to another. It usually has a volume of 4-5 kg and is made from wood, earthenware or grass stalks. Another measuring device is known as *Enkeb*. This is a basket, is equivalent in volume to 3-4 *kunnas*. A *Dawula* is the other measuring unit. There is no container to measure a *Dawula* but it is an imaginary container which will hold about 20 *kunna* or 4-6 *Enkebs*. Other types of measuring devices are fibre and cloth sacks and *Akomada* which is a sack made from goat or sheep skin. Many other measuring methods are used, but are far too many to mention here.

**Figure 19:Utensils for measurements: Kunna and Enkeb.**

The farmer measures his crop to determine how much he can sell and how much he must retain for his family's use and for seed (Taddesse, 1969).

## 2.5 Packaging

Farmers pack their produce in different packing materials, which are either the traditional types such as *Akomada* or the modern packing materials such as plastic bags, sisal or plastic sacks. The traditional ones are not preferred because of the odour that could affect the quality of the produce. Modern packaging materials, especially plastic sacks, are much better since they prevent water from penetrating into the seeds. The size of packaging materials differs according to the amount of the seed to be stored or to be transported. For sale at the local market, small plastic sacks are preferred while for long distance transport, export sacks of bigger sizes which contain 100kg tef are preferred. Packing is done within the family. Mostly women put the grains in the sacks and males close the sacks by hand sewing or tying with sisal or jute fibres.

## 2.6 Storage

After the grain is threshed, cleaned, and measured at the threshing ground it is stored in the house or outside. Today, outside storage is not seen, unless it is in very remote areas. Farmers justify that this is due to theft occurring from time to time. The seeds are already dried at the time of harvesting and threshing. There is not as such quantified moisture content of seed for storage. The moisture content of tef during storage as for other cereals is about 12 percent. Normally seeds are dried in the open air under natural sun heat that will decrease the moisture content of the seeds. Up to now there is no artificial drying facility for tef. Since it is dried during harvesting and storage, the shelf life of tef is longer and can be stored quite safely for several years. Tef seeds are stored for seed reserve for the next cropping season, for human consumption, for trade and at the cooperative and governmental level for food reserves. The government is buying tef seeds for human consumption from different teaching institutions, hospitals, and military institutions and for food reserves. Tef as a food reserve is used during periods of famine in the country.

Usually tef is moved from a highly productive area to drought prone areas. A 3kg of tef flour, 480g of *Ersho*, 10 kg of water (6kg of water for dough and 4kg of water for baking) will make 18 *Enjeras* each *Enjera* weighing 450g (ENI, 1980). Accordingly, a family of three, consuming 6 *Enjeras* a day, needs only 190 kg of tef as a food reserve, which will last six months. Storage is in baskets, pots, *Gotera* and *Gusgusha* or *Gugusi*, *Gota* or *Gumb*i, in barrels (Figure 20) and *Debgnt* or *Doggo*

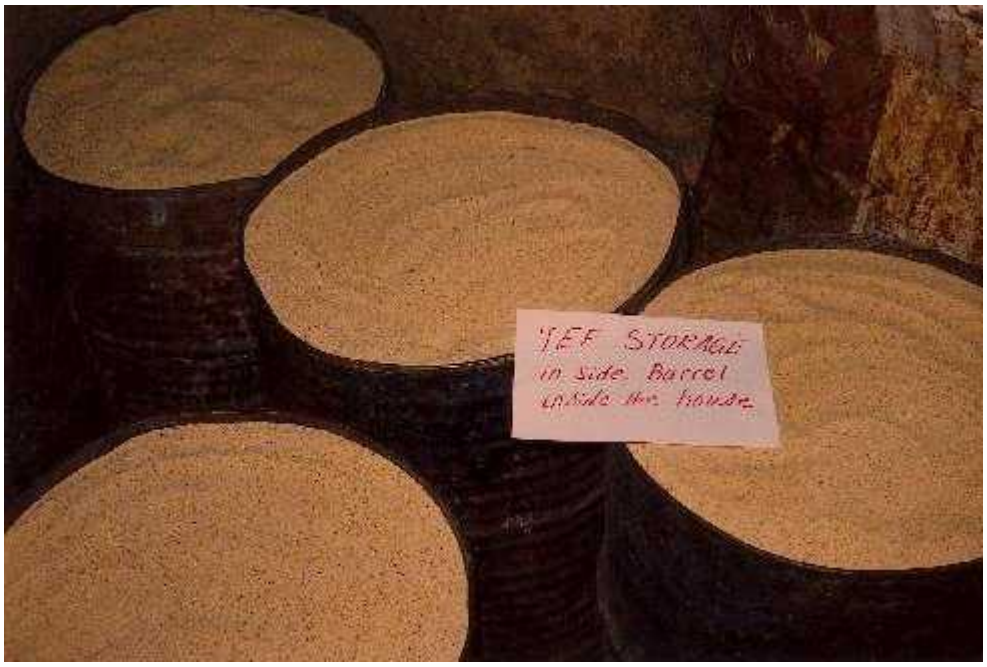


**Figure 20:Tef storage: Tef stored inside barrel and placed inside the store or the house.**


**Figure 21:Tef storage: Tef stored inside Debgnt also called Doggo, which is placed inside the house.**

There are several kinds of granaries; the most common ones are mentioned here. These containers can be made in one piece or from 2-3 or more pieces fitted together. Usually a container made in one piece is called a *Gusghusha* or *Gugusi*. It is mostly used for one kind of grain. The one made of many pieces or sections are called *Gota* or *Gumbi*. These are used for more than one type of grain. When the grain is all used from the upper section, the housewife can lift up the upper section and use the grain below. Children can get into the storage, *Gota* from the top and hand out the grain in small containers. The size of a *Gusghusha* and *Gota* depends on the amount of grain one has. These granaries are usually raised from the ground on pieces of stones placed at the corners. They are moveable and can be used for a number of

years if well made. There is a larger type of granary referred to as *Gotera*(Figure 22). Richer farmers having a large amount of grain usually use them.

**Figure 22:Tef storage: Gotera built in the house with different sections inside.**

The size of this sort of granary varies in size, i.e. from a larger *Gota* to one "that measures 3. 4 meters or more in diameter depending, of course, on the amount of grain. A *Gotera* is usually circular or rectangular in shape made from wickerwork and cemented with mud. It is reinforced with tef straw, both inside and outside. During the last ten to twenty years, it has been placed outside the house raised from the ground on short posts with a moveable conical thatched roof. However, nowadays it is built with the house to protect their produce from theft. Different varieties of tef (Figure 23) or other crops are stored in a *Gotera* by putting a layer of tef straw and chaff between the grains.

**Figure 23:Tef storage: Tef seeds stored inside Gotera.**

Tef can be stored or conserved for many years in practically any kind of storage system without any appreciable change or damage from insect pests, if vermin and water are exclude from the storage bins. Some farmers store chickpea and other pulse crops along with tef. This is due to the minute size of the tef seeds, which could hamper the movement of weevils inside tef seeds and the low level of oxygen by closing air holes. Small farmers store their grain in an upright earthenware container made from mud reinforced with tef straw and sun dried during the dry period. These are placed in the house. In some areas in the vicinity of Jimma, farmers store their grain on straw (before threshing) in their granaries. In these, the sheaves are counted when they are put up. The wife takes a sheaf or more according to the size of the family and threshes it on a fine woven mat or basketry by hitting it with a small stick or by rubbing the panicles between her palms. Grains, such as sorghum and corn, are stored under ground in some parts of the country, for example in Harar, but it is unusual for tef to be stored in such pits (Taddesse, 1969).

In all of the storage facilities mentioned above, the farmers monitor and maintain the systems themselves. The major defects of these storage facilities are:

- there cannot be observed in an in-first out system;
- they are very liable to rodent attack;
- water could easily penetrate into the storage container, which could deteriorate the quality of the produce.

Communal or cooperative storage facilities are very rare and farmers. cooperatives and/or Ministry of Agriculture make use of these. However, in such storage facilities, fumigation is not used. Storage facilities under government and/or traders are very large. The roofs are made from corrugated metal sheets. The walls are either made of bricks, cement blocks or wood cemented with mud. The floors are made of cement. The store can be used for different kinds of cereals. Large sacks filled with seeds are stored there (ca. 100kg). Tef is not attacked by weevils, therefore it does not need storage pest control chemicals, and can easily be stored under local storage conditions. This makes it an ideal stored food and the basis of an alternative, low-cost, low-risk Food Security Reserve System (FSRS).

In some parts of the country including the main grain store in the capital, Addis Ababa, imported modern storage bins can be seen. In these kinds of storage bins the principle of first in first out method is easily implemented. Attack by rodents and water leakage is minimal.

## *3. Overall losses and pest control*

**Yield Loss Because of Lodging**

Lodging is a serious problem in tef cultivation. No lodging-resistant varieties have been developed so far. No acceptable agronomic practices have been developed to control it. Using lower seed rates and late sowing dates decreased the problem of lodging.

**Table 14. Weight gains of steers fed on crop residue-based diets for 116 days, Holetta, (1974/75).**

| Roughage Source | Initial weight (kg) | Final weight (kg) | Daily intake (kg) | Feed per kg of live weight gain | Daily gain (g) |
|---|---|---|---|---|---|
| Tef straw | 186.0 | 258.8 | 6.9 | 11.0 | 628 |
| Wheat straw | 185.0 | 225.9 | 5.0 | 14.2 | 352 |
| Oats hay | 182.0 | 231.9 | 5.5 | 12.8 | 430 |
| Native hay | 184.3 | 239.6 | 5.9 | 12.4 | 477 |

Source: (Lulseged and Jemal, 1989, citing IAR, 1975)

**Table 15. Yielding ability of three different tef varieties under different growth conditions.**

| Variety | Farmers' Condition (kg/ha) | Experimental Lodged Condition (kg/ha) | Experimental Non-lodging Condition (kg/ha) |
|---|---|---|---|
| DZ-01-94<br>DZ-01-354<br>DZ-Cr-37<br>National Average | 2 000-2 500<br>1 700-2 200<br>1 700-2 200<br>890 | 2 400-3 400<br>2 400-3 200<br>1 800-2 800 | 4 600<br>4 100<br>4 200 |

Source: EARO, 1999.

However, these are not the accepted and refined recommendations, since no contingencies have been developed to counterbalance their negative effects on grain yield. Lodging causes damage to the vegetative part of the plant, due to rotting and the fast spread of pests and diseases; it renders the straw relatively useless as fodder and also reduces grain yield. The overall loss in grain yield due to lodging is estimated to be within the range of 11-22 percent with an average loss of 17 percent. It significantly lowers 1 000 seed weight by 35 percent, reduces grain yield per panicle by 51 percent and decreases percentage of germination.

## *4. Pest Control*

*Tef Diseases*

In general, tef suffers less from diseases and insect pests than the rest of cereal crops grown in Ethiopia. No exhaustive research has been done with regard to tef diseases in order to determine how many kinds of diseases of tef exist and what harm these diseases cause. Until now about 33 types of diseases (fungus and nematodes) have been recorded in most parts of tef growing areas.

### 4.1 Relative Status of major pest species

*Tef Insect Pests*

The insect pests recorded and their pest status is given in Table 16. Among these insect pests the Welo bush-cricket (*Decticoides brevipennis* Ragge), locally it is known as *Degeza* , is probably a new species to science. This tettigoniid was virtually unknown until the early 1970's when the first outbreaks occurred in Welo province. By 1974, the outbreak had spread to most of the western Welo and the insect had become a major pest of tef, wheat and sorghum.

*Storage insect Pests*

According to McFarlane and Dobi (1972), the attacking and damaging effects of eight storage insect pests on tef and wheat were investigated. The pests used for their study were *Sitophilus oryzae, Rhyzoperha dominica, Sitotroga cerealella (Oliv.), Trifolium castaneum (Herbst), Trifolium destructor (Uyttenb.), Oryzaephilus surinamensia* (L), *Cryptolestes pusillus (Schon.),* and *Ephestia cautella (*Wlk.). The results indicated that under experimental conditions, where insects were reared at 27$^{o}$C and 70 percent R.H., all the eight species were able to attack wheat, while *Trifolium castaneum* (Herbst) was the only insect capable of multiplying itself effectively on undamaged whole tef and predominantly fed on the grain embryo. *T. destructor* Uytt. *Ephestia cautella* (Wlk) showed some ability to produce surviving progeny on whole tef but is unlikely to become serious pests. *Cryptolestes pusillus*

(Schonh.) was able to infest tef in the presence of other insect species and also multiplied effectively on milled tef, which suggests that, it is the nature of the intact seed that prevents infestation in the absence of *T. castaneum.* It should be noted that evens this finding was obtained under experimental conditions, where temperature and relative humidity were controlled to create a favourable environment for the insect. Results of experiments conducted in Ethiopia under natural environmental conditions and traditional storage systems, indicate that tef does not incur any loss as a result of damage by any storage insect pests (Table 17). According to Yemane and Yilma (1989), weight loss studies conducted on grains under traditional storage conditions indicated that emmer wheat showed the lowest weight loss of 0.6 percent, followed by tef 1.9 percent, and thus were the only cereals that were not damaged at all. The weight loss of emmer wheat was attributed to rodents while that of tef was attributed to leakage caused to the stores by rodents and birds. The weight loss of maize was 3.5 percent, of wheat 4.2 percent, and of barley 4.5 percent. The report also stated that the nutrient loss of tef under storage conditions was relatively low (Table 8).

**Table 16. Insect pests of tef recorded in Ethiopia.**

| **Scientifc Name** | **Common Name** | **Status** |
|---|---|---|
| Ailopus simulatrix (Walier) | Clay grasshopper | Uncertain |
| Atherigona hyalinipennis (Emden) | Shootfly | Uncertain |
| Atherigona sp. | Shootfly | ---- |
| Delia arambourgi (Segny) | Barley fly | Major |
| Decticoides brevipennis (Ragge) | Wello bush cricket | Major |
| Diuraphis noxius (Mordv.) | Russian wheat aphid | Minor |
| Epilachna similis (Thumberg) | Tef epilachna | Minor |
| Erlangerius niger (Weise) | Black tef beetle | Major |
| Eysarcoris inconspicuus (Harrich-Schoeffer) | | Uncertain |
| Macrotermes subhyalinus (Rambur) | Mendi termite | Major |
| Mentaxya ignicollis (Walker) | Red tefworm | Major |
| Medicogryllus sp. | Crickets | Uncertain |
| Rhopalosiphum maidis (Fitch) | Maize aphid | Minor |
| Rhopalosiphum padi (L.) | Oat aphid | ---- |
| Spodoptera exempta (Walker) | Armyworm | Sporadic |

Source: Adugna and Kemal, (1966)

*Rodents*

Rodents are the vertebrate pests of many crops both in the field and in storage. However, the extent a percentage of the damages and losses incurred is not well known. Beside their direct feeding damage, they are also responsible for damage to quality in such a way that the older tef seeds will change. In some cases rodent faeces are also observed.

**Table 17. Physical grain damage by types of grain and storage**

| Type of grain | Damage (%) Initial | Damage (%) Final | Type of store | Period of Storage(months) |
|---|---|---|---|---|
| Cereals | | | | |
| Tef | 0.0 | 0.0 | *Gotera* (new) | 13 |
| Wheat | 0.0 | 2.0 | *Gotera* (new) | 13 |
| Corn | 4.7 | 11.1 | *Gotera* (new) | 12 |
| Sorghum (alt. 1 780m) | 7.0 | 34.6 | Underground pit (new) | 8 |
| Sorghum (alt. 2 050m) | 1.7 | 19.2 | *Gotera* (new) | 13 |
| Barley (alt. 3 110m) | 0.0 | 1.0 | *Gotera* (old) | 13 |
| Barley (alt. 2 050m) | 0.0 | 5.5 | *Gotera* (old) | 13 |
| Emmer wheat | 0.0 | 0.5 | *Gotera* (old) | 13 |
| **Average** | 1.7 | 9.2 | | |
| **Legumes** | | | | |
| Horse bean | 4.2 | 40.2 | *Gotera* (new) | 13 |
| Chickpea | 0.2 | 26.3 | *Gotera* (new) | 13 |
| Field pea | 2.9 | 6.6 | *Gotera* (new) | 13 |
| Vetch | 0.0 | 25.6 | *Gotera* (new) | 13 |
| Lentil | 1.4 | 12.8 | *Gotera* plastered with cow dung (new) | 13 |
| Lentil | 1.4 | 5.4 | *Gotera* plastered with clay (new) | 13 |
| **Average** | 1.7 | 19.5 | | |

Source: Yemane and Yilma, (1989)

# *5. Economic and social considerations*

## 5.1 Major problems

*Limitations and Prospects for Improving Tef*

The small size of tef seed poses problems during sowing, and indirectly during weeding and threshing. At sowing the very small seed size makes it difficult to control population density and its distribution. This remains true whether one sows the seed by hand, uses a sower or a seed driller. The plants stand unevenly after germination and have a nutrient efficiency use of the crop and crop yield. Owing to scattered plants, farmers find it difficult to use mechanical weeding implements and are forced to either hand-weed or use chemical herbicides.

**Table 18. Percent of labour and time inputs of male and female farmers in crop and livestock production in sample surveyed areas of three regions in Ethiopia.**

| Agricultural Activities | Amhara region | | | | | | Tigray region | | Southern region | |
|---|---|---|---|---|---|---|---|---|---|---|
| | North Wello | | West Hemra | | Eastern | | Southern | | North Omo | |
| | M | F | M | F | M | F | M | F | M | F |
| Crop production | 50 | 50 | 50 | 50 | 42 | 58 | 53 | 47 | 66 | 34* |
| Livestock production | 48 | 52 | 55 | 45 | 23** | 52 | - | - | 33 | 77 |

* A crop known as *Enset* is the main crop of the surveyed sample areas in North Omo and about 60 percent of the activities are done by women.

** Children or hired labour usually undertake herding activities.

Source: Summarized from Women in Development Program Proposal: UNECA: Amhara National Regional State Vol. IX; Eastern and Southern Tigray, Vol. IX, 1997 and Vol. IX, 1998; and Southern Nations Nationalities and peoples Regional State, IX, 1997. Addis Ababa, Ethiopia. (As cited by Wundensh Hailu, 1999).

Threshers or combine harvesters are used to thresh tef. However, seed loss is incurred because tef seed is very small and light and gets blown away with the chaff. Harvesting of the crop is difficult because of lodging. Since tef lodges heavily it is not advisable to use higher rates of fertilizer to increase yield. The current landraces and cultivars used are not lodging resistant and the development of genetically lodging-resistant cultivars is essential. Landraces and current cultivars give a low yield.

At present the national average grain yield of tef is 910 kg/ha. Improved varieties of tef give a grain yield of 1 700-2 200 kg/ha on farmers' fields and 2 200-2 800 kg/ha under research-managed large farms. However, no comprehensive study has been conducted to assess the yield potential of the crop.

The study of 2 255 accessions of tef have demonstrated the high yield potential of the crop. Thus, it is not fair at this point to state that a low yield is one of the genetic limitations of the crop. The crop has great potential for improvement and could give more that 6 t/ha if it receives adequate research attention. Low grain yield and production constraints such as lodging, drought, water-logging, heat and frost might be overcome through a comprehensive plant breeding program since there exists a genetic variation in tef germplasm for these traits. In addition to using the existing genetic variation to overcome some of the production constraints, development of improved and appropriate agronomic practices and cropping system would greatly contribute to overcoming production constraints and improving the productivity of the crop. An improved agronomic practice does include appropriate seed rate, sowing dates, seedbed preparation, fertilizer type, rate and time of application. The cropping

systems also includes crop sequence, relay cropping, intercropping, etc. (Seyfu, 1993, IAR, 1993 and Seyfu, 1997).
The gaps in current germplasm collections and suggestions made for future action, both of which were indicated earlier, need to be addressed in order to utilize the germplasm and overcome present constraints. Targeted collecting of germplasm from stress areas such as waterlogged areas, low-temperature and drought-prone areas, etc. would be useful. Development of rapid and cheap screening techniques to identify various stress-tolerant cultivars and identify and utilize efficient breeding or biotechnology techniques for developing superior cultivars are essential in order to overcome the present constraints.
By comparison to other grain crops, no regional or international research network exists and improvement work is mainly confined to Ethiopia. The progress in improvement work on tef has not been as rapid as on other major cereals consumed worldwide. This is mainly due to the fact that tef is only consumed in Ethiopia at present. Hence, contrary to wheat, maize or rice, the combined research funds in billions of dollars and the efforts of thousands of scientists from different nations have not been oriented to its improvement. At present, Ethiopia is the only country providing the major input for both research funds and the scientists who work towards its improvement. Therefore, the lack of rapid progress in research is not due to the fact that the crop cannot be improved, but only because of limitations in funds and research personnel. Even with the limited amounts of funds and research personnel made available, progress in both basic as well as applied research so far is encouraging (Seyfu, 1997).

## 5.2 Other: The Role of Women in Tef Production and Utilization Process

The gender pattern of labour utilization is often referred to as the *triple roles* of gender. These are productive, reproductive and community management roles. In Ethiopian agriculture the role of women is very high especially in post harvest production system though it is not well quantified. The main source of labour is the family, which includes the wife and the children. The average family size in most places, especially in the highlands of Ethiopia where tef is the main crop, is more than six people per household. It is noted that over 50-80 percent of the labour force required in crop, livestock production as well as in environmental rehabilitation is provided by female farmers in rural Ethiopia and elsewhere in the world (UNECA/WARDIS, 1997 and Tamirie, 1995 as cited by Wundensh, 1999). In the Ethiopian context, females are actively involved in the following farming activities, though the degree of their involvement might vary due to various reasons such as traditional/religious influence and type of farming system.
Seed Cleaning
Land preparation called *Gulgualo*
Sowing/planting
Weeding and applying manure
Hoeing
Scaring of birds
Harvesting
Preparation of threshing fields (includes provision of dung, water and smearing the ground)
Collection and pilling
Winnowing
Storing of produce and care of stored seeds
Food preparation for labour assistance or hired labourers in the field
Most of the post harvest operations such as cleaning, milling or taking to the milling plants, preparation and baking of food for the family.

The role of Ethiopian women in tef production system alone is not quantified enough. Some attempts were done to quantify their role in either crop production or livestock husbandry in some regions of Ethiopia (Table 18). In tef production activities, males do most of the field activities from ploughing till threshing, storage and transport. Women have important role mostly in weeding; harvesting or collecting of harvested plants, preparation of threshing ground, transportation and selling of the seeds and the straw in the cities and towns. The rest of the activities such as milling of tef and preparation of food in different forms including the sausages such as *Wot* are exclusively left to the women. However, males and females participate according to their division of labour in some organizations, hotels, teaching institutions, hospitals, military feeding centres, drought affected areas feeding centres, etc. mostly in the post harvest operations.

A study was made in predominantly tef growing areas of Ada, Lume and Gimbichu districts of the central highlands of Ethiopia in 1997 (Table 19). In this study, it was observed that unlike some African countries where the gender division of family labour by agricultural production is becoming less distinct, no woman farmer is found to have been engaged in land preparation and planting. The role of women in tef production was observed during weeding, harvesting, transporting, threshing and storage. Preparation of tef for food is accepted in the study district as a woman's job.

**Table 19: Gender division of family labour by tasks of agricultural production in Ada, Lume and Gimbichu woredas, 1997**

| Tasks of agricultural production | Ada | | Lume | | Gimbichu | |
|---|---|---|---|---|---|---|
| | MHH* | FHH** | MHH | FHH | MHH | FHH |
| 1. Land, Preparation Average no. of days | | | | | | |
| Head | 34 | - | 21.5 | - | 30 | - |
| Son | 29.3 | 29.8 | 26.6 | 28.2 | 20.3 | 19.6 |
| Relatives | - | 28.7 | 40 | 32 | 14.3 | 19 |
| Non-relatives | 27.8 | 31.4 | 16.4 | 28.2 | 29 | 20.8 |
| Average hours per day | | | | | | |
| Head | 7.4 | - | 6.6 | - | 6.9 | - |
| Son | 7.1 | 7.5 | 6.6 | 6.5 | 7.8 | 7.6 |
| Relative | - | 6.7 | 6.2 | 6.8 | 6.4 | 6.2 |
| Non-relative | 6.5 | 8 | 7.4 | 6.4 | 6.9 | 7.1 |
| 2. Planting Average no. days | | | | | | |
| Head | 17 | - | 11.4 | - | 15.5 | - |
| Son | 14.1 | 13.1 | 9.2 | 13.6 | 14.7 | 13 |
| Relatives | - | 15.7 | - | 8 | 18.7 | 15.2 |
| Non-relatives | 16.5 | 15 | 9.2 | 12 | 14 | 14.1 |
| Average hours per day | | | | | | |
| Head | 8.6 | - | 7.9 | - | 8.6 | - |
| Son | 8.5 | 8.8 | 7.6 | 7.7 | 7.4 | 8.5 |
| Relative | - | 11.3 | - | 4 | 7.3 | 7.5 |
| Non-relative | 9 | 9.2 | 8 | 7.1 | 8.4 | 9 |
| 3. Weeding 3.1 First weeding Average no. of days | | | | | | |
| Head | 14.3 | 13.7 | 21.3 | 18.6 | 14.5 | 15.9 |
| Wife | 13.7 | - | 18 | - | 16.9 | - |
| Son | 22.6 | 20.9 | 26.3 | 26 | 19.3 | 20.2 |
| Daughter | 18.3 | 20.7 | 20.2 | 19 | 16 | 21.3 |
| Relative | 3.3 | 12.7 | 9 | 8 | 18.3 | 21.3 |
| Non-relative | 21 | 18.7 | 19.7 | 18.6 | 19.9 | 20.2 |
| Average hours per day | | | | | | |
| Head | 8.7 | 8.8 | 7.8 | 7.2 | 7.6 | 7.3 |
| Wife | 8.9 | - | 7.7 | - | 7 | - |
| Son | 9.1 | 8.5 | 7.7 | 7.8 | 7.3 | 7.8 |
| Daughter | 8.9 | 8.3 | 7.8 | 7.6 | 7.8 | 7.3 |
| Relatives | 9.5 | 8.5 | 8 | 9 | 6.3 | 8 |
| Non-relative | 8.4 | 9.2 | 7.9 | 7.3 | 7.7 | 7.2 |

| Tasks of agricultural production | Ada | | Lume | | Gimbichu | |
|---|---|---|---|---|---|---|
| | MHH* | FHH** | MHH | FHH | MHH | FHH |
| 3.2 Second weeding Average no. of days | | | | | | |
| Head | 6.7 | 8.6 | 7.8 | 9.6 | 4.7 | 3 |
| Wife | 7.1 | - | 7.9 | - | 4.5 | - |
| Son | 10.6 | 9.3 | 13.9 | 13 | 10.5 | - |
| Daughter | 12.4 | 9 | 9.2 | 8.3 | 8 | 10 |
| Relatives | 11 | 7.7 | - | 4 | - | - |
| Non-relatives | 13 | 10.3 | 10.3 | 10.7 | 2 | - |
| Average hours per day | | | | | | |
| Head | 7.7 | 9 | 6.8 | 7.8 | 9 | 7 |
| Wife | 8 | - | 7.2 | - | 9 | - |
| Son | 8.4 | 8.5 | 6.6 | 8.8 | 8.9 | - |
| Daughter | 7.2 | 8.3 | 6.1 | 7.8 | 8.5 | 9 |
| Relative | 7.5 | 5.5 | - | 9.5 | - | - |
| Non-relative | 7.7 | 8.3 | 7.5 | 9.3 | 8 | - |
| 4. Harvesting Average no. days | | | | | | |
| Head | 12.2 | 3.2 | 11.2 | 6.4 | 18.9 | 7.2 |
| Wife | 4.1 | - | 6.1 | - | 5.3 | - |
| Son | 16.5 | 16 | 12.1 | 11 | 21.5 | 23.4 |
| Daughter | 6.3 | 6 | 5.2 | 8.2 | 9.9 | 10.7 |
| Relatives | 20.3 | 16.5 | 9.1 | 9.8 | 17.1 | 20.7 |
| Non-relatives | 0.2 | 15.4 | 12 | 8.3 | 25 | 27 |
| Average hours per day | | | | | | |
| Head | 7.7 | 7.4 | 7.2 | 6.5 | 8.8 | 7.1 |
| Wife | 7.2 | - | 6.8 | - | 7.8 | - |
| Son | 7.5 | 8.2 | 7.1 | 7 | 8.7 | 8.6 |
| Daughter | 7 | 5.3 | 7.5 | 8.1 | 8.1 | 8.1 |
| Relatives | 8 | 8.2 | 7.8 | 7.8 | 8.5 | 8.1 |
| Non-relative | 7.9 | 7.9 | 7.3 | 7.4 | 8.4 | 7.5 |

| Tasks of agricultural production | Ada | | Lume | | Gimbichu | |
|---|---|---|---|---|---|---|
| | MHH* | FHH** | MHH | FHH | MHH | FHH |
| 5. Transporting Average no. of days | | | | | | |
| Head | 9.6 | - | 9.4 | 5.7 | 10.6 | 6.9 |
| Wife | 8.5 | - | 8.9 | - | 8.3 | |
| Son | 16.9 | 11 | 12.1 | 9.2 | 13.8 | 12.5 |
| Daughter | 10.1 | - | 7.7 | 9.3 | 7.3 | 7.8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Relatives | 17.1 | 9.2 | 21.7 | 19.2 | 10.4 | 20.1 |
| Non-relatives | 9.7 | 11.8 | 11.3 | 5.2 | 15.3 | 17.6 |
| Average hours per day | | | | | | |
| Head | 6.9 | - | 7 | 6.6 | 6.2 | 5.8 |
| Wife | 6.4 | - | 7.2 | - | 6.5 | - |
| Son | 6.7 | 7 | 7.1 | 6.8 | 6.2 | 5.7 |
| Daughter | 6.5 | - | 7.3 | 7.2 | 6.8 | 5.8 |
| Relative | 7.4 | 6.8 | 7.8 | 8.5 | 6.3 | 6.1 |
| Non-relative | 7.2 | 6.7 | 6.5 | 7.5 | 5.9 | 5.9 |
| 6. Threshing/storage Average no. days | | | | | | |
| Head | 13 | 4.7 | 16.4 | 9.5 | 11.9 | 7.2 |
| Wife | 7.1 | - | 10.8 | - | 8.3 | - |
| Son | 17.8 | 14.1 | 19.5 | 19.1 | 14.5 | 12.6 |
| Daughter | 12.9 | 3.3 | 8.5 | 16.4 | 9.3 | 7.9 |
| Relatives | 22.5 | 10.4 | 9.6 | 14 | 6.2 | 11.1 |
| Non-relatives | 18.3 | 13.3 | 19.1 | 12 | 18.3 | 9.9 |
| Average hours per day | | | | | | |
| Head | 8.6 | 6.5 | 8.5 | 7.9 | 8.7 | 6.5 |
| Wife | 6.9 | - | 7.7 | - | 7.9 | - |
| Son | 8.8 | 8.8 | 8.6 | 8.5 | 8.8 | 8.6 |
| Daughter | 7 | 9 | 8.1 | 7.3 | 7.6 | 7.6 |
| Relatives | 7.7 | 7.8 | 8.4 | 8.4 | 7.3 | 8.2 |
| Non-relative | 10 | 8.4 | 8.2 | 8.9 | 8.6 | 8.2 |

* MHH = Male Headed Households.
** FHH = Female Headed Households.

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# *7 Annex*

## 7.1 Annex - Glossary of Local Terms

Local Terms English Translation

Absit (A)* Fermented paste mixed with water, boiled and added to the fermented batter just before baking *Enjera.*

Abachara (O) A bundle of branchy shrub used to remove straws which are too small to be removed with *Mansh***.** (see also **Matoya (A)**)

Afarssa (O) Small piece of stiff skin from a wild hog or the head of cattle with semicircular wooden handle used as a fan. (see also **Maragabiya (A)**)

Aflangna (A) A very heavy cake, thicker near the edge than at the centre, baked from relatively unfermented dough. (see also **Chumbo (O)** and **Bekuo (T)**)

Akembalo (A) Concave shaped cover for a *Metad.*

Akomada (A) A sack made from goatskin.

Alecha (A) Sausage which is tan (yellow) in colour and made of meat and /or pulse, potato etc.

Annababaro (A) *Enjera* made by doubling tow ordinary thin *Enjera.* (see also **Chabetta (O)** and **Hansa (T)**)

Arake (A) Native alcohol (see also **katikalla (O)**)

Atat (A) *Maytenus ovatus.*

Aule Taffi (O) A slender stick or a long curved stick used for flailing grain.

Awdemma (A) Threshing ground.

Baggi (O) *Combretum paniculatum.*

Barbarre (A) pepper; *Capsicum frutesens* or *C. abyssinicum.*

Bawuza (A) **A thick strong Tella made from ref tef.** (see also **Embushbush (A)**)

Bedde (O) A small concave *Metad.*

Bedena Balla (O) This is a loaf of *Enjera* baked in leaf with a lot of spices. (see also **Dabbo (A)** and **Mugara (A)**)
Bedena Galla A large loaf with sweet flavour made in leaves from a fermented thick batter with spices, such as onion, garlic, black cumin, false cardamom, etc are added.
Bekuo (T) A very heavy cake, thicker near the edge than at the centre, baked from relatively unfermented dough. (see also **Aflangna (A)** and **Chumbo (O)**)
Belg (A) Ethiopian Autumn.
Berbera (A) *Milletia ferragenca.*
Bittile (O) A small flat bread like loaf baked in or on hot coal from unfermented batter, wrapped in leaves, used for between meal snacks for children. (see also **Daguwalo (T)** and **Eremmto (A)**)
Bogeto (O) A piece of wood with flat end used for stirring when making porridge.
Bola Obid (O) Shallow hole used to mix cattle dung manure and water for smearing the threshing ground.
Buhaka (A) Earthenware, wooden, gourd, or metal container for batter *Lit* for making *Enjera.*
Chabetta (O) *Enjera* made by doubling tow ordinary thin *Enjera or Tayeta.* (see also **Annababaro (A)** and **Hansa (T)** )
Ched (A) Straw of tef.
Chelfa (A) Wooden or metal dipper used to scoop out *Wot* (big spoon).
Dabbi (O) An early maturing variety of red (brown) grained tef.
Dabbo (A) A large loaf with sweet flavour made in leaves from a fermented thick batter with spices, such as onion, garlic, black cumin, false cardamom, etc are added.(see also **Bedena Balla (O)** and **Mugara (A)**)
Dabbo Kolo (A) Small hard bread balls made by roasting moistened tef or wheat flour. (see also **Hunkuro**)
Daguwalo (T) A small flat bread like loaf baked in or on hot coal from unfermented batter, wrapped in leaves, used for between meal snacks for children. (see also **Bittile(O)** and **Eremmto (A)**)
Dawella (A) A measuring unit for grain; it is an imaginary container which will hold about 20 *Kunnas* or 6-7 *Enkebs*.
Debo (A) Cooperative party where the neighbours help each other.
Dest (A) Earthenware bowl in which *Wot* is prepared.
Elle Chabetta (O) *Metad* used for baking *Tayeta*.
Elle Chumbo (O)*Metad* used for baking *Chumbo.*
Embushbush (A) A thick strong *Tella* made from ref tef. (see also **Bawuza (A)**)
Enjera (A) Ethiopian bread, which is circular, thin, porous and pancake-like with numerous eyes. The average thickness is about 5mm and the diameter is 35-50cm. It is sour tasting.
Enkeb (A) A measuring device which is a basket made from grass stocks and equivalent in volume to about 3-4 *Kunnas*.
Ensat (A) False banana, *Ensete ventricosum*.
Eremmto (A) A small flat bread like loaf baked in or on hot coal from unfermented batter, wrapped in leaves, used for between meal snacks for children. (see also **Bittile(O)** and **Eremmto (A)**)
Ersho (A) A fermented thin, yellowish fluid saved from a previous fermentation that will help newly made batter to ferment faster (yeast).
Fachassa (O) A plot of land which can be cultivated with a team of oxen in one working day. (see also **Messa (O)**)
Fersso (O) A native or local beer. (see also **T'ella (A)**)
Fetfet (A) *Enjera* broken or chopped into small pieces and mixed with *Wot*.

Gabata (A) Container with a rather flat top with cupped edge and flat base made of wood, used to eat *Enjera*.
Galaba (A) Chaff
Ganfo (A) Porridge
Gerd (A) Low quality grain that contain dirt and chaff usually used for poultry and cattle feed.
Geri (O) Army worm, *Spodoptera exempta.*(see also Tamch (A))Gommanzar (A) Rapeseed, Barassica sp.
Gota (A) A smaller container than *Gotera* with 2-4 piece or sections fitted together made from mud reinforced with tef straw, sundried and placed in the house. (see also **Gumbi (O)** )
Gotera (A) A large granary usually circular or rectangular in shape made from wickerwork and cemented with mud reinforced with tef straw. It is placed inside or outside with conical or rectangular thatched roof.
Gugusi (O) A kind of Gota made in one piece. (see also **Gusgusha (A))Gullecha (A)** Three small pieces of stone at the fire place upon which Metad or pot is placed during cooking or baking.
Gulo (A) Castor bean, Ricinus communis.
Gumbi (O) A smaller container than *Gotera* with 2-4 piece or sections fitted together made from mud reinforced with tef straw, sundried and placed in the house. (see also **Gota**) )
Gusgusha (A) A kind of Gota made in one piece.
Hansa (T) Enjera made by doubling tow ordinary thin Enjera. (see also **Annabaro(A)** and Chabetta (O))
Hongochy (A & O) A flat breads, bigger than *Enjera* made of unfermented batter.
Hunkuro (O) Small hard bread balls made by roasting moistened tef or wheat flour. (see also **Dabbo Kolo (A)**)
Kalawa (A) *Maesa lanceolate.*
katikalla (O) Native alcohol. (see also **Arake (A)**)
Kayy Shenkurt (A) Onion, *Allium cepa.*
Kayy tef (A) Red or brown grained tef.
Kayy Wot (A) Red *Wot.*
Kemmer (A) A large stack or pile of untrashed tef or heap of grain after trashing.
Kitta (A) Sweet dry bread made from unfermented dough. (see also **Matino (O)**)
Kodakomby (O) Mud made in a form of pot at the lower end of *Wefcho* to catch flour. (see also **Kuwat (A)**)
Kubbayya (A) A standardized measuring unit usually used in the market place.
Kunna (A) A measuring device for grains made from wood or earthenware has a volume of 4-5 kg.
Kuwat (A) Mud made in a form of pot at the lower end of *Wefcho* to catch flour. (see also **Kodakomby (O)**)
Lahada (A) Wooden shovel. (see also **Layda (A)**)
Layda (A) Wooden shovel. (see also **Lahada (A)**)
Lit (A) Batter or dough.
Luflufo (O) A loaf similar to *Bedena Balla* except that this one is very small, useed by travelers as a reserve food called*Senk*. (see also **Bedena Galla (A)** and **Tibbennya (A)**)
Manngna tef (A) First class white tef.
Mansh (A) A long wooden fork with three pointed prongs used in the course of threshing to separate straw from grin and for keeping the grain on the threshing floor.
Maragabiya (A) Small piece of stiff skin from a wild hog or the head of cattle with semicircular wooden handle used as a fan. (see also **Afarssa (O)**)
Marka Buko (O) Porridge made from batter.

Masfiya (A) A small can or gourd used to get batter from *Buhaka* and pour it on the *Metad*. (see also **Mazoriya (A)**)
Massa or Zar (A) A small piece of cultivated land of about 2 000-2 500 sq. m.
Matino (O) Sweet dry bread made from unfermented dough
Matoya (A) A bundle of branchy shrub used to remove straws which are too small to be removed with *Mansh***.** (see also **Abachara (O)**)
Matragiya (A) A small bundle of dried kale head used to sweep the grain with chaff to one side of *Awdemma* after the straw is removed.
Mawkariya (A) A round or oval stone used to roughen the *Wefcho* when it gets slippery and fails to grind well.
Mazoriya (A) A small can or gourd used to get batter from *Buhaka* and pour it on the *Metad* **.**
Medejja (A) Fireplace.
Megg (A) The top piece of stone grinder for grain that makes *Wefcho*, this piece is moved forward and backward by women to grind the grain.
Messa (O) A plot of land which can be cultivated with a team of oxen in one working day. (see also **Fachassa (O)**)
Messob (A) A rather slender basket with somewhat flat top and cupped edge made from grass stems used as plate to eat *Enjera*.
Metad (A) A circular almost flat earthenware pan oven on which *Enjera* is baked (a griddle for baking *Enjera*).
Mugara (A) A large loaf with sweet flavour made in leaves from a fermented thick batter with spices, such as onion, garlic, black cumin, false cardamom, etc are added.(see also **Bedena Balla (O)** and **Dabbo(A)**)
Muk (A) Soup like food made from batter of tef.
Mukacha (A) A mortar with a pestle.
Nach Azmud (A) White cumin.
Nach Shenkurt (A) Garlic.
Nado (A) Large bundle or sheaf of tef wheat, barley, etc.
Oromigna (O) A language of the *Oromo people.*
Sefed (A) It is a kind of basketry fan woven from grass stem. This is a multipurpose material used for cleaning, winnowing, and removing *Enjera* from the oven during baking.
Senk (A) A mixture of white and ref grained tef. Provision, food item carried by travelers, warriors, and traders to be consumed over relatively a longer time. (see also **Sergagna tef (A)**)
Sergagna tef (A) A mixture of white and ref grained tef. Provision, food item carried by travelers, warriors, and traders to be consumed over relatively a longer time. (see also **Sergagna tef (A)**)
Taf (T) Tef crop, *Eragrostis tef* (Zucc.) Trotter. Staple food crop of the Ethiopian people. (see also **Tef (A)** and **Tafi (O)**)
Tafi (O) Tef crop, *Eragrostis tef* (Zucc.) Trotter. Staple food crop of the Ethiopian people. (see also **Tef (A)** and **Taf(T)**)
Tamch (A) Army worm, *Spodoptera exempta.*
Tasa (A) A standardized measuring unit usually used in the market place.
Tef (A) Tef crop, *Eragrostis tef* (Zucc.) Trotter. Staple food crop of the Ethiopian people. (see also **Tafi (O) and Taf(T)**)
Tef Tara (A) A special location in the market place where tef is sold.
Tekur Azmud (A) Black cumin.
T'ella (A) A native or local beer. (see also **Fersso (O)**)
Tibbennya (A) A loaf similar to *Bedena Balla* except that this one is
Tigrigna (T) A language of the Tigray people.

Tuwe Marka (O) Pot for cooking porridge.
Wachett (A) A wooden or earthenware bowl.
Wefcho (A) Two hard pieces of stone, the bottom much larger than the top piece *Megg* used for grinding grain, spices, etc.
Wot (A) A kind of stew or soup made from meat, pulses or other vegetables, *Enjera* and *Wot* make up the Ethiopia national dish.
(A) Amharic language
(O) Oromigna language
(T) Tigregna language which are widely spoken languages in Ethiopia with out undermining the others.

## 7.2 Annex- Recipes

Operation Flow of baking *Enjera*
IngredientsTef flour (Brown or white) --- 32kg
*Ersho* ----- 480 g (Preserved from previous fermentation)
Water ------ 3 litre

Stir the whole content
↓
Add more 3 litres of water
↓
Stir the whole content until it is homogenized
↓
Cover the dough and leave it to ferment 2-3 days
↓
↙ After 3 days pour away that settled on top of the dough
Take half litre of dough↙ ↓
And a litre of water and boil Add 3 litre of cold water to the dough
(now called *Absit*)↓
Ø
Ø ↓
Mix *Absit* and the dough
↓
Stir well and allow 30 minutes to stand
↓
Put some dough in a can called *Mazoria*
↓
Pour the content on the *Metad* beginning from the outer edge to the centre in circular motion
↓
Cover the lid called *Akembalo* and wait for 3-6 minutes
↓
Take out *Enjera* and put it on the *Messob* with the help of *Sefed*

### *Annex 2b.*

Operation Flow of baking *Hongochy* or *Chumbo*
Mix tef flour mostly red (brown) tef and water so that thick and homogenized dough is formed
↓
↓
Clean big *Metad* & rub it with oil with a piece of cloth
↓

↓
Heat red hot a small *Metad* called *Bedde*
↓
↓
Pour the thick batter on the centre of the big *Metad*
↓
↓
Put the small *Metad* on top of the thick batter
↓
↓
Cover both *Metads* with the lid called *Akembalo*
↓
↓
Close all the surrounding edge with cloth, cattle dung or mud reinforced with tef straw
↓
↓
Wait for 2-4 hours
↓
↓
Take all the covers and take *Hongochy* or *Chumbo* out

### *Annex 2c.*

Operation Flow of baking *Annababaro* or *Chabetta* or *Hansa*

First bake *Enjera* according to the procedure indicated on Annex 2a. And take it out
↓
↓
Start to bake another *Enjera*, pour the dough called *Lit* on the *Metad*
↓
↓
Put the first baked *Enjera* on top of the second *Enjera* face down while the second is already on the process of baking on the *Metad*
↓
↓
Cover the lid and wait for 5-10 minutes.
↓
↓
Take them together and put them on the *Messob*

### *Annex 2d.*

Operation Flow of baking *Kitta* or *Mitino*
Mix tef flour and water to form thick unfermented dough
↓
↓
Work on dough to form flat dough
↓
↓
Put on the *Metad*
↓
↓

Wait for about 30 minutes
↓
↓
Turn the flat semi bread upside down
↓
↓
Wait for about 20 minutes
↓
↓
Take it out from the *Metad* and put it on the *Messob*

### *Annex 2e.*

Operation Flow of baking *Bedena Balla*
Mix tef flour & water to form thick batter
↓
Cover the dough and leave it to ferment 2 to 3 days
↓
After 2 to 3 days, add spices (Chopped garlic, chopped onion, ground black & white cumin, chopped ginger, false cardamom etc.) inside the dough
↓
Heat big *Metad*
↓
Put the first layer of leaves of false banana leaves called *Ensat*
↓
Pour thick dough layer
↓
Put the second layer of false banana leaves
↓
Pour thick dough layer
↓
Put the third layer of false banana leaves
↓
Cover the dough with leaves
↓
Put another big *Metad* face down
↓
Put fire on top of the second *Metad* and on the first *Metad* underneath
↓
Wait for about 1 to 2 hours depending on the thickness of the dough
↓
Take off the fire from the top *Metad* & remove the *Metad*
↓
Remove the loaf of bread called *Bedena Balla*, enjoy the aroma and test.

### *Annex 2f.*

Operation Flow of baking *Tibbenny*a
or *Bedena Galla* or *Luflufo*
Mix tef flour & water and leave it for one or one and half day to partially ferment
↓
↓
Add spices (chopped garlic, chopped onion, ground black & white cumin,

chopped ginger, false cardamom etc.) in the dough & mix well
↓
↓
Heat big *Metad*
↓
↓
Put the first layer of false banana leaves on the *Metad* top surface
↓
↓
Pour thick dough on the top of the leaves
↓
↓
Put the second layer of false banana leaves and try to make tight.
↓
↓
Wait for 1 to 2 hours depending on the heat intensity until it is partially baked
↓
↓
Turn upside down the half-baked bread
↓
↓
Wait until it is fully baked (about 1 hour depending on the heat intensity)
↓
↓
Remove all leaves and enjoy the test and the aroma.

### *Annex 2g.*

Operation Flow of baking porridge *Ganfo*
Option OneOption Two
Take thick fermented batter Boil water in a pot
↓↓
Pore inside pot Step by step add flour of tef with constant stirring
Boil (20 to 40 minutes)
Stir constantly
↓↓
Cool to normal temperature
Make very thick dough or batter
↓↓
Put on curved plates
Boil 20 to 40 minutes
↓↓
Put batter and spice at the centre
Put on curved platesof the porridge in which usually a hole is made to contain the spice and butter
↓↓
Feed with spoon made of different materials put batter & spices at the middle of the (animal horn, silver spoon, wooden spoon etc.) porridge in which usually hole is dug at the centre to contain them
↓
Feed with spoon made of different
materials
(animal horn, silver spoon, wooden spoon etc.)

***Annex 2h.***

Operation Flow of making soup called *Muk*
Take fermented batter
↓
Boil in pots (15 to 30 minutes)
↓
Add spices & butter
↓
Cool to normal temperature
↓
Feed with spoon.

***Annex 2i.***

Operation Flow of *Dabbo Kolo*
Take tef flour (white tef flour is preferred)
↓
↓
Mix with warm water to form thick dough
↓
↓
Take small amount if dough and rub is between
Palms to form slender dough of pencil size in diameter
↓
↓
Cut in small size to about field pea size with scissors
↓
↓
The grains them on put on warm, *mixed*
For 10 to 20 minutes
↓
↓
Stir them out & cool them
↓
↓
Feed them as tef bread grains