

# Nutritive content of indigenous fodder trees and shrubs in highland of Ethiopia

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## Abstract

The shortage of animal fodder is a priority problem in the mountainous landscapes of Ethiopia. Leaves of indigenous trees and shrubs species were used as a source of supplemental animal feed especially during dry season. Fodder trees are playing a crucial role to meet the deficiency of animal feeds in highland areas during the dry season. To know the preference of the farmers' and nutritive content of the highland indigenous fodder trees and shrubs thus a study was conducted in highland agroforestry practices of Hadiya & Kembata-Tembaro Zones, Southern Ethiopia. The six important indigenous fodder trees and shrubs were taken in this study for biomass estimation and chemical analysis were *Buddleja polystachya*, *Dombeya torrida*, *Erythrina brucei*, *Hagenia abyssinica*, *Vernonia amygdalina*, *Yushania alpine* and *Chamaecytisus palmensisca*. The first six were indigenous, and the last one was an exotic species. The potential leaf biomass yield of the selected indigenous fodder trees and shrubs ranges from 40.82 kg for *Chamaecytisus palmensisca* to 317.18 kg for *Erythrina brucei* in the study area and vary significantly ( $P < 0.05$ ) among the selected indigenous fodder trees and shrubs. The six selected indigenous fodder species had chemical composition of 191 - 236 mg g<sup>-1</sup> Crude protein, 357 - 545 mg g<sup>-1</sup> Neutral detergent fiber, 301 - 449 mg g<sup>-1</sup> Acid detergent fiber, 56 - 171 mg g<sup>-1</sup> Acid detergent lignin, Digestible energy, 240.58 - 348.52 in Mcal kg<sup>-1</sup> dry matter indicating their wide variability among species ( $P < 0.05$ ). The study revealed that *Yushania alpine*, *Vernonia amygdalina*, *Erythrina brucei* and *Buddleja polystachya* were promising indigenous fodder trees and shrubs interims of the farmers' preferences and the chemical analysis of nutritive contents. Therefore, we should promote indigenous fodder trees and shrubs over exotic fodder tree species in the highland agro-ecology where there are limited feed resources in dry season.

**Keywords:** agroforestry; farmers' preference; indigenous fodder trees; nutritional content; Ethiopia

## Introduction

Agroforestry is a dynamic, ecologically based natural resources management system in which trees and/or shrubs are grown in association with agricultural crops, pastures or livestock either simultaneously or sequentially on the same unit of land. In this system there is ecological and economic interaction between the trees/shrubs and other components including human being (Alao and Shuaibu, 2013; Atangana et al., 2013; Atangana et al., 2014).

The livestock production system provides smallholders with a number of benefits, but it also possess real threats to the environment, which can be mitigated through methods such as farmland enclosure, mixed farming systems with agroforestry interventions. The production of livestock in East Africa has to date mostly focused on these interventions (Cecchi et al., 2010; Dawson et al., 2014; Baudron et al., 2015). It has been reported that status of animal protein deficiency in developing world is caused by shortage of forage (Gaikwad et al., 2017). Shortage of feed supply in terms of both quantity and quality is the main constraint limiting the realization of exploitation of the full potential of the livestock resources. If animals are not properly fed, they cannot express their genetic potential for production and reproduction (Adugna et al., 2012).

Pastureland and fodder trees, shrubs, fodder grasses are integral part of livestock sector in highlands across the world viz Mexico (Lopez-Gonzalez et al 2017), Nepal (Pokharel & Ghimire, 2023). Fodder tree and shrub have always played a role in feeding livestock. They are increasingly recognized as important component of animal feeding; especially as supplies of protein in different parts of world. Different scholars (e.g. Chakeredza et al., 2007; Aynalem and Taye, 2008) studied and reviewed about the importance of these fodder trees and shrubs in different area at different time. To meet the maintenance requirement of animal for part of the year the contribution from trees and shrubs is significant. The fodder trees/shrubs that contain high level of crude protein, mineral matter and digestibility are acceptable by the livestock, because of their deep root system; they continue to produce well into the dry season.

African farmers have fed tree foliage to their livestock for centuries, using wild browse or trees that grow naturally on their farms. Fodder trees are widely grown in the East African highlands, including Kenya, Uganda, Tanzania and Rwanda, primarily among dairy farmers (Wambugu Cet.al, 2011). As a major source of animal feeds in Africa, fodder trees and shrubs are highly valued by farmers. Browsers have multiple roles in farming systems such as feed, fuel wood and as human and veterinary medicines. These forage species contain appreciable amounts of nutrients that are deficient in other feed resources such as grasses during dry seasons and dry periods. They have deep root systems enabling the extraction of water and nutrients from deep in the soil profile (Teferi et al., 2008). In Ethiopia 85% of the population depends on agriculture for their livelihood. Agriculture is the basis for the entire socio-economic development, provides about 80% of total employment, and is the source of 85% of earnings from export (EEA, 2002). Livestock is an integral component for most of the agricultural activities in the country. The livestock sector has a share of 12-16% of the total Gross Domestic Product (GDP), and 30-35% of agricultural GDP (Ayele et al., 2002,).

In many tropical countries the shortage of fodder, particularly in the dry season, is a major constraint to animal production. In the tropical regions of Ethiopia, cattle frequently suffer significant weight losses during the dry season as fodder is not only limited in supply but is also of poor nutritive value. The shortage of animal feed is a priority problem in the mountainous landscapes of Ethiopia (Seyoum et al 2001). In the highlands of Ethiopia (2500–3000 meters above sea level), grasses and barley straw are major sources of animal feed. However, grasses and barley straw are characterized by low digestibility, low protein content, and poor mineral composition. In addition to grasses and crop residues, where few or no alternative feed resources are available, the foliage of woody plants are important components of sheep and cattle diets. Farmers cut branches of trees and feed them to animals. Some farmers allow their animals to feed on fallen leaves under the fodder plants. There are also a few farmers who feed leaves with salts. Hence, the utilization of woody fodder species as a supplemental feed is becoming increasingly important in the highlands. In the highlands, exotic trees and shrubs such as *Leucaena leucocephala* (Lam.) de Wit., *Sesbania sesban* (L.) Merr., *Gliricidia sepium* (Jacq.) Steud., and *Calliandra calothyrsus* Meissn have been introduced and promoted to increase biomass for supplemental animal feed and soil fertility management. Ammonia treatment have been tried to solve the problem of tannins in the tree leaves (Mohamed et al 2021).

Local fodder trees and shrubs have the advantage over exotic ones in that they are well adapted to the local environment, farmers know them, and locally available planting material is abundant. Involving farmers in the process is important because as potential users of new technologies, their knowledge and preferences are critical. Twenty-nine indigenous fodder tree species used by farmers were identified in Dendi and Jeldu Districts, West Shewa Zone, central Ethiopia (Kindy et al., 2011). The major limiting factor for livestock production is feed in terms of both quantity and quality. To curb the problem of feed shortage, use of indigenous multipurpose fodder trees could be regarded as good option. Indigenous multipurpose fodder trees are potentially good protein supplements for ruminants, particularly during the critical periods of the year when the quantity and quality of herbage is limited (Takele et al., 2014). Indigenous browse shrub and tree foliages represent locally available crude protein and mineral supplements for ruminant livestock in the tropics and these plants remain green during the dry season and provide vegetation with better nutritive value than other annual grass and herbaceous species (Aregawi et al., 2008).

Indigenous MPFTs are grown as part of the farming system. Although most of the indigenous fodder tree species are not primarily grown for fodder but for other purposes, they are readily available for livestock feed. Multipurpose fodder trees (MPFTs) are woody perennials grown for several functions (for example, shelter, shade,

land sustainability) within the land-use system (Moges Y. 2004). The traditional knowledge and management practices on fodder trees offer relevant techniques and insights for foresters and other relevant scientists. In addition, farmer's preferences and cultural practices also need to be considered when species are screened for their appropriateness. Farmers in some parts of the world have some practical knowledge about the quality of fodder trees. Taping this knowledge would be much faster and cheaper than carrying out elaborate analysis in laboratories, for the purpose of screening the nutritive values of trees. However, previous studies in this field have shown variable correlation between farmer's knowledge and laboratory assessment. No study has been taken to investigate nutritive value of indigenous fodder trees and shrubs in the study area. Hence, this study has conducted to fulfil such gaps. Therefore, this project was initiated with the following objectives.

To estimate nutritive content of indigenous fodder trees and shrubs,

To find out fodder production potential of trees and shrubs,

To assess farmers perception towards indigenous fodder trees,

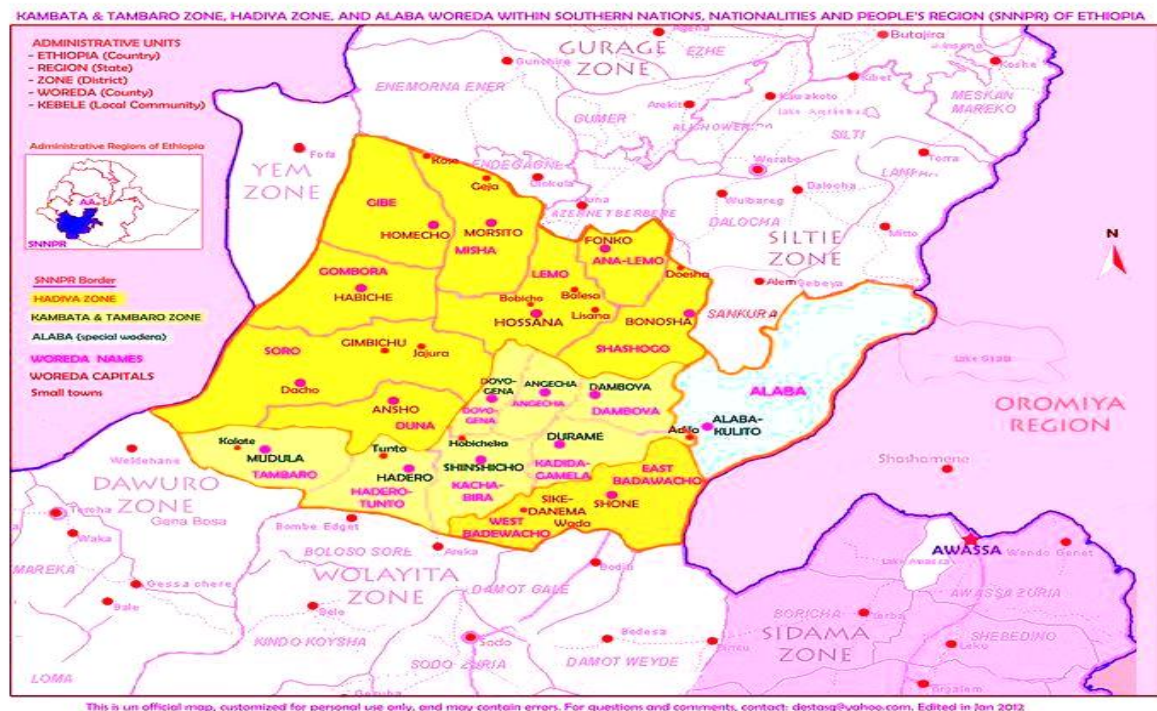
## Materials and Methods

### Description of the study area

This study has been carried out in some selected districts of Hadiya and Kembata-Tembaro zones, Southern Ethiopia (Figure 1). The study sites were selected purposively with the consideration and presence of indigenous fodder tree species as well as the farmers experience on livestock management. The selected districts from Hadiya zone were Misha and Lemo, and Angacha, Kacha-Bira and Tembaro districts from Kembata-Tembaro zone of Southern Ethiopia.

### Sampling procedures

The study locations were purposively selected from the highland agroforestry practices of each zone. Thirty households were randomly selected in each zone. The sample of households was not stratified by gender. All household members involved in fodder tree management – the household head, the spouse, other relatives and employees – were normally interviewed together. In some cases only male or female respondents were available. Farmers without cows (less than 20% of farmers in each of the three zones) were excluded from the survey. Interviews were conducted using a pre-tested. The questions were asked on the following topics: agroforestry practices, livestock, fodder tree species and use, quality aspects. Interviews began with a tour of the farm to view the common fodder trees that the farmer grew and used.



**Figure 1.** Map of Hadiya and Kembata-Tembaro zone in SNNPR, Ethiopia

The languages used during the survey were Hadiyassa and Kembatissa in the respective zones. The tour around the farm was an important tool to identify the species and minimize confusion about their botanical names. Samples of several morphological parts for every local species name were collected and the allocation of botanical names was cross-checked with the National Herbarium of Ethiopia.

Farmers were asked to rank their six most important fodder tree species in order of importance. All farmers then scored each species on selected criteria which were determined by a group of seven farmers in each zone through informal interviews prior to the survey. In addition, two criteria, palatability, growth rate, ease propagation and regrowth after cutting were determined by the researchers in order to obtain information about biomass production potential. Data were also analysed by SPSS, either using descriptive statistics, in case of basic information on fodder trees, or SAS in case of nutritive value of fodder tree species and fodder production potential.

### **Description of indigenous fodder tree and shrubs species**

African farmers have fed tree foliage to their livestock for centuries, using wild browse or trees that grow naturally on their farms. Fodder trees are widely grown in the East African highlands, including Kenya, Uganda, Tanzania and Rwanda, primarily among dairy farmers (Wambugu *et al.*, 2011). The most common indigenous multipurpose fodder trees and shrubs (Table 1) were selected for detailed scientific study in highlands of some selected districts of Hadiya and Kembata-Tembaro zones, Southern Ethiopia.

The most prevalent indigenous fodder trees and shrubs and exotic fodder species were evaluated for nutritive value and their potential fodder production. Farmers' preferred species were screened using the following characteristics: palatability, fast growth rate, ease propagation, harmlessness to animals, availability during the dry season, coppicing ability, high biomass, and fast to intermediate growth. *Chamaecytisus palmensis* an exotic fodder species was included in the study for the purpose of comparison with the indigenous species. *Chamaecytisus* and *Erythrina* fix nitrogen, unlike the other indigenous species that were included in the present study. The botanical names of the indigenous fodder trees and shrubs evaluated were given as follows: *Hagenia abyssinica*, *Buddleja polystachya*, *Dombeya torrida*, *Erythrina brucei*, *Yushania alpine*, *Vernonia amygdalina* and *Chamaecytisus palmensis*.

### **Leaf samples collection and processing**

The leaf samples were collected from selected six indigenous fodder trees and shrubs from agroforestry practices of highland agro-climate in Hadiya and Kembata-Tembaro zones. Most dominant indigenous fodder tree and shrubs leaves in the zones, which are being used for feeding ruminants locally were collected (Figure 2). The green leaves were rinsed in distilled water to remove dust and stored in a refrigerator to be freeze dried as soon as possible after collection. All the leaves were cut into small pieces so as to facilitate easy handling and uniform sampling for analysis. Samples were dried in the hot air oven at 65°C for 24 hrs and ground to pass through 1 mm sieve, grinded and stored in polythene bags at room temperature until they were needed for further analysis. All samples were collected within 25 days to minimize effects of sampling time on nutrient composition. These samples were analyzed chemically. The procedures were followed are described below: Foliage samples were air dried until the weight of dry matter became constant. The moisture content was determined by drying the sample at 75°C to a constant weight. The difference between the fresh and dry weight were used for calculation of moisture content of the sample. The dry matter percentage was calculated by following formula: The air dried foliage samples were oven dried at 100 °C for 24 hrs for chemical analysis.

Dry matter (%) =  $\frac{\text{Dry weight of leaves}}{\text{Fresh weight of leaves}} \times 100$

Fresh weight of leaves

### **Chemical analysis of fodder leaves**

Indigenous fodder trees and shrubs were evaluated for quality, preference and availability. The fodder quality parameters like crude protein (CP), *in vitro* dry matter digestibility (IVDMD), moisture content, and dry matter were estimated. Dry matter (DM) content was determined by drying the sample at 105°C in forced air oven till the constant weight. Crude protein (CP) was determined by Kjeldahl method (Anon., 1995). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined by methods of Van Soest *et al.*, (1991) without the use of alpha amylase but with use of sodium sulfite. All chemical analyses were done in triplicate. Digestible energy (DE) was calculated by determining the gross energy (Harris, 1970) of tree leaves and residues of leaves at 48 h of incubation of *in sacco* trial. This estimation of DE was further used for the calculation of ME contents by following equation (Anon., 2001).  $ME = 1.01 \times DE - 0.45$ .

### **Farmers' preferences towards fodder trees and shrubs**

Farmers' preferences for certain fodder species were based on fodder values (palatability and ability to fatten), tree growth characteristics (fast regrowth, ease of propagation and establishment) and tree management issues. For farmers it is important that the trees are tolerant of frequent cutting and the cut fodder is easy to handle. Farmers like to plant various different species as they say that animals do not like to eat the same fodder all the time (Figure 3), but prefer to consume mixtures of several species. Questionnaires were developed and interview was conducted to assess the farmers' preferences for indigenous fodder trees and shrubs.



**Table 1** Description of indigenous fodder tree and shrub species

Species	Family name	Altitude range (masl)	Estimated age of trees (year)	Propagation
<i>Hagenia abyssinica</i>	Rosaceae	2000 - 2400	7-9	Seed
<i>Buddleja polystachya</i>	Loganiaceae	2200 - 2900	5 - 6	Seed, cutting
<i>Dombeya torrida</i>	Sterculiaceae	2100 - 3000	6 - 7	Seed
<i>Erythrina brucei</i>	Papilionoideae	2300- 2600	8 - 9	Seed, cutting
<i>Yushania alpina</i>	Poaceae	2400- 3200	3 - 4	Culm, Rhizome
<i>Vernonia amygdalina</i>	Compositae	2300- 2700	5 - 7	Cutting
<i>Acacia abyssinica</i>	Minosoideae	2100- 2800	6 - 8	Seed

**Figure 2.** Collection of *Hagenia abyssinica* (Left) and *Yushania alpina* (Right) leaves from standing trees.**Figure 3.** Sheep feed on Bamboo leaves and cows feed on *Hagenia abyssinica* leaves in the study area

### Estimation of leaf fodder biomass/yield

The leaf fodder yield/biomass was estimated for indigenous fodder trees and shrubs. In case of tall fodder trees the tree canopy was divided into three parts as upper, middle and lower canopy in each strata all number of branches having leaves were counted and the sample branches in all sides were cut and then the leaves weight was taken. In case of shrubs the total leaf yield/biomass was estimated by picking and weighing the whole leaves, also the checklist was prepared to collect fodder tree data in the field.

### Data Analysis

To analyse the quantitative and qualitative data, statistical package for social sciences (SPSS 20 version) was used. Descriptive statistical methods such as frequency, percentage, mean, and standard deviation were used. For categorical variables, an ANOVA was used to test the difference between the fodder trees at the significance level (0.05). The nutritive values of indigenous fodder trees and shrubs as well as fodder production were analyzed employing SAS.

## Results and Discussion

### Fodder trees and shrubs in different agroforestry practices

In the highland of study zones and districts fodder trees were found in various agroforestry practices (Table 2) such as home garden, parkland, boundary planting, live fence, woodlot, front-yard planting and trees on grazing land. The *Erythrina brucei* was in home garden, parkland, boundary planting and live fence agroforestry practices (Figure 5&6). Fodder or browse production from trees is one of the benefits of agroforestry. Fodder trees and shrubs become then important as a source of energy and protein to keep the animals' body healthy, improve growth rates and even increase milk and wool production.

### Fodder availability to livestock

In both zones all interviewed respondents (100%) agreed that they face the shortage of fodder throughout the whole year thus it constrained the productivity and production of livestock sector. The implication is that availability of fodder to livestock was a crunch, to be addressed if we are interested in improving the nutrition of the herds. The result of household survey revealed that, about 21.6% of the respondents have not integrated any fodder trees and shrubs into their farmlands whereas only 78.4% of the respondents integrated fodder trees and shrubs into their farmlands. The foliage of tree present on farmland forms the alternative source of green fodder (Pandey and Singh, 1984) on one hand and supplements fuel and fruits on other.

### Availability and prevalence of fodder tree

The major animal feed sources in the study area during dry season were crop residues in the form of barley and wheat straw, grasses in the form of hay, tree fodder in the form of leaves and every part of ensset. The indigenous multipurpose fodder trees could be an alternative green fresh fodder source to livestock in highlands of the study area. The survey revealed that the occurrence of fodder tree species (Table 3) were abundant (*Buddleja polystachya*, *Erythrina brucei*, *Yushania alpina* common (*Hagenia abyssinica*, *Dombeya torrida*, *Vernonia amygdalina*) and rare (*Acacia abyssinica* (Figure 5). Indigenous agroforestry systems play an essential role in supplementation of fodder wood requirement (Rawat and Vishwakarma, 2011).

### Feeding season and other uses of fodder trees and shrubs

Fodder tree species like *Buddleja polystachya*, *Erythrina brucei*, *Yushania alpina* and *Vernonia amygdalina* could be fed throughout the whole year being evergreen species (Table 4). The evergreen fodder trees have advantage over deciduous tree species because they would be fed throughout the year. Almost all indigenous fodder trees and shrubs have multiple uses (Table 4). Indigenous browse shrub and tree foliages represent locally available crude protein and mineral supplements for ruminant livestock in the tropics and these plants remain green during the dry season and provide vegetation with better nutritive value than other annual grass and herbaceous species (Aregawi et al., 2008).

### Farmers' preference ranking of fodder trees and shrubs

The farmers' preference status of seven indigenous fodder trees based on different criteria was recorded (Table 5). This study revealed that majority of the farmers agreed with *Yushania alpina* as a highly preferred species followed by *Vernonia amygdalina* and *Erythrina brucei* whereas, *Buddleja polystachya*, *Hagenia abyssinica*, *Dombeya torrida*, and *Acacia abyssinica* were lowest preferred species for palatability criteria (Jarial et al., 2013; Mondal et al., 2016). However, *Erythrina brucei*, *Yushania alpina* and *Vernonia amygdalina* were found to be highly preferred species for its ease propagation. Based on the growth rate *Yushania alpina*, *Erythrina brucei* and *Buddleja polystachya* were found to be highly preferred species.

### Leaf water content of the fodder trees and shrubs

The leaf water content was higher in *Hagenia abyssinica* than that of *C. palmensis* (Table 6). The moisture content pattern in indigenous fodder trees and shrubs was in the following order: *H.abyssinica*> *B. polystachya*> *E. brucei*> *D.torrida*> *V.amygdalina*> *Y.alpine*. Water content of almost all indigenous fodder trees was more than exotic fodder shrub (*C. palmensis*). Their water content result of our investigation is in line with the findings of JAMA et al. (2000).





**Figure 5.** *Erythrina brucei* (left) and *Hagenia abyssinica* (right) as a boundary planting.



**Fig 6.** Bamboo lot (*Yushania alpine*) at left and *Vernonia amygdalina* with faba bean at right.

**Table 2.** The selected highland indigenous fodder tree species in different agroforestry practices

No	Scientific name	Family	Life form	Agroforestry practices
1	<i>Hagenia abyssinica</i>	Rosaceae	Tree	Hg, Pla, Bp
2	<i>Buddleja polystachya</i>	Loganiaceae	Shrub	Lf
3	<i>Dombeya torrida</i>	Sterculiaceae	Tree	Hg, Pla, Bp
4	<i>Erythrina brucei</i>	Papilionoideae	Tree	Hg, Pla, Bp, Lf,
5	<i>Yushania alpine</i>	Poaceae	Grass	Bl
6	<i>Vernonia amygdalina</i>	Compositae	Shrub	Lf,Pla
7	<i>Acacia abyssinica</i>	Minosoideae	Tree	Hg, Pla

Bl = Bamboo lot, Bp = Boundary planting, Hg = Homegarden, Lf = Live fence, Pla = Parkland agroforestry

**Table 3.** Availability status and prevalence of indigenous fodder tree species in study area.

Scientific Name	Local Name	Family	Prevalence (> msl)	Availability status
<i>Hagenia abyssinica</i>	Koso	Rosaceae	2000 - 3200	**
<i>Buddleja polystachya</i>	Anfer	Loganiaceae	2000 - 3200	***
<i>Dombeya torrida</i>	Wulkeffa	Sterculiaceae	2000 - 3200	**
<i>Erythrina brucei</i>	Korich	Papilionoideae	2000 - 3200	***
<i>Yushania alpina</i>	Kerkaha	Poaceae	2000 - 3200	***
<i>Vernonia amygdalina</i>	Girawa	Compositae	2000 - 3200	**
<i>Acacia abyssinica</i>	Girara	Minosoideae	2000 - 3200	*

\*\*\* = Abundant, \*\* = Common, \* = Rare

**Table 4.** Feeding season, nature and indigenous uses of highland fodder trees

No	Scientific name	Feeding season	Nature	Indigenous uses
1	<i>Hageniaabyssinica</i>	Dry	Evergreen	Fd, Ti, Md, Fu
2	<i>Buddlejapolystachya</i>	Dry, Wet	Evergreen	Fd, Fu
3	<i>Dombeyatorrida</i>	Dry	Evergreen	Fd, Fu, Ti
4	<i>Erythrinabrucei</i>	Dry, Wet	Deciduous	Fd, Fu
5	<i>Yushaniaalpina</i>	Dry, Wet	Evergreen	Fd, Fu, Hc, Fe
6	<i>Vernoniaamygdalina</i>	Dry, Wet	Deciduous	Fd, Md, Fu,
7	<i>Acacia abyssinica</i>	Dry	Evergreen	Fd, Fu

Fd = Fodder, Fu = Fuel, Md = Medicinal, Hc = House construction, Ti = Timber, Fe = Fencing

**Table 5.** Criteria for preference ranking of different fodder trees

No	Scientific name	Palatability	Ease of propagation	Growth rate	Forage yield (kg /tree )
1	<i>Hagenia abyssinica</i>	V	VI	VI	III
2	<i>Buddleja polystachya</i>	IV	V	III	VII
3	<i>Dombeya torrida</i>	VI	IV	V	II
4	<i>Erythrina brucei</i>	III	I	II	I
5	<i>Yushania alpina</i>	I	II	I	VI
6	<i>Vernonia amygdalina</i>	II	III	IV	V
7	<i>Acacia abyssinica</i>	VII	VII	VII	IV

**Table 6.** Water content, dry matter, leaf yield and leaf chemical composition of the six selected indigenous fodder trees leaves. CP, NDF, ADF, and ADL are in mg g<sup>-1</sup>, and DE is in Mcalkg<sup>-1</sup> dry matter; IVDMD is in %

Tree species	B. polystachya	D. torrida	E. brucei	H. abyssinica	V. amygdalina	Y. alpina	C. palmensis	SEM
Water Content (%)	75a	73a	74a	77a	71a	59b	58b	2.3
Dry matter (%)	53.0b	54.4a	52.6b	50.8b	51.3b	55.1a	56.2a	0.4
Leaf yield (kg)	83.9b	232.5a	317.1a	265.7a	95.6b	56.3c	40.8c	8.9
CP	231.0a	235.0a	236.0a	191.0b	232.0a	223.0a	230.0a	8.3
NDF	524.0a	450.0b	545.0a	357.0c	525.0a	523.0a	539.0a	15.2
ADF	447.0a	352.0b	452.0a	301.0c	449.0a	374.0a	362.0a	17.7
ADL	171.0a	101.0b	102.0b	56.0c	168.0a	135.0a	123.0b	13.8
IVDMD	46.0c	57.0b	73.0a	71.0a	48.0c	57.0b	70.0a	3.1
DE	240.5b	265.6b	348.5a	332.0a	281.3b	274.7b	347.6a	12.5
ME	260.5c	290.7c	374.8a	360.2b	303.4c	296.2c	377.1a	14.3

Means with different letters within a row are significantly different (p &lt; 0.05). CP=crude protein NDF=neutral detergent fiber ADF= acid detergent fiber ADL= acid detergent lignin IVDMD=invitro dry matter digestibility DE=digestible energy ME=metabolizable energy

### Dry matter of fodder trees and shrubs

Dry matter (Table 6) was the lowest in *Hagenia abyssinica* (50.82%) and the highest in *Chamaecytisus palmensis* (56.29%). The dry matter pattern in indigenous fodder trees and shrubs was in the following order: *C. palmensis* > *Y. alpina* > *D. torrida* > *B. polystachya* > *E. brucei* > *V. amygdalina* > *H. abyssinica*.

### Potential leaf biomass yield of fodder trees and shrubs

Leaf biomass yield that can be used for animal feed differed (P < 0.05) among the six selected fodder tree species in all the study districts (Table 6). Biomass yield in all districts were greatest (P < 0.05) for *E. brucei* followed by *H. abyssinica* and *D. torrida*. Leaf biomass yield of the selected indigenous fodder tree species ranges from 40.82 kg to 317.18 in the study area. The variation among species in leaf biomass yield suggests differences in potential biomass yield that may be associated with differences in growth of the species. Generally, the result



revealed that highest weight yield recorded in *Erythrina brucei* followed by *Hagenia abyssinica*, *Dombeya torrida* in the study area.

#### Nutritive value of indigenous fodder trees and shrubs

The leaf chemical composition of indigenous fodder trees and shrubs were depicted in Table 6. Crude protein content was the highest in *Erythrina brucei* and the lowest in *Yushania alpine* ( $P < 0.05$ ). The CP content was in the order of *Erythrina brucei* > *Dombeya torrida* > *Vernonia amygdalina* > *Buddleja polystachya* > *Chamaecytisus palmensis* > *Hagenia abyssinica* > *Yushania alpine*. The CP content of the foliage of all indigenous fodder trees species was much higher than the minimum required CP level (70 mg /g) of beef cattle. The high CP content in the foliage of *Erythrina brucei* and *Chamaecytisus palmensis* could be due to the N-fixing ability of the species.

The content of NDF was greater for *Erythrina brucei* than the other and the lower for *Hagenia abyssinica*. The NDF content of indigenous trees was similar to the finding of on similar issues (Solomon, M. et. al., 2003). The content of ADF was greater for *Erythrina brucei* in than the other and the lower for *Hagenia abyssinica*. The NDF, ADF, and ADL contents of the foliage in *H. abyssinica* were relatively low as compared to the other species. The contents of NDF and ADF in *H. abyssinica*, *D. torrida*, *B. polystachya*, *E. brucei*, *V. amygdalina*, *Y. alpine* and *C. palmensis* were within the ranges reported for browsed tree species by El Hassan et al (2000), and Khanal and Subba (2001). High ADL content can limit the voluntary feed intake, digestibility, and nutrient utilization of ruminant animals (Khanal and Subba 2001).

The IVDMD value of *Hagenia abyssinica*, *Erythrina brucei* and *Vernonia amygdalina* in our study was high as compared to the IVDMD value reported for *Chamaecytisus palmensis*, *Leucaena leucocephala*, *Sesbania sesban*, *Acacia angustissima*, and *Vernonia amygdalina* (El Hassan et al 2000). The digestible energy of the foliage of *E. brucei*, *H. abyssinica* and *C. palmensis* was significantly higher than the digestible energy of *V. amygdalina*, *Y. alpine*, *D. torrida* and *B. Polystachya* (Table 6). *Buddleja polystachya* had the lowest digestible energy as compared to the other 6 species. Variations in the chemical composition of the fodder trees considered in this study could probably be due to difference in their ability to accumulate proteins at the stage of their leaf sampling, growth potential of the plant and possible differences in the amounts of minerals or nutrient in the soil (Salem, A. 2006).

#### Conclusion and Recommendation

The evaluated six indigenous fodder trees and shrubs had comparable nutritive values as that of exotic fodder shrub. The potential leaf biomass yield of the selected indigenous fodder trees and shrubs was higher than exotic fodder shrub. In general, the leaves of all investigated fodder tree and shrub species can be used as sources of supplemental fodder within a proper feeding management scheme. Therefore, we should promote indigenous fodder trees and shrubs over exotic fodder tree species in highland agro-ecology of Ethiopia.

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