Journal of Innovative Agriculture: 8(4) : 8-13, 2021
DOI: 10.37446/jinagri/rsa/8.4.2021.8-13
Research paper

Assessing, evaluation and demonstration of highland indigenous fodder tree and shrub species in Debub Ari district, Southern Ethiopia

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Received: 05 August 2021
Accepted: 01 December 2021
Published: 31 December 2021

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Feed shortage is the major limiting factor in the tropics during the dry season, particularly in Ethiopia. This study was designed to assess indigenous fodder tree/shrub species and evaluate the nutritional quality, which can easily be found during the dry season. A multistage sampling procedure was employed to conduct the present study. Group discussion, key informant interviews, and questioners were tools used to collect primary and secondary data. Leaf samples of fodder tree/shrub species were collected, dried, ground, packed, and send to the laboratory for nutritive value analysis. In the wet season, the feed source is green grass whereas leaf biomass of trees/shrubs, crop residue/straw, and cuttings of Enset with other additive concentrate are used as an alternative feed source during the dry period. The present study result revealed that *Milletia ferruginea*, *Vernonia amygdalina*, *Hygenia abysinica*, *Terminalia laxiflora*, Ficus sure, and Musa species were most ranked and have good nutritional quality. These species are taken the concentration of farmers because of their availability during the dry season to sustain livestock production. Based on the result in the study area , livestock feed is a main factor in the dry season, at the same time there are enough feed sources with higher nutritional value but not similarly well known by all farm households. Therefore, indigenous fodder trees/shrubs are recommended as suitable sources of feed during the dry period, and integrating into different agroforestry practices and management options should be designed to provide sustainable feed for livestock production.

Key words: *agroforestry, fodder species, land use type, leaf analysis, production components*

INTRODUCTION

Livestock is the primary aspect of the agriculture sector, which takes part in a capability pathway out of poverty for farm households working towards small-scale farming in Ethiopia (Lijalem et al., 2015). Livestock performs a critical function in countrywide GDP is 15% - 17% and more than 50% of family income (Leta and Mesele, 2014). Livestock production is a

critical detail of the smallholder farming device. Within side the trendy and the south area in particular. In tropical countries, shortage of fodder, specifically in the dry season, is a first-rate challenge to animal manufacturing. The scarcity of animal feed is priority suffering in the mountainous landscapes of Ethiopia (ICRAF, 1990; Bediye et al., 2001). (ICRAF, 1990; Bediye et al., 2001). In the highland areas of Ethiopia (2500–3000 meters above sea level), grasses and barley straw are major sources of animal feed. In the tropical regions of Ethiopia, cattle frequently suffer substantial weight losses during the dry season as fodder is not only limited in supply but is also of poor nutritive value. However, grasses and barley straws are characterized by low digestibility, low protein content, and poor mineral composition (Bediye and Sileshi, 1989). In addition to grasses and crop remnants/residue, where few or no alternative feed resources are available, the leaf part and flower bud of woody plants are important products of sheep and cattle diets. Farmers prune branches of trees/shrubs and feed animals. Some farmers feed their animals on dropped leaves under the fodder plants. Farm households feed tree leave incorporating salts (Mekonnen et al., 2006). Despite the circumstance that growing human populations and high demand for food is imposing farmers to extend the farmland with the expense of grazing area (Mekuriaw et al., 2011). Further, low quality and quantity of feed sources, disease, and poor management practices are the major constraints for the livestock productivity of smallholder farmers (Beyene et al., 2015). This in turn made the extent of the animal feed problem even worse than ever before in mid and highland areas of the country. Hence, the livestock inhabited in these areas is executed to stick on natural pasture and crop residues where few or no alternative feed sources are available (Mekonnen et al., 2009). These feed resources are characterized as low digestibility, protein content, and mineral composition (Bediye and Sileshi, 1998).

Sustainable livestock production demands efficient utilization of available feed resources, and thus emphasizing indigenous fodder tree/shrub species is imperative for livestock productions and supporting rural livelihoods. To curb the problem of feed shortage, the use of indigenous multipurpose fodder trees could be regarded as a good option. Indigenously existing 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 are limited (Takele et al., 2014). Moreover, most fodder tree and shrub species have multi-functional characteristics such as firewood, protect soil erosion, and provide shade and shelter. Hence, the provision of fodder was not the primary use of fodder trees and shrub species (Franzel et al., 2014). Consequently, the scale of fodder tree planting and utilization undertaken by smallholder farmers in the country have shown not consistent success rates and not meet the required goals (Mekoya, 2008). Thus, giving attention to indigenous fodder tree/shrub species can have benefits over the exotic species in terms of adaptability to the local environment, resistance to pests and diseases, availability of planting material, and familiarity to the farmers (Mekonnen, 2007). Very scares studies have been done so far regarding the assessment and nutritional quality of indigenous fodder tree species (Mekoya et al., 2008; Mekonnen et al., 2009). This research gap requests to support the indigenous knowledge of the community with a scientific basis. Thus, the present study was initiated with objectives of assessing and identifying the indigenous fodder tree/shrub species and their contribution as an alternative feed source for livestock's of the district, to evaluate the nutritive value of indigenous fodder trees/shrubs & demonstrate the use of indigenous fodder trees and shrubs.

MATERIALS AND METHODS

From April 2018 to July 2018, research work was carried out on various mango plantations in the Chittagong hill tracts of Bangladesh, and the experimental parameters in RARS, Hathazari Chattogram, Mango cv BARI Aam 3, and BARI Aam 4 were used for evalutions. The bagging material was considered as a treatment, and the absence of bagging for mango fruit (open fruit) was considered as a control, so the sample had four (04) treatments: T_1: brown paper bag, T_2: white paper bag, T_3: transparent polyethylene bag, T_4: control. Bagging materials were purchased from Lal Teer. Two mango varieties were treated in duplicates, namely 50 fruits from BARI Aam 3 and BARI Aam 4. So, each interaction is 10 trees of 5 repetitions and 40 trees of 4 treatments. The test was organized as a randomized complete block design (RCBD), four (04) treatments were repeated five (05) times, and each treatment included 50 fruits as a unit, and each replicate. Depending on the processing conditions, decide whether the fruit will develop evenly (35, 45, 55 days after fruit setting). The fruit is bagged in appropriate bagging materials. Insects cannot get into the bag. The sturdy bag is properly wrapped on the stem and properly cared for so that it does not fall down or leave an empty space. During the research period, all trees were kept in once crop. After three (03) months of curing, it is fully tested. Ten (10) mango fruits were randomly selected for each treatment, and various physical parameters were recorded using an accompanying iterative system.

Study area description

This study was conducted in Sheshere and Metsere kebele, Debub Ari district, South Omo Zone. The location has a bi-modal rainfall sample with a shorter rainy season from March-May, which is essential for crop production, and the longest wet season from August- November. It is located between 36041' E and 05050' N. Biophysically, the study area is characterized as altitudinal ranges from 1435–2400m above sea level, annual rainfall is 1304.4 ± 250.7 mm. The annual minimal and maximum temperature is 16.3 ±0.9 °C and 27.7 ± 1.4 °C from the Jinka station and the major soil texture of the location is sandy loam. The communities exercise the mixed type of production system that means cropping and animal rearing.

Research design

A multi-stage sampling procedure was employed to conduct this study in the selected area where the resources are available. The study sites were selected by using purposive sampling, each kebele was selected to address the high

priority areas with high livestock population, severity of feed shortage, and indigenous tree/shrub species occurrence. The present study was used 84 randomly selected household respondents from both selected kebele. The kebele households' resident list was employed to make a random selection of the respondents. Semi-structured/open-ended questionnaires have been employed to collect information from FGD's and HH interviews. Focus group discussions were held with 10 members of the community whom with different local positions, ages, and gender. These group discussants were selected purposively from each studied kebeles based on their knowledge about the subject in the study and hence, they are representing the community. Totally four focus group discussions were held with two discrete groups from each kebele. These members of the community were selected by employing the snowball method. The primary data were supplemented by information obtained from key informants, making field checks at the time of survey and secondary data from Agriculture and Rural Development offices and written documents. The collected quantitative and qualitative data were analyzed through employing Statistical Package for Social Science Studies (SPSS version16) and SAS software. For data organization, a Microsoft Excel spreadsheet was used.

Evaluation of fodder trees/shrubs

Fodder trees/shrubs were evaluated for nutritional quality, animal preference, and availability. The fodder nutritional quality parameters like crude protein (CP), neutral detergent fiber(NDF), acid detergent fiber(ADF), and acid detergent lignin (ADL). The most preferred indigenous fodder trees/shrubs leaf samples collected, labeled, and packed to estimate nutritive value had been taken for nutritional evaluation at Debra Brihan agricultural research center.

Demonstration of fodder trees and shrubs

The demonstration of indigenous fodder trees and shrubs was undertaken to exploit abundant and underutilized feed resources at hand. This display on-farm evaluation was conducted with farmers to help refine the best bet fodder trees/shrubs that would fit into existing feeding circumstances. The farmers identify different fodder trees/shrubs and rank them according to characteristics identified by the farmers and the researcher.

Farmers' preferences for fodder trees/shrubs

Farmers' preferences for certain fodder species were based on feeding values (palatability and ability to fatten), tree growth features (fast regrowth, ease of propagation, and establishment), its' availability in dry season, and tree management issues. For farmers, the trees must be tolerant to frequent cutting and easy to handle. The palatability and digestibility of forage determine the amount of feed that an animal will consume and convert into products (Etgen and Reaves, 1978). Ruminants attempt to select a diet that promotes a high level of feed intake (Cooper et al., 1996). Potential Intake Rate (PIR) is the best indicator of palatability (Kenney and Black, 1984).

RESULTS AND DISCUSSION

Identifications of indigenous fodder tree species

The information obtained from HH respondents, key informant interviews, and preliminary surveys reveal that there was a feed shortage during the dry season, and to alleviate this problem fodder tree/shrub species are assessed in the study area. The trends of livestock population have been decreased in number according to *Sheshere* kebele, due to the main reasons feed shortage and limited access to pasture resulting from mounting population growth, on the other hand, *Metsere kebele* the trend has been shown increasing due to the increasing community awareness and market accessibility. Moreover, the secondary data that has been gathered from Woreda agricultural rural development office agreed with the increasing trends; among several reasons, the increasing market price and demand of livestock and their products have triggered communities to presume engagement in intensive livestock mixed production experiences unlike before. According to *(*CSA, 2007*)* data, the kebeles found in the Debub Ari district are categorized as densely populated of the South Omo zone. Consequently, the land shortage is the foremost reason for pasture and other feed shortage *(crop residues)*. Especially during the dry season, the feed shortage is extensive due to lacking the main feed attribute, and hence the indigenous fodder tree/shrub species are the only option to complement with crop residues to fulfill the livestock feed demand. Even though the bi-modal rainfall distribution has given a possibility of prolonged rainy months, according to Mekoya et al., (2008) who reported natural pasture and crop residues are characterized as poor in protein, vitamin, and mineral contents. Still the perennial indigenous fodder species have been given due attention owing to the enhancement intake and utilization of fibrous crop residues for livestock. The present study resulted in different options that have been identified by the HH respondents using different criteria for each ranked fodder species in the area. Farmers' have been their criteria for selected fodder tree/shrub based on feed values and tree growth characteristics; palatability, ability to fatten, fast growth, ease of propagation, and re-establishment among others. The identified fodder species were found in different land-use types in association with other species. This result is in line with the findings of Mekonnen et al., (2006) who reported twenty-nine indigenous fodder tree species used by farmers in the Dendi and Jeldu Districts of West Shewa zone. The study conducted in Burkina Faso agrees with the present research result, about 70 indigenous fodder tree species were identified that do farmers in the area commonly use (Sibiri JO, et al., 2000).

Ranking criteria and most preferred fodder trees in the study area

Farmers used fodder trees for feed sources, particularly during the dry season. Their preference is based on the availability of fodder species and palatability for animals as the main criteria for selecting indigenous tree/shrub species for fodder production in the dry season. The present study revealed that most of the respondents preferred (98.4%) fodder trees. The respondents identified about nineteen

Table 1. Field identified species, farmers' preference ranking and land use (niche) where fodder species found

No	List of fodder tree/shrub species**	Niches	Propagation method	Rank
1	Girawa *(Vernonia amygdalina)*	Homestead and farm land	Seed and cutting	1
2	Arkinitti	Forest land	Seed	2
3	Birbira *(Millettia ferruginea)*	Homestead and farm land	Seed	3
4	Wisha *(Dracaena steudneri)*	Near water ways	Cutting	4
5	Washa	Near water ways	Seed	5
6	Wachi *(Murdannia simplex)*	Live fence	Seed	6
7	Shaffa *(Ficus sur)*	Farmland	Seed	7
8	Zemma	Farmland	Seed	8
9	Shembeqo*(Arundo donax)*	Homestead	Cutting	9
10	Durri *(Arundinaria alpina)*	Near water ways	Cutting	10
11	Laggi	Swampy area	Cutting and Seed	11
12	Cuqesha	Near water ways	Seed	12
13	Kultepe	Near water ways	Seed	13
14	Warkka *(Cordia africana)*	Homestead and farm land	Seed and Cutting	14
15	Umbba *(Solanum incanum)*	Homestead and farm land	Seed	15
16	Ruzza *(Acacia brevispica)*	Homestead and farm land	Seed	16
17	Avocado*(Persea americana)*	Homestead	Seed	17
18	Shoshi	Near water ways	Seed	18

Table 2. Ranked tree/shrub species, identified as an important feed source to livestock in Debub Ari district

Scientific name	L/name	Respondents(n) in %	Niches	Season	Livestock type
Ficus sur	Sholla	95.2(78)	near farmland	dry	Cattle, Goat
Vernonia amygdalina	*Girawa*	96.2(81)	near farmland & homestead	W/dry	Cattle, horses, goat
Millettia ferruginea	Zagi	96.2(81)	near farmland & homestead	dry	Cattle, Horses
Hagenia abyssinica	Kosso	45.2(22)	near farmland	dry	Cattle, Horses
Terminalia laxiflora	Senegilla	37.3(23)	near farmland & homestead	W/dry	Cattle Horses
Musa species	Gumuza	98.4(83)	near farmland & homestead	W/dry	Cattle, Horses

Table 2. Leaf Chemical composition of selected fodder trees/shrub species in high land areas of Debub Ari district

Types of species	Nutritional quality parameters					
	DM %	ASH%	CP%	NDF%	ADF%	ADL%
Militia ferguna	94^{a}	8.51^{c}	22.81^{a}	68.62^{c}	51.35^{c}	11.07^{c}
Hygenia abyssinica	93^{ab}	4.30^{e}	16.93^{c}	76.53^{b}	58.87^{b}	12.17^{b}
Vernonia amygdalina	92^{bc}	13.04^{b}	19.25^{b}	58.65^{e}	39.13^{e}	8.60^{e}
Musa spp	92^{bc}	15.22^{a}	10.15^{e}	59.57^{d}	43.48^{d}	10.00^{d}
Terminalia laxiflora	92^{bc}	6.52^{d}	11.30^{d}	56.34^{f}	32.61^{f}	6.52^{f}
Ficus sure	91^{c}	13.19^{b}	10.34^{e}	80.00^{a}	63.39^{a}	14.50^{a}
LSD	1.265	0.21	0.704	0.797	1.879	1.0018
CV	1.065	1.11	2.56	0.658	2.1455	5.26

Where ADF (acid detergent fiber), ADL (acid detergent lignin), Ash (ash content), DM (dry matter), CP (crude protein), NDF (neutral detergent fibre), the same letters within column shows no significant difference among treatments ($p<0.05$)

(Table 1) fodder tree species in the study area and a few of the most ranked are specified to evaluate nutritional quality. Tree leaves and straw fill the gap of feed shortage in the dry season. Most farmers cut branches of trees and feed their animals. Some farmers allow their animals to feed on fallen leaves under fodder trees. A similar criterion was used by Ghimire et al., (2011) to rank the fodder trees and had a relatively good understanding in ranking the species. Similarly, about 70 indigenous fodder tree species were identified in Burkina Faso that farmers use in the area commonly (Sibiri JO, et al., 2000). Most of the identified species are found in different land-use types, particularly in homestead and farmlands of the farm households. This is due to the farmers' due attention to manage their farm in a closer manner. These practices are easy to access fodder at any time in terms of availability near to home stead and improving the livestock product. These niches are commonly known to plant or retain fodder trees by considering the minimum competitive effect of trees on other crops. Boundary plantations, life fences, hedges, and homesteads are most commonly niches of fodder trees. Geleti et al., (2014) found that a home garden is rich in species or has higher diversity. Similarly, Méndez and Somarriba (2001) reported high plant species diversity in the home garden.

Nutritional composition of fodder trees/shrub leaves

The nutrient composition of identified fodder tree/shrub species derived from laboratory analysis is shown below (Table 3). Nutritional parameters like dry matter (DM), ash content, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were analyzed for most preferred fodder trees/shrub species.

The dry matter content of analyzed leaf sample for fodder tree found in the range b/n 91 and 94, from which the dry matter content of *Millettia ferruginea* (94) was significantly higher than the other ranked fodder tree/shrub species. The highest crude protein (CP) content was found in *Millettia ferruginea* followed by *Vernonia amygdalina* and *Hygenia abyssinica,* the lowest was recorded in Musa spp. The neutral detergent fiber(NDF), acid detergent fiber(ADF), and acid detergent lignin content of Musa spp (80, 63.39, and 14.50) were significantly higher than the other fodder species in the study area respectively, while *Terminalia laxiflora* has significantly lower neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL). Feed quality analysis for leaf sample results revealed that trees/shrubs are recognized as an important source of animal feed, fodder trees/shrubs leaves were rich in important nutritional parameters like protein, soluble carbohydrates, minerals, vitamins, and showed significant potential as an alternative feed source (Bakshi and Wadhwa, 2007; Azim et al., 2011). The fodder species were more efficient during alternative options were inaccessible (Hamer et al., 2007). This is due to their deep root enables to maintain high protein especially during the dry season (Wambugu et al., 2011).

CONCLUSION

Depending on the findings of the present study, the feed shortage for livestock in the dry season is the main problem in the study area. *Millettia ferruginea, Vernonia amygdalina, Hygenia abysinica, Terminalia laxiflora, Ficus sure and Musa species* and, best fodder trees and shrubs in Debub Ari district. These species are found in homestead, the boundary of farmland, as life fences in all study areas. The result is shown in the study area there are abundant fodder species, in terms of trees and shrubs even if in the dry season but the major problem with this is there is a skill gap in management and utilization in most farm households. There are indigenous trees that have enough nutritive quality compared with exotics, which have better quality than crop residues and grass in the dry period in . From the obtained findings we recommended that the resource found in different land-use types should be widely demonstrated to solve their feed problem. The knowledge and skill of farmers about fodder tree management need improvement. Further research is important on management, their interaction with crops, and their supplementation rate with other concentrations.

AUTHOR CONTRIBUTIONS

Alemayehu Hido set-up the experiments; Belayneh Lemage and Alemayehu Hido carried out the experiments in their respective locations. Belayneh Lemage analyzed the data and developed the manuscript. Belayneh Lemage contributed in data analysis and manuscript review.

ACKNOWLEDGEMENTS

The authors acknowledge Southern Agricultural Research Institute for the contribution of financial support to handle this research. The contribution of researchers in the Natural Resource Research Directorate and experts participation during data collection highly appreciated.

COMPETING INTERESTS

The authors declare that they have no competing interests.

ETHICS APPROVAL

Not applicable

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