Potentials of Moringa stenopetala foliage as livestock feed, Southern Ethiopia

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Abstract

The study was carried out in three selected zones of Southern Ethiopia to assess seasonal availability, utilization practices, and livestock preferences as well as farmers' perceptions, and barriers to using M. stenopetala as livestock feed. Multi-stage sampling techniques were used to select zones, woredas, kebeles, and households. The primary data were collected using structured questionnaire, field observation, focus group discussion, and measurements. Statistical variations for categorical data were tested employing cross tabs, with significant differences at $P \leq 0.05$; while the quantitative data were analyzed using one-way analysis of variance. Mean comparisons were carried out using Duncan's Multiple Range Test. Indices were computed to provide ranking parameters. M. stenopetala tree is a major asset and considered as a milking cow and called as "a mother and dairy plant" that they breastfeed. The respondent farmers ranked food value (1st) followed by income generation (2nd) and feed value (3rd) as major purposes of planting M. stenopetala. About 66.75% of the respondents' farmers were able to differentiate the species of M. stenopetala found in their vicinity. Accordingly, two types of M. stenopetala were identified. The production of M. stenopetala is available both in dry and wet seasons and its abundance was higher in backyard/homestead. About 48.07% and 44.75% of the respondents were supplied edible parts for cattle and goats in the form of fresh leaves and twigs, respectively. Overall, the current study demonstrated practical identification of M. stenopetala tree types and used a portion of it for ruminants to supplement nutrient scarcity in the areas. Working on the nutrition composition of edible parts of the various varieties of M. stenopetala is thus recommended in order to evaluate the variation.

Introduction

Ethiopia holds the largest livestock population in Africa. According to the estimation of CSA (2021), the country owns about 70 million heads of cattle, 42.9 million sheep, and 52.5 million goats, 8.1 million camels, 56.06 million poultry, 2.15 million horses, 10.8 million donkeys and, 0.38 million mules. Livestock production plays a vital role in the economies and livelihoods of farmers and pastoralists.

However, the contribution of sub-sector to the agricultural sector in the country is very low (Jabbar et al., 2007; Negassa et al., 2011). The low productivity level of ruminant livestock is mainly as a result of various constraints that include inadequate nutrition, unimproved genetic resources, the prevalence of diseases and parasites, poor research, and extension services (Demeke et al., 2017; Welay et al., 2018; Duguma and Janssens et al., 2021). Among these constraints, the issues related to inadequacy in feeds in terms of quality and quantity is the most critical areas on the performance of livestock. Likewise, Tolera et al. (2012) noted that the availability of feed resources and the nutritional quality of the available feeds are the most important factors that determine the productivity of livestock.

Natural pastures and crop residues account for the largest proportion of available feed resources in livestock production. According to Mebrate and Tewodros (2019), these sources of supplied feed resources are both insufficient in quality and quantity. Not only that, but instead of having a large stockpile of livestock, the producer farmers have not well-adjusted the supply of feeds to meet their goals.

Furthermore, livestock feeds derived from natural pasture and crop residues have low feeding value, poor quality, and low digestibility and intake. These shows require more high-quality concentrate diets to boost livestock production and productivity. However, commercial concentrate diets are difficult to obtain in rural areas. Owing to these calls to search for alternative available feed resources to replace the limited feed resource bases. Accordingly, the study is therefore aimed to assess M. stenopetala seasonal availability, utilization practices, and livestock preferences as well as farmers' perceptions, and barriers to using M. stenopetala as livestock feed.

Materials And Methods

Description of Study Area

The study was carried out in southern nations, nationalities, and peoples regional states (SNNPR) of Ethiopia. For the study, the assessment was conducted in three selected zones, namely Gamo, Gofa, and Konso in southern Ethiopia (Fig. 1).

Sampling Procedure

Multi-stage stratified sampling techniques were used to select zones, woredas, kebeles, and households. Accordingly, three zones (Gamo, Gofa, and Konso) were selected from SNNPR purposively based on the availability of M. stenopetala. As a follow-up, one woreda from each zone was selected purposively. A reconnaissance survey was conducted and a discussion was held with stakeholders (woreda administration, livestock experts, and community elders) to identify specific kebeles with wider distribution of M. stenopetala. Accordingly, nine kebeles (three per woreda) were selected purposively. Then, households were selected by random sampling method from the list of M. stenopetala growers collected from the respective kebeles. The sample size was determined using probability proportional to the sample size sampling technique (Cochran, 1977).

$$no = \frac{Z^{2*}(P)(q)}{d^2} \rightarrow n_1 = \frac{no}{(1 + no/N)}$$

Where;

n_o = desired sample size when study population is greater than 10,000; n_1 = finite population correction factors when study population size is less than 10, 000; Z = standard normal deviation value (1.96 for 95% confidence level); P = 0.1 (proportion of population to be included in sample i.e. 10%); q = is 1-P i.e. (0.9); N = is total number of population; d = is degree of accuracy desired (0.05). Household population of each study site was considered in this particular study.

Data Collection Methods

Both primary and secondary data were collected using Semi-structured questionnaires, field observations, focus group discussions, and measurements. The following are the procedures used to collect primary data:

Focus group discussion

One focus group discussion was conducted in each of the study kebeles with 8 to 12 grower farmers. The participants were chosen with the active participation of development agents and kebele leaders, taking into account their age and verified long years of cultivation of M. stenopetala. Important points such as types of Moringa species cultivated in the area, utilization experience of M. stenopetala as livestock feed, and edible parts of M. stenopetala were discussed.

Questionnaire survey

A structured questionnaire was used to collect data on feed resource for livestock production, traditional feeding practices, types of non-conventional feedstuffs, and seasonality of feed availability, opportunities and constraints of livestock production, and knowledge on the use of M. stenopetala as animal feed. Data on M. stenopetala types, characteristics, density, and distribution were also collected and recorded. Farmers' indigenous knowledge on M. stenopetala edible parts and preference by type of livestock species were also gathered.

Measurement and Estimation

To estimate dry matter yield per tree basis, M. stenopetala trees were selected using a stratified random sampling technique. As a result, 15 Moringa stenopetala trees per kebele (1–5 years, 6–10 years, and older than 10 years) were chosen at random. Following tree identification, the DM yield was estimated using Pet Mark's (1983) methods for estimating DM yield of fodder trees. Thus, the potential fodder yield of M. stenopetala trees was estimated using a measuring tape and the allometric equation. The diameter of the plants were calculated using the formula; D = 0.636C where D is the diameter and C is the circumference of the plant. The potential yield of M. stenopetala trees were calculated using the following formula developed by Pet Mark (1983).

- Log W = 2.24logDT-1.50, for trees

Where: W = leaf yield in kilograms of dry weight

DT = Diameter of trunk (cm) at 1.2 meter height (for tree leaf biomass)

Statistical Analysis

All data collected during the survey were analyzed using statistical procedures for social science (SPSS) version 20 (SPSS, 2011). Cross tabs (chi-square) were used to test statistical variations for categorical data, with significant differences at $P < 0.05$; quantitative data were analyzed using one-way analysis of variance (one-way ANOVA) using SPSS's general linear model procedure. Duncan's Multiple Range Test

was used for mean comparisons. The significance level of $P < 0.05$ was also considered. Indexes were calculated for the parameters that required ranking.

Results

Feed Resources and Feeding System of Livestock

According to the present study quality, quantity, type of feed and the availability of feed resources varied according to the seasons. Crop residues, grass hay, browse trees, grazing natural pasture, and stubble grazing are the most common dry-season feed sources. Grazing natural pasture, browse trees, crop residues, stubble grazing, and grass hay, in order of their extent of use, are important feed resources during the wet season (Table 1).

Table 1
Major feed resources used by respondents in the study area

Major feed resources (%)	Dry season (n = 379)	Wet season (n = 379)
Natural Pasture	47.76	69.92
Crop residues	81.79	43.80
Stubble Grazing	45.91	39.84
Hay	53.83	23.75
Feed supplement	5.80	3.96
Browse Trees	63.85	45.91

However, the majority of the interviewed households (97.89%) in the study area stated that they are experiencing feed shortages, despite the fact that the problem was not significant ($\chi2 = 4.029$, $P = 0.133$) across the study zones (Table 2). As a result, the majority of households (60.95 percent) relied on farm residues to get by during the critical feed shortage season, which lasted from January to May. The coping mechanisms of the study zones differed ($\chi2 = 108.343$, $P < 0.05$) during the severe period of feed shortage (Table 2).

Table 2
Feed shortage and coping strategies in the study area

Variables (%)		Gamo (n = 124)	Gofa (n = 125)	Konso (n = 130)	Overall (n = 379)	χ2	*P*-value
Is there a feed shortage	Yes	96.77	100.00	96.92	97.89	4.029	0.133
	No	3.23	0.00	3.08	2.11		
If yes, coping mechanisms						108.343	< 0.001
o Rely on stored feed		5.65	25.60	42.31	24.80		
o Rely on farm residues		69.35	74.40	40.00	60.95		
o Rely on the market		4.03	0.00	13.85	6.07		
o Rely on the natural pasture		20.97	0.00	3.85	8.18		

The majority of households in the study area (85.22 percent) do not provide additional commercial diets for their livestock due to a lack of available sources. However, in the Gamo and Konso zones, 31.5 percent and 13.08 percent of respondents use commercial feeds from markets and homemade mixed diets to supplement their livestock, respectively (Table 3).

Table 3
Source and supplementation of additional commercial diets

Variables (%)		Gamo (n = 124)	Gofa (n = 125)	Konso (n = 130)	Overall (n = 379)	χ2	*P*-value
Supply additional commercial diets	Yes	31.45	0.00	13.08	14.78	49.53	< 0.001
	No	68.55	100.00	86.92	85.22		
If yes, source of commercial diets						87.57	< 0.001
o Home-made mixed diet		6.45	0.00	13.08	6.60		
o From the markets		25.00	0.00	0.00	8.18		
o Inaccessible of source		68.55	100.00	86.92	85.22		

The majority of respondents (96.57%) don't buy commercial diets for goats and sheep in the study area because of limited access and lack of awareness (Table 4).

Table 4
Supplementation of commercial diets for sheep and goat

Variables (%)		Gamo (n = 124)	Gofa (n = 125)	Konso (n = 130)	Overall (n = 379)	χ2	*P*-value
Do you purchase feed for shoat	Yes	10.48	0.00	0.00	3.43	27.68	< 0.001
	No	89.52	100.00	100.00	96.57		
If no, reasons						268.76	< 0.001
o Unavailable		12.10	93.60	33.08	46.17		
o High cost		4.84	4.00	32.31	13.98		
o Not aware		58.87	2.40	34.62	31.93		
o Shoat does not require purchased feed		6.45	0.00	0.00	2.11		
o Haven't shoat		7.26	0.00	0.00	2.37		

M. stenopetala Cultivating trends and production

M. stenopetala is a major asset and considered like a milking cow in the study area. Participants of the focus group discussion indicated that its economic importance is much higher than a cow. The main reason mentioned by the participants for its higher economic importance is cows eventually stop production but M. stenopetala produces a sustainable product. Particularly in Konso zone, the farmers were reported that M. stenopetala is a staple food and an asset for resistance of life. Moreover, it is a tool for the transition from poverty to a higher standard of living. That's why they planted M. stenopetala in the backyard to picked up leaf and eaten as a main food every day and their livelihood rely on, they called a “mother and dairy plant” that they breastfeed. Where there is no crop product, they get it out of the poverty and out of the crisis.

Purposes of Planting M. stenopetala

The farmers in the area ranked food value (1st) followed by income generation (2nd), feed value (3rd) and medicinal value (4th) as major purposes of planting M. stenopetala. However, the grower farmers in the Gofa and Konso zones ranked as a food value (1st) followed by for feed value (2nd), for sale (3rd) and medicinal value (4th) major purposes of planting M. stenopetala (Table 5).

Table 5
Purposes of planting M. stenopetala in the study area

Purposes	Respondents rank in the study zone						Overall (n = 379)	
	Gamo (n = 124)		Gofa (n = 125)		Konso (n = 130)			
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
For food value	0.15	1st	0.15	1st	0.15	1st	0.15	1st
For feed value	0.12	3rd	0.14	2nd	0.13	2nd	0.13	3rd
For sale (income generation)	0.13	2nd	0.13	3rd	0.13	3rd	0.13	2nd
For medicinal value	0.10	4th	0.10	4th	0.11	4th	0.11	4th
For water purification	0.04	11th	0.03	11th	0.05	10th	0.04	11th
For alley cropping	0.07	8th	0.04	10th	0.06	7th	0.06	10th
For honey production & purifier	0.02	12th	0.01	12th	0.04	12th	0.03	12th
For live fence (boundary planting)	0.10	5th	0.08	7th	0.09	5th	0.09	5th
For fuel wood	0.06	10th	0.08	6th	0.05	9th	0.06	8th
For windbreaks	0.06	9th	0.07	8th	0.06	8th	0.06	9th
For soil erosion control & fertility	0.08	6th	0.07	9th	0.05	11th	0.07	7th
For beauty and shade	0.08	7th	0.09	5th	0.07	6th	0.08	6th

Index = sum of all single purpose rank [(12 for 1) + (11 for 2) + (10 for 3) + (9 for 4) + (8 for 5) + (7 for 6) + (6 for 7) + (5 for 8) + (4 for 9) + (3 for 10) + (2 for 11) + (1 for 12)] divided by sum of all weighed purposes of livestock rearing mentioned by respondent

Types of M. stenopetala in the area

This study showed that about 66.75% of the respondents' farmers were able to differentiate the species of M. stenopetala that was found in their vicinity (Fig. 2). M. stenopetala cultivating farmers in the Gofa and Konso zones had better experince in differentiating different varieties than those in the Gamo zones. Accordingly, farmers are identified two types of M. stenopetala in the study area. The first one is *Argole/Macha Halako/* (in the Gofa zone) or *Shelaqta ati* (in the Konso, Fig. 3) and the second is *Adde Halako* (in the Gofa zone) or *Shelaqta bora* (in the Konso, Fig. 3). Concerning to their specification the *Argole/Macha Halako* or *Shelaqta ati* is sweet in taste and it's delicious when consumed as a vegetable, has broad leaf and ripening quickly whereas *Adde Halako* or *Shelaqta bora* is bitter in taste when

consumed, has thin leaf and does not ripening quickly. On the other hand, some of farmers particularly in the Gamo zone (62.1 percent) reported that the bitter taste on ripening is taking place due to the way of cooking and maturity stages of leaves (Fig. 2).

Availability and Harvesting of M. stenopetala

The season in which biomass/yield production highly available are significantly vary ($\chi 2$ (2, n = 379) = 89.61, $p < 0.05$)) among the study zones (Table 6). Accordingly, the majority of respondent households in the Gamo zone (66.94%) and the Konso zone (100%) reported that it is highly available in wet season, while about 99.2% of respondent households in the Gofa zone reported higher availability in dry season.

Table 6
Availability, yield production, and harvesting of M. stenopetala

Variables (%)	Gamo (n = 124)	Gofa (n = 125)	Konso (n = 130)	Overall (n = 379)	$\chi 2$	*P*-value
Harvesting frequency per week					48.24	< 0.001
• 1–2 times	14.52	29.60	20.00	21.37		
• 3–4 times	13.71	0.00	8.46	7.39		
• 5–6 times	26.61	4.00	19.23	16.62		
• Daily	45.16	66.40	52.31	54.62		
Season of availability and harvesting						
• Both dry and wet season	100.00	100.00	100.00	100.00		
The season in which biomass/yield production and availability are higher					377.97	< 0.001
• Dry season	66.94	0.00	100.00	56.20		
• Wet season	10.48	99.20	0.00	36.15		
• Both season	22.58	0.80	0.00	7.65		

Distribution and Management of M. stenopetala per land use pattern

The current study indicated that the distribution of M. stenopetala trees was higher in backyard/homestead ranked as 1st followed by farmland (2nd), edge of land (3rd), and pasture or marginal land (4th). Whereas, merely in the Konso zone the 3rd and 4th ranked higher distribution of trees are in pasture or marginal land, and the edge of the land, respectively (Fig. 4). This difference might be due to the planting habit of the farmer in the valley area.

The average land holding particularly homesteads per household in Konso zone is smallest than the Gamo and Gofa zones and the abundance of the plant per large area is higher than the small area. Based

on maturity, about 3.3 ± 0.21 is categorized under five years, while 4.84 ± 0.28 is under the age between 5–10 years and the rest 10.25 ± 0.53 is accounted above 10 years (Table 7).

Table 7
Average number of *M.stenopetala* trees per household in study area

Presence of M. stenopetala tree		Gamo (n = 124)	Gofa (n = 125)	Konso (n = 130)	Overall (n = 379)	*P*-value
Total no M. Stenopetala trees		19.69 ± 1.47[a]	21.05 ± 1.46[a]	14.65 ± 1.43[b]	18.46 ± 0.84	0.005
Based on maturity/age	1–5 years	2.99 ± 0.36	3.14 ± 0.36	3.78 ± 0.35	3.3 ± 0.21	0.248
	6–10 years	4.82 ± 0.49[ab]	5.64 ± 0.49[a]	4.05 ± 0.48[b]	4.84 ± 0.28	0.071
	Above 10 years	11.83 ± 0.92[a]	12.2 ± 0.92[a]	6.71 ± 0.9[b]	10.25 ± 0.53	< 0.001

[a – b] means with different superscripts within a row are significantly different (P < 0.05)

Fodder yield of M. stenopetala

Fodder yields of M. stenopetala based on order of maturity or ages of tree in the study area were presented in Table 8. Generally fodder biomass yield is increasing with the maturity or age of tree with the significant variation among the study zones. This might be take place due the difference in planting methods of M. stenopetala in the Gofa zone was using stem than seeds. Whereas, in the Gamo and in the Konso zones the farmers were use the seed for planting.

Table 8 Mean (±SEM) leaf yields (kg DM/tree) of M. stenopetala at 1.2 meter height

	Yields/Tree (kg DM/Tree)				
Age of tree / Order of maturity	Gamo (n = 10)	Gofa (n = 10)	Konso (n = 10)	Overall (n = 30)	*P*-value
1 - 5 years	0.96 ± 0.051[b]	1.86 ± 0.051[a]	0.93 ± 0.051[b]	1.25 ± 0.03	<0.001
6 - 10 years	1.73 ± 0.051[b]	2.11 ± 0.051[a]	1.73 ± 0.051[b]	1.86 ± 0.029	<0.001
Above 10 years	2.89 ± 0.069[b]	3.24 ± 0.069[a]	2.89 ± 0.069[b]	3.01 ± 0.04	0.005

Perception of Farmers on Supplementation of M. stenopetala as Livestock Feed

The majority (95.51%) of respondents in study areas were supplied edible parts of M. stenopetala for the livestock as a feed. Fig 5 shows farmers' perception who express (from their indigenous knowledge and experiences) of M. stenopetala as the best alternative feed of livestock to fill the gap of high quality proteins feeds.

Utilization Practices and Favored part of M. stenopetala for Livestock

According to the current study, edible parts of M. stenopetala were supplied by 48.07 % and 44.75 % of the respondents for cattle and goats, respectively. The chi-square test difference of $\chi 2$ (2, n=362) = 48.11; P< 0.05) shows that the types of livestock species that the households primarily supplied were different among the study zones. As a result, the vast majority of respondents in the Gamo (52.73 percent) and Gofa (64.80 percent) zones primarily supplied edible M. stenopetala parts for cattle. In the Konso zone, however, approximately 56.69 percent of respondents supplied primarily for goats (Table 17). There was a statistically significant difference in the mainly supplied edible parts of M. stenopetala for livestock ($\chi 2$ (2, n=362) = 68.72; p< 0.05). As a result, the majority of respondents in the Gamo and Gofa zones were primarily provided with leaves for livestock. In the Konso zone, however, 52.76 percent of respondents received twigs for their livestock. As a result, the majority of respondents provided edible parts in the form of fresh leaves and twigs, and it was observed that that no statistically significant difference existed between the study zones (Table 9).

Table 9 Utilization practices and favored parts of M. stenopetala for livestock

Variables	Gamo (n = 110)	Gofa (n = 125)	Konso (n = 127)	Overall (n = 362)	χ2	*P*-value
Livestock species fed *M.stenopetala*					48.11	<0.001
• Cattle	52.73	64.80	27.56	48.07		
• Sheep	5.45	0.00	15.75	7.18		
• Goat	41.82	35.20	56.69	44.75		
Mainly supplied parts of M. stenopetala					68.72	<0.001
• Leaves	76.36	93.60	47.24	72.10		
• Twigs	23.64	6.40	52.76	27.90		
Form of supplementation					4.27	0.118
• As fresh leaves & twigs	96.36	100.00	97.64	98.07		
• As processed feed	3.64	0.00	2.36	1.93		

Indigenous Knowledge of Farmers on Medicinal Value of M. stenopetala

M. stenopetala is traditionally used as a medicine for a variety of ailments as shown in Table 10.

Table 10 Indigenous knowledge of farmers on medicinal value of M. stenopetala

Parts of M. stenopetala	Indigenous knowledge of farmers in utilizing M. stenopetala
Leaves	• To treat common colds, high blood pressure, stomach cramps, arthritis.
	• To download a guest child for cattle.
	• The soup of leaves is drunk to treat diabetes.
	• When it is pressed against a wound, it dries up.
	• It heals the sick eye. They especially use the leaves for red eyes.
Roots and Barks	• By nose relieves eye pain, colds, and headaches.
	• Used to treat malaria
	• It cures morbidity and epilepsy
	• In cattle, they hit the stem with a fork and tie it around their mouths to cure lesion (qafuri in Gofigna language)
	• For stomach cramps and bloating, the fluid is swallowed
	• Prevent snake venom and expel snakes from homesteads
	• For a man and an animal designed for snakes
Trunk and Barks	• Beat the upper part and tied it to the mouths of the cattle to cure qafuri
Branches	• To raise a stranger (from cattle) or expel retained placenta
Pod	• It cure trypanosome

Discussion

Non-traditional feeds such as fruit and vegetable wastes (mango, avocado), sweet potato roots and leaves, cassava root and leaves, banana leaves and pseudo-stems, enset leaves and pseudo-stems, sugarcane tops, maize and sorghum tillers, and sludge (Atela) were also mentioned in the group discussion as important available feed resources. Similarly, Duguma and Janssens et al. (2021) identified important non-conventional feeds in the study area that have the potential to increase feed availability during the dry season.

Consistent with the current study Shonde (2017) reported that M. stenopetala is multipurpose tree used as a measure of wealth which saves the life of family and surviving tool to resist the crop failure in the area. Thus, during the marriage whether or not the M. stenopetala presented is a big question from the daughter's family in Konso. In line with this, in the same area Shonde (2017) reported that to make marriage relationship between two families, the enormously presence of M. stenopetala trees where a criteria asked from families of daughter to accept the relation.

M. stenopetala is a unique tree that produces both in winter and summer. Consistent with this finding, Abay et al. (2015) reported that M. stenopetala appear throughout the year even during the dry season where the foliage's of another plants are detached from their mother plants. M. stenopetala is age gifted tree plant that grows from one to two generations. Accordingly, it has various vernacular names like "*Halako*" in Gamogna and Gofaagna languages, "*Talahe*" in Zeysegna language, "*Shelaqta*" in the Konso language, and "*Shiferaw*" in Amharic. In line with the current result, Kumssa et al. (2017) reported the purposes of M. stenopetala growing in Southern Ethiopia as used for source of food, income generation, drink, feed value and as it has medicinal value. M. stenopetala also commonly used to ripen the banana and mango by covering with it so as to give optimum heat for fast ripening.

Ripen (sweet) and unripe (bitter) *M. stenopetala* in the market is identified by pressing the leaves with hand. When it is ripening, it is blackened while the unripen one whitened. Most of the cultivating farmers offer unripen/ bitter leaves for livestock and supply in the market. Agreed with the finding of this study, in earlier, Seifu (2014) reported as there are different ecotypes and varieties of M. stenopetala found in Ethiopia. M. stenopetala trees are often planted in the backyard/homestead and next up is farmland. Consistent with the current findings Dechasa et al. (2006) reported that in Konso area M. stenopetala is widely grown in home garden to save lives of densely populated communities. The plant abundance presented per respondents' was ranged from 1–100 M. stenopetala trees which is higher than the range of 1–40 M. stenopetala trees reported by Abay et al. (2015) in Tigray region of Northern Ethiopia. On average 18.46 ± 0.84 M. stenopetala trees were presented per respondents' which is four folds higher than average numbers reported by Abay et al. (2015).

M. stenopetala is a valuable resource and acts as a milking cow in the research area. It's also a one-of-a-kind tree that bears fruit in both the winter and summer seasons. Farmers planted M. stenopetala for food value, income generation, feed value, and medicinal value, in that order. The fodder biomass yield of M. stenopetala increases with tree maturity or age. M. stenopetala is used to supplement nutrient scarcity in the area for almost all types of ruminants. The twigs (leftover leaves) were the parts of *M. stenopetala* mainly provided to livestock as feed. M. stenopetala is traditionally used as a medicine for a variety of ailments.

M. stenopetala is also a fast-growing, drought-tolerant, easy-to-adapt-to-poor soil and arid-conditions tree plant with year-round leaves. Using year-round rurally available proteins fodder is the best option for closing the current commercial diet gap in the country as a whole and in the study area in particular. As a result, there is a need to popularize and promote the planting of this unique and multipurpose tree in all suitable lands and governmental institutions to replace costly and difficult-to-access agro-industrial concentrate feed resources in order to improve livestock production and productivity.

Declarations

Authors' contribution All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Guyo Demisse. The first draft of the manuscript was

written by Guyo Demisse and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability Data will be made available on request.

Ethics approval This is an observational study. The manuscript does not contain clinical studies or patient data.

Consent to participate All authors were participated in this manuscript.

Consent for publication All authors have consented to the submission of the manuscript in this journal.

Conflict of interest The authors declare no competing interests.

References

1. Abay, A., Berhane, E., Tadesse, T. and Meles, H, K., 2015. Moringa stenopetala Tree Species Improved Selected Socio-economic Benefits in Tigray, Northern Ethiopia. Science, Technology and Arts Research Journal, 4(2), 68-78, http //dx.doi.org/10.4314/star.v4i2.10
2. Demeke, S., Mekuriaw, Y., and Asmare, B., 2017. Assessment of livestock production system and feed balance in watersheds of North Achefer district, Ethiopia. Journal of Agriculture and Environment for International Development, 111(1), 175-190. https://doi.org/10.12895/jaeid.20171.574
3. Central statistical agency (CSA), 2021. Agricultural Sample Survey Volume II: report on livestock and livestock characteristics (Private peasant holdings). Central Statistics Authority (CSA), Statistical Bulletin 589. Addis Ababa, Ethiopia.
4. Cochran, W.G., 1977. Sampling Techniques, 3rd ed., New York: John Wiley and Sons
5. Dechasa, J., Sonder, K., Lalisa, A., Yalemtshay, M., Agena, A., 2006. Leaf yield and nutritive value of Moringa stenopetala and Moringa oleifera accessions: its potential role in food security in constrained dry farming agroforestry system. In: *Moringa* and other highly nutritious plant resources: strategies, standards and markets for a better impact on nutrition in Africa. Accra, Ghana, November 16–18
6. Duguma, B., Janssens, G.P.J., 2021. Assessment of Livestock Feed Resources and Coping Strategies with Dry Season Feed Scarcity in Mixed Crop–Livestock Farming Systems around the Gilgel Gibe Catchment, Southwest Ethiopia. Sustainability, 13, 10713. https://doi.org/ 10.3390/su131910713
7. Seifu E., 2014. Actual and Potential Applications of *Moringa stenopetala,* Underutilized Indigenous Vegetable of Southern Ethiopia: A review. International Journal of Agricultural and Food Research 3 (4): 8-19.
8. Jabbar, M., Negassa, A. and Gidyelew, T., 2007. Geographical distribution of cattle and shoats populations and their market supply sheds in Ethiopia. Discussion paper No. 2. Improving Market

Opportunities, International Livestock Research Institute (ILRI). Nairobi, Kenya. pp 54.

9. Kumssa D,B., Joy E.J.M., Young, S.D., Odee, D.W., Ander, E.L., Magare, C., 2017. Challenges and opportunities for Moringa growers in southern Ethiopia and Kenya. PLoS ONE 12(11): e0187651. https://doi.org/10.1371/journal.pone.0187651
10. Mebrate, G., Tewodros, A., 2019. The Application of Biotechnology on Livestock Feed Improvement. Archives in Biomedical Engineering & Biotechnology, 1 (5), ABEB.MS.ID.000522. DOI: 10.33552/ABEB.2019.01.000522
11. Negassa, A., Rashid, S. and Gebremedhin, B., 2011. Livestock Production and Marketing in Ethiopia. Ethiopian Support Strategy Program II (ESSP II) Working Paper 26. Washington, D.C.: IFPRI.
12. Pet Mark, M.V., 1983. Primary production, Nutrient cycling and OM turnover of tree plantation after agricultural intercropping practices in north east Thailand. PhD Dissertation. University of Philadelphia, Los Banos, Philadelphia, pp: 228.
13. Shonde, Y., 2017. Livelihood Contributions of Moringa Tree based Agroforestry Practices in Konso District, Southern Ethiopia. Journal of Resources Development and Management. 36, 1–9.
14. SPSS (Statistical Procedures for Social Sciences), 2011. SPSS (Version 20). Statistical Procedures for Social Sciences (SPSS) INC. Chicago, Illinois, USA. Support Program II, Addis Ababa, Ethiopia.
15. Tolera, A., Getnet, A., Diriba, G., Lemma, G., Alemayehu, M., 2012. Feed Resource Availability and Quality: In: Adugna Tolera, Yami Alemu, Alemu Daw it (Eds.). Livestock and Feed Resources in Ethiopia: Challenges, Opportunities and the need for transformation. Addis Ababa, Ethiopia: Ethiopian Animal Feed Industry Association, p. 5-36.
16. Welay, G.M., Tedla, D.G., Teklu, G.G., Weldearegay, S.K., Ishibashi, M.B., Kidane, H.H., Gebregziabher, B.B., Abraham, T.H., 2018. A preliminary survey of major diseases of ruminants and management practices in Western Tigray province; northern Ethiopia. BMC Veterinary Research, 14, 293.

Figures

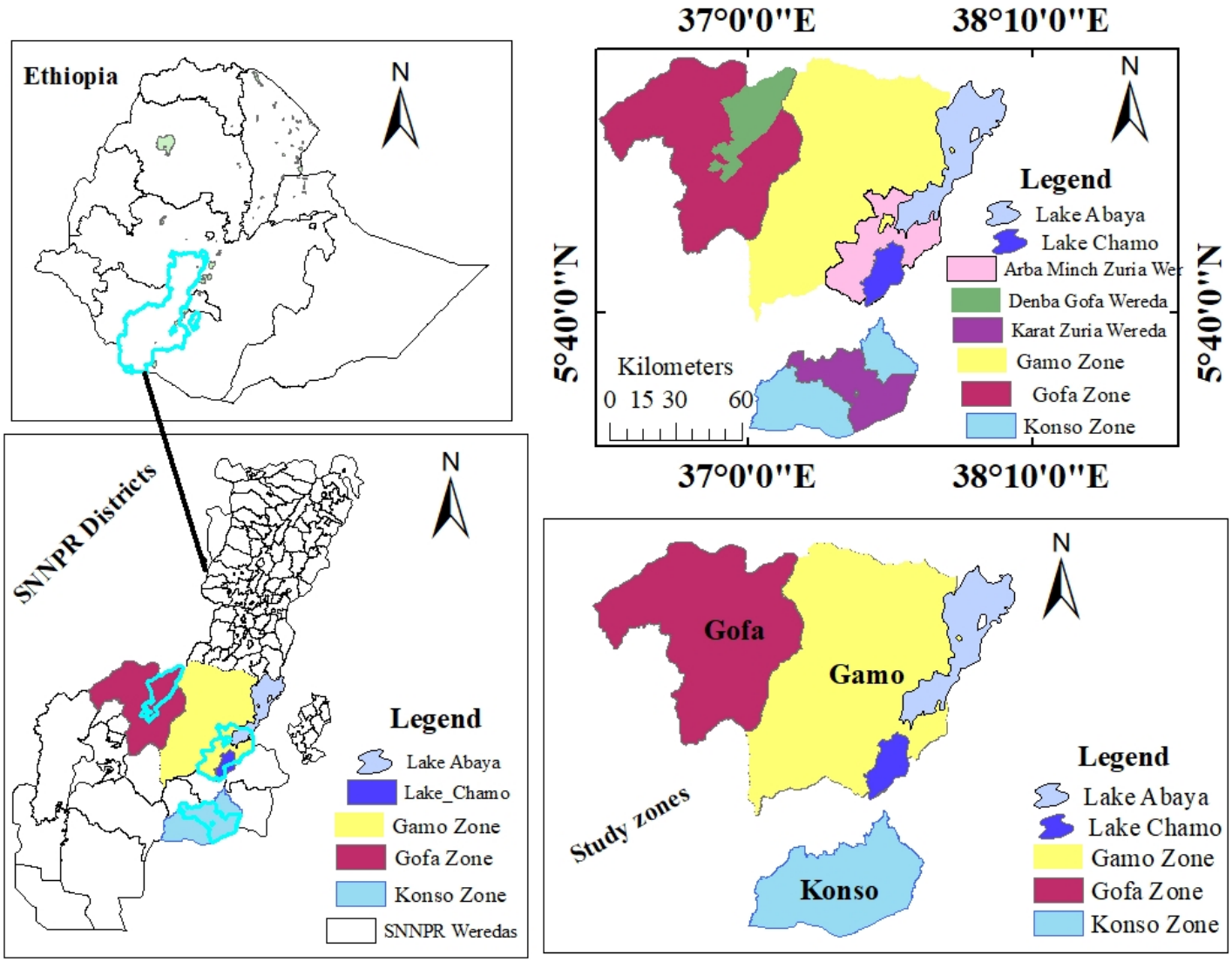

Figure 1

Map of the study area

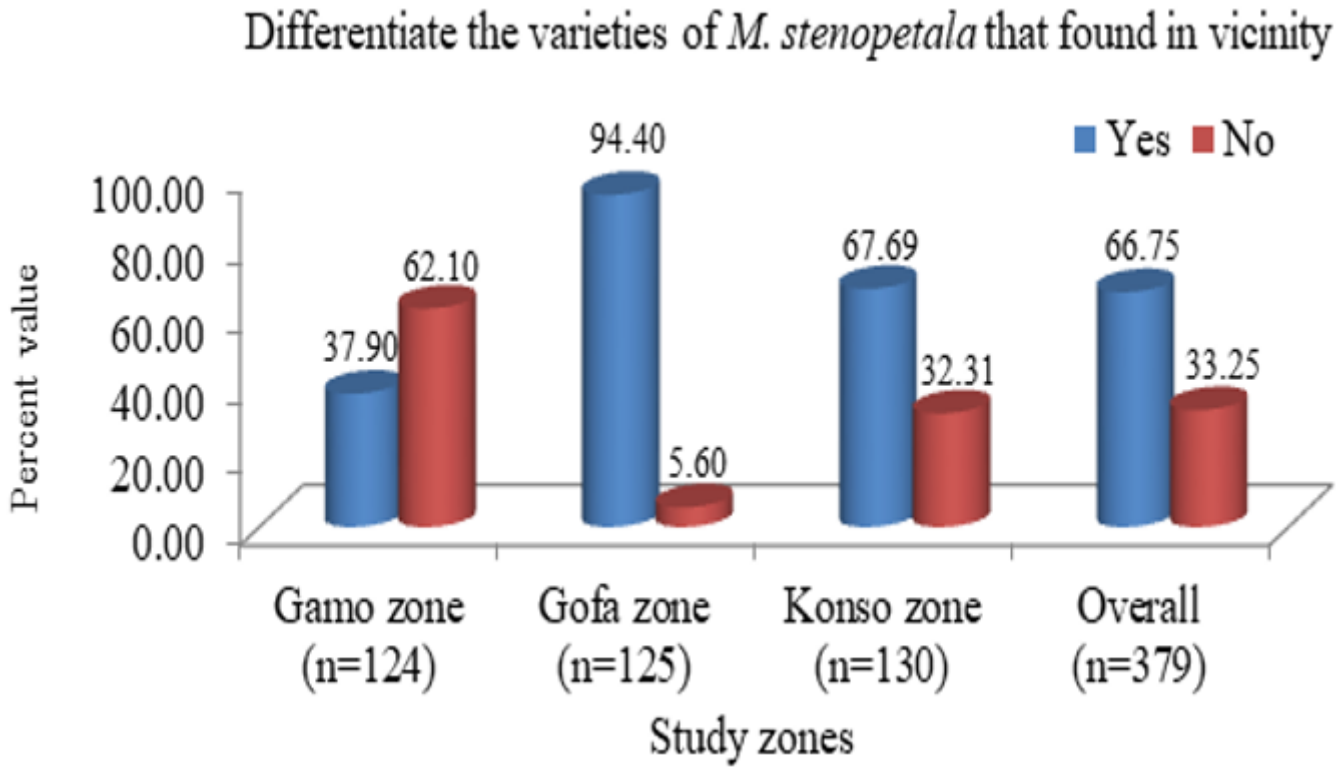

Figure 2

Farmers knowledge on identification of different M. stenopetala

Figure 3

Identified types of M. stenopetala: varieties of Photo captured from Konso zone

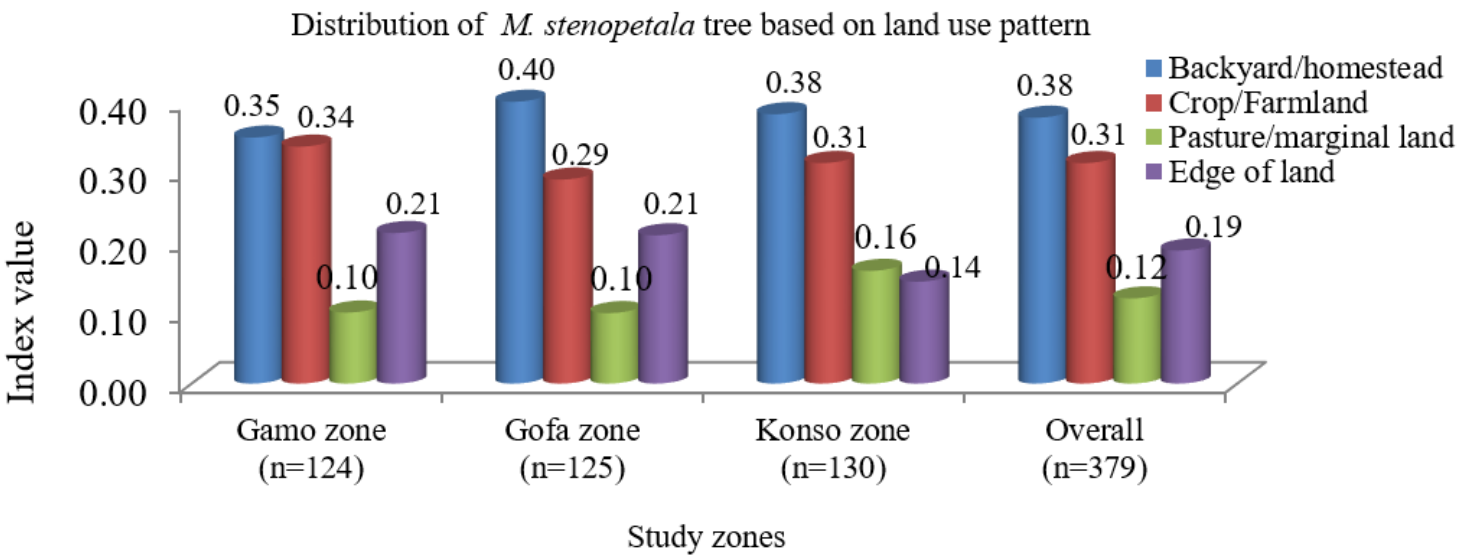

Figure 4

Planting population of M. stenopetala at different land-use patterns

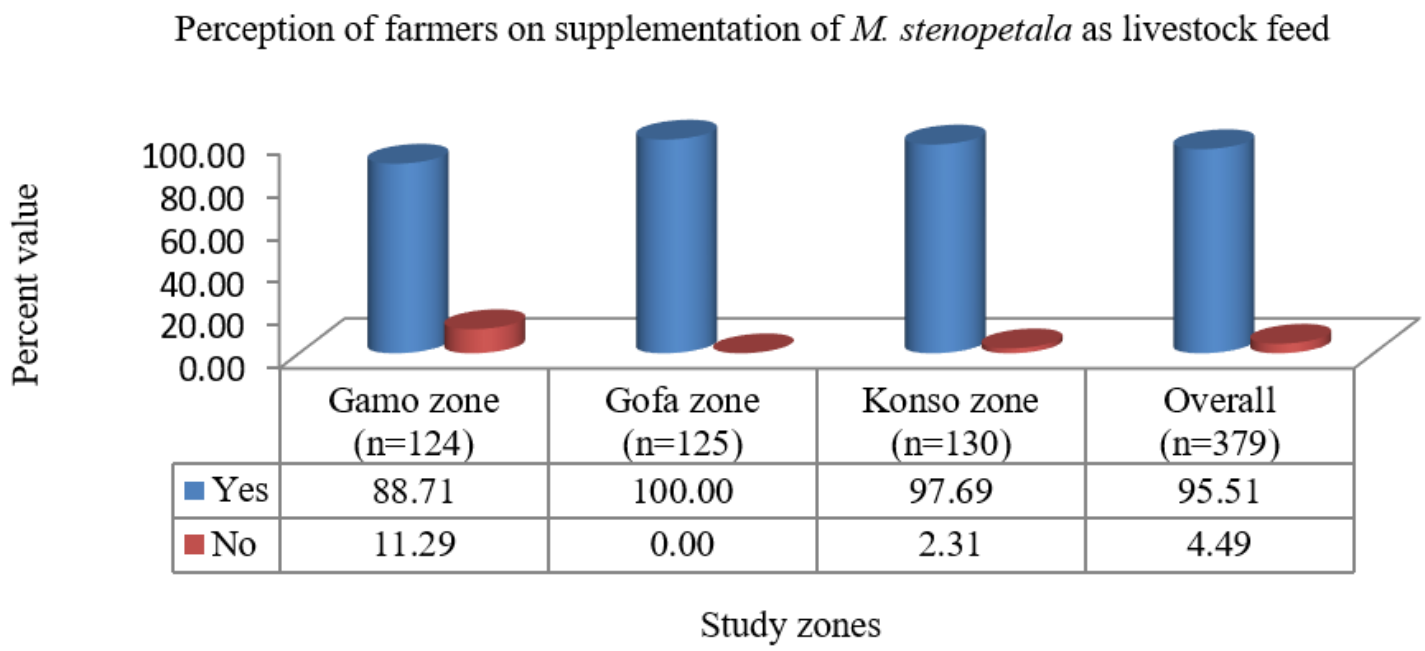

Figure 5

Perception of farmers on supplementation of M. stenopetala as livestock feed