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Unlocking the Potential of Multipurpose Fodder Trees and Grasses: Farmers' Perceptions, Adoption, and Management Practices in Aleta Wondo, Sidama, Ethiopia

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Abstract: Mixed crop–livestock systems dominate the Ethiopian highlands, yet their productivity remains constrained by chronic feed shortages and declining feed quality, particularly during the dry season. Integrating multipurpose fodder trees into these systems offers a sustainable strategy to improve livestock nutrition, enhance resource use efficiency, and strengthen the resilience of smallholder farming systems. This study examined farmers' perceptions, adoption, and management of multipurpose fodder trees and grasses (MPFTs) in Aleta Wondo district, Sidama, Ethiopia. Data were collected from 144 households selected through stratified random sampling across two kebeles. Descriptive statistics and a binary logistic regression model were employed for data analysis. The results revealed the presence of 26 fodder tree and grass species widely known and utilized by farmers. Respondents demonstrated strong knowledge of both indigenous and improved species, with high preference for grasses such as *Hyparrhenia rufa*, *Pennisetum purpureum*, and Desho grass, alongside protein-rich legumes including *Medicago sativa* and *Sesbania sesban*. Multipurpose trees such as *Leucaena leucocephala* and *Grewia bicolor* were highly valued for their palatability, adaptability, and year-round availability. Farmers selected species based on feed value, durability, ease of propagation, and resilience, while sustainable management practices particularly partial canopy harvesting and organic soil enrichment were commonly applied. The logistic regression results indicated that access to seedlings, institutional support, education level, household income, and land size significantly influenced adoption. Overall, the findings underscore that effective adoption of multipurpose fodder trees depends not only on farmers' knowledge but also on enabling institutional and resource conditions. Strengthening extension services, improving access to quality planting materials, and promoting locally adapted fodder species are therefore critical for enhancing livestock productivity, livelihood resilience, and sustainable farming systems.

Keywords: Adoption; Agroforestry; Aleta Wondo; Farmers' perception; Fodder trees; Livestock feed.

INTRODUCTION

In the Ethiopian highlands, mixed crop-livestock farming systems dominate the agricultural landscape, providing livelihoods for millions of smallholder farmers (Amejo et al., 2019). These systems, typically situated at elevations above 1500 meters above sea level with annual rainfall exceeding 700 mm, are characterized by intensive land use where crop and livestock sub-sectors compete for limited resources. Despite favorable climatic and edaphic conditions, livestock productivity remains low due to chronic feed shortages, especially during dry seasons when herbaceous forage becomes scarce (Mengistu et al., 2017). The predominant feed sources, natural pastures and cereal crop residues are often nutritionally inadequate, limiting both intake and digestibility (Bhandari, 2019). Agroforestry, defined by the deliberate integration of trees, crops, and/or livestock, offers a promising avenue to enhance livestock nutrition, conserve soil, and promote ecological resilience (Dissanayaka et al., 2023).

Consequently, the integration of protein-rich supplementary feeds, particularly multipurpose fodder trees (MPFTs), has been widely advocated as a sustainable solution to bridge the nutrient gap in smallholder systems (Mekoya, 2008). Within this framework, MPFTs such as *Sesbania sesban, Leucaena leucocephala, Calliandra calothyrsus*, and *Chamaecytisus palmensis* (Tree Lucerne) have been introduced in Ethiopia to solve such a feed shortage problem (Nair et al., 2022). These species, valued for their high protein content, rapid growth, and soil fertility benefits, was promoted extensively for both livestock feed and land restoration (Mekoya et al., 2008). More recently, over 30 organizations have been involved in the distribution and promotion of these species, with the moderate dissemination due different factors (unpublished report). Despite these large-scale efforts, adoption rates of MPFTs in smallholder systems remain low and uneven.

Many farmers ceased cultivation once external support was withdrawn, raising concerns about the sustainability and relevance of these interventions (Mekoya et al., 2008). Limited understanding or local perceptions, practical challenges in management, and socio-cultural factors have often been overlooked in fodder tree promotion programs (Jera & Ajayi, 2008). In some cases, farmers have reported negative effects of fodder trees on animal health for instance, concerns over reproductive issues in sheep fed with *S. sesban*: which were partially supported by short-term on-station studies (Mekoya, 2008; Oosting et al., 2011). These observations underscore the need to integrate farmer knowledge and experience into fodder development strategies to ensure their effectiveness and long-term sustainability. Furthermore, while MPFTs have received considerable attention, the role of grass species in smallholder forage systems is often under-researched despite their complementary functions in biomass production and erosion control (Feyissa et al., 2022). The adoption and management of these resources are constrained by several factors including land scarcity, labor requirements, limited access to planting material, and poor extension support (Lapar & Ehui, 2004; Maina et al., 2022). These challenges are embedded within broader socio-economic and policy environments that shape farmers' decisions and capacities to adopt new technologies. Therefore, enhancing the utilization of both fodder trees and grasses requires a deeper understanding of how farmers perceive their value, manage their cultivation, and navigate associated constraints in their specific agro ecological and socioeconomic contexts. This study was initiated to fill this knowledge gap by investigating farmers' perceptions, knowledge, and practices related to multipurpose fodder trees and grass species in the Aleta Wondo district of the Sidama region, Southern Ethiopia. The district, known for its diverse agro ecology and dynamic mixed farming systems, which is suitable for advancing sustainable forage development strategies. By focusing on farmers' perspectives, this research offer practical insights for enhancing the adoption of integrated forage resources in smallholder systems.

MATERIALS AND METHODS

Description of the Study Area

Aleta Wondo Woreda is one of 30 rural administration districts in the Sidama region, which is situated in a central geographic position inclining towards southern Ethiopia. With respect to its absolute location, it is situated between 6°30'00'' - 6°40'00'' latitude and 38°20'00''-38°30'00''longitude (Figure.1). The woreda has again 30 kebeles (the smallest administration unit in Ethiopia), among them about 19 kebeles are known by their potential production of *Coffea arabica L*. The total population of the woreda is 492,929, out of which male comprises 252,135 (51.2%) 68,238 and female 240,793 (48.8%) (Woreda Administration report, 2025). The total area of Aleta Wendo is 575.5 km², among these 64% is covered with agroforestry with permanent crops, 25% with annual crops, 8% is covered by natural, cooperative, and private forests, 2% is covered by grazing land and the remaining 1% of the land is covered by others.

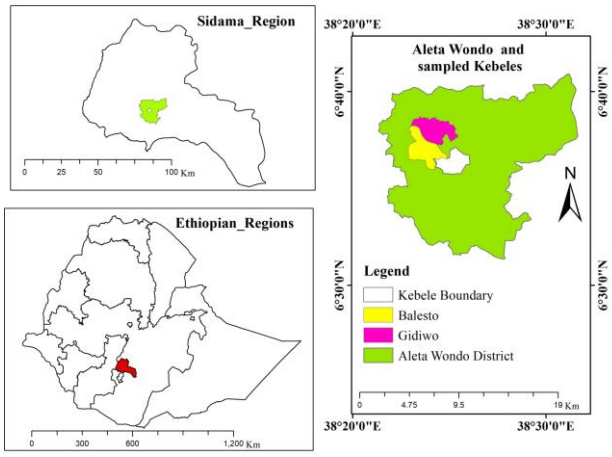

Figure 1. Geographic location of the study area in Ethiopia, showing Aleta Wondo district and the selected kebeles; Gidiwo and Balesto targeted for fodder species assessment.

Furthermore, the district is known for producing agro-forestry practices which make it greener ever. Regarding its agro-climatic condition, 63% is categorized under midland/woyina dega agro- climatic zone, while the remaining 37% of the landmass of the district constitutes highland/dega agro-climatic condition. The annual temperature of the district varies between 15.1°C to 22.5° while the annual rainfall ranges between 1200mm and 1600mm. The Farming system of the study area has the unique characterstics comprising both rainfall agriculture and mixed farming system which involves both crop production and animal husbandry. The major growing crops are *Coffea arabica L., Ensete ventricosum (Welw.) Cheesman., Zea mays L., Psophocarpus Neck. ex DC, Triticum aestivum L. and Myrtoideae Sweet, while Ensete ventricosum (Welw.) Cheesman and Zea mays L., are the main staple crops. Fruit trees like Persea americana Mill., Mangifera indica L., Jarilla heterophylla subsp. Heterophylla Heliconia densiflora subsp. densiflora,*

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Psidium guajava L., Passiflora edulis(Passion fruit) and shade trees like *Millettia ferruginea (Hochst.) Hochst. ex Baker* and *Albizia gummifera* are the dominant trees in the district. Farmers grow *Ensete ventricosum (Welw.) Cheesman* for multipurpose such as food, animal feed, construction of traditional houses by its physical parts and to keep the homegarden green and beauty (Mengistu and Fitamo, 2015; Matewos et al. 2023). Stall feeding using *Ensete ventricosum (Welw.) Cheesman* leaves, *Zea mays L.* stover, and foliage from local multipurpose trees is the prevailing livestock feeding practice. Exotic multipurpose fodder trees (EMPFT) such as *Sesbania sesban*, *Calliandra calothyrsus*, and *Leucaena leucocephala*, along with grass species like Napier and Guatemala grass, were introduced for animal feed and soil conservation.

Theoretical Framework

This study is guided by the Diffusion of Innovations Theory, the Sustainable Livelihoods Framework, and behavioral theories of adoption. Farmers' adoption and management of multipurpose fodder trees and grasses are influenced by their perceptions of benefits and risks, access to resources, and institutional support. Socio-economic characteristics, access to extension services, and environmental conditions shape farmers' perceptions, which in turn determine adoption decisions and management practices. Together, these factors explain variations in farmers' uptake and sustainable management of multipurpose fodder species in Aleta Wondo, Sidama, Ethiopia.

Sampling techniques

The administrative system of Ethiopia follows the region- zone-woreda-kebele hierarchy. Woreda is equivalent to a district, while kebele refers smallest administrative unit. Two kebeles namely Gidiwo and Balesto were chosen to collect primary data with a history of engagement in fodder tree cultivation. To determine the appropriate sample size, Yamane's formula (1967) was used: n=N/1+N(e)2 ; Where: n = sample size, N = total number of households in the study kebeles (which is equal to 1,700); e = desired level of precision (0.08), n≈144. Thus, a sample size of 144 households were determined and proportionally selected from the two kebeles using stratified random sampling, ensuring representation across adopters and non-adopters of MPFTs.

Data Collection Methods

A **cross-sectional survey** design was employed to assess farmers' knowledge, perception, and use of multipurpose fodder trees and grasses. Primary data for the household survey were collected through face-to-face interviews conducted in the local Sidama language by trained enumerators using a structured and pre-tested questionnaire. During data collection, socio-economic characteristics such as age, gender, education level, family size, and off-farm income activities; farm characteristics including landholding size, land use type, livestock types and holdings, crop types, and integration practices; knowledge of fodder tree and grass species, past experience, Value, interest, focusing on awareness, perceptions, motivations for planting were gathered. Moreover, the number and types of multipurpose fodder trees (MPFTs) and grasses on farms; management and utilization practices, encompassing feeding practices, constraints and adoption barriers would also have been gathered. To enrich and validate survey data, 2 FGDs were conducted with 20 farmers selected from the two kebeles. Farmers also participated in a ranking exercise for a five-point likert scale (1 = poor, 5 = excellent) giving them five corn kernels to evaluate performance attributes such as palatability, growth rate, drought tolerance, and biomass yield for the fodder trees and grass species. Key informants including development agents, agricultural experts, and local leaders were interviewed to provide contextual information on fodder promotion activities, extension interventions, and institutional support systems.

Data Analysis

Quantitative data were entered and analyzed using SPSS (Version 25). Descriptive statistics (means, frequencies, and percentages) were used to summarize socio-economic and farm characteristics. Likert scale was employed to rate their perception on the quality of fodder trees and grasses. The binary logistic regression model was used to identify adoption factors of MPFTs and grass species. Qualitative data from FGDs and key informant interviews were analyzed thematically, and triangulated with quantitative findings to provide a holistic understanding of farmers' perceptions and practices.

RESULTS AND DISCUSSIONS

Socio-economic characteristics play a significant role in influencing the adoption of agroforestry practices, including the integration of multipurpose fodder trees (MPFTs) and grasses. Understanding these characteristics provides valuable insights into the demographic, educational, and economic profiles of the surveyed households, which are critical in shaping their adoption behavior and decision-making processes. This section presents key socio-economic variables such as age, gender, education level, household size, farm size, livestock holdings, and income sources (Table 1). Additionally, distinctions are made between adopters and non-adopters to highlight the variations in their socio-economic profiles.

Table 1: Socio-Economic Characteristics of Respondent Households

Variable	Adopters (n = 90)	Non-Adopters (n = 54)	Entire Sample (n = 144)
Age of Household Head (years)	42.5	44.8	43.5
Proportion of Male-Headed Households (%)	75.6	68.5	72.2
Proportion of Female-Headed Households (%)	24.4	31.5	27.8

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Education Level of Household Head			
- No education (%)	30.0	42.0	34.7
- Primary (%)	45.0	36.0	41.7
- Secondary (%)	15.0	11.0	13.9
- Above Secondary (%)	10.0	11.0	9.7
Family Size (persons)	6.5	5.9	6.3
Farm Size (ha)	0.80	0.65	0.75
Land per Adult Equivalent (ha)	0.52	0.39	0.46
Off-Farm Income (%)			
- Engaged	35.0	48.0	39.6
- Not Engaged	65.0	52.0	60.4
Land Use Type (%)			
- Agroforestry	66	69	none
-Annual crops	20	20	-
-plantation	8	8	-
-grass and others	6	3	-
Livestock Holdings (TLU)	3.7	2.3	3.0
Number of Crossbred Cows (TLU)	1.2	0.4	0.8
Number of Local Breed Cows (TLU)	2.5	1.9	2.2
Crop Types Grown			
- Zea mays L.	✓	✓	✓
- *Ensete ventricosum (Welw.) Cheesman*	✓	✓	✓
- *Coffea arabica L.*	✓	✓	✓
- *Saccharum officinarum L.*	✓	✓	✓
- *Musa accuminata Colla*	✓	✓	✓
- *Psophocarpus Neck. ex DC*	✓	✓	✓
- Fruits	✓	✓	✓

The socio-economic characteristics of households reveal critical differences between adopters and non-adopters that influence their adoption behavior. Adopters tended to have slightly younger household heads (42.5 years compared to 44.8 years for non-adopters) and a higher proportion of male-headed households (75.6% vs. 68.5%), while female-headed households were more common among non-adopters (31.5%). Education levels also played a significant role, with a smaller proportion of adopters having no education (30% vs. 42% for non-adopters), and a higher proportion completing primary education (45% vs. 36%). Additionally, adopters had slightly larger family sizes (6.5 persons vs. 5.9 persons), larger farms (0.80 ha vs. 0.65 ha), and more land per adult equivalent (0.52 ha vs. 0.39 ha), indicating that resource availability positively influenced adoption decisions. Interestingly, a greater proportion of non-adopters (48%) were engaged in off-farm income activities compared to adopters (35%), suggesting that reliance on off-farm income might divert attention from agricultural activities.

Livestock holdings were also slightly higher among adopters, with an average of 3.7 TLU compared to 2.3 TLU for non-adopters, and adopters owning more crossbred cows (1.2 TLU vs. 0.4 TLU). Both groups extensively practiced agroforestry and cultivated a diverse range of crops, including Zea mays L., *Ensete ventricosum (Welw.) Cheesman, Coffea arabica L., Saccharum officinarum L., Musa accuminata Colla*, *Psophocarpus Neck. ex DC*, and fruits, reflecting the importance of integrated farming systems in the region. Among the entire sample, 62.5% of households were adopters, while 37.5% were non-adopters. These findings suggest that adopters typically benefit from better access to land, education, and improved livestock breeds, while non-adopters may face constraints related to resource availability and income dependence, which limit their ability to adopt agricultural practices.

Multipurpose Fodder Species and their Palatability for the cattle

The following table presents a list of locally known indigenous and exotic fodder species in both local and scientific names. These species, including trees, grasses, legumes, and alternative feed sources, play a critical role in sustaining livestock productivity, especially during periods of forage scarcity. Each species has been categorized based on its botanical and local name, type or classification, the plant parts used as fodder, and its palatability or preference by cattle (Table 2).

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Table 2: Diversity and Utilization of Multipurpose Fodder Species and their Palatability for the cattle

No.	Botanical name	Sidama Local name	Type/ classification	Parts Used as Fodder	Palatability/Preferred by Cattle
1	*Persea americana*	Awukaato	Tree	Leaves	Moderate
2	*Typha angustifolia*	Shisho	Tree	Leaves	High
3	*Millettia spp*	Hengedicho	Tree	Leaves	High
4	*Cordia africana*	Wadicho	Tree	Leaves, tender shoots	Moderate to high
5	*Vernonia amygdalina*	Hecho	Tree	Leaves, tender branches	Moderate to high
6	*Ekebergia capensis*	Oloncho	Tree	Leaves,tender branches	Moderate to high
7	*Olea capensis*	Setamo	Tree	Leaves, pods	High (young leaves are preferred)
8	*Grewa bicolar*	Soyama	Tree	Leaves, pods	Very high (leaves are highly palatable)
9	*Calliandra calothyrsus*	kallindra	Tree	Leaves, flowers	Moderate to high
10	*Sapium ellipticum*	Gaancho	Tree	Leaves	Moderate
11	*Acacia spp*	Waacco	Tree	Leaves, young pods	High (leaves are especially preferred)
12	*Sesbania sesban*	Sasbaniya	Shrubs	Leaves, pods	High (pods are highly preferred)
13	*Leucaena leucocephala*	Lusiniya	Shrubs	Leaves,	Moderate to high
14	*Moringa stenopetala*	Shifara	Tree	Leaves, pods	Very high (leaves are highly palatable)
15	*Faidherbia albida*	Fayiderbiya	Tree	Leaves, young pods	High (leaves are especially preferred)
16	*Tripsacum andersonii*	Guwatimala	Grass	Leaves, pods	High (pods are highly preferred)
17	*Hyparrhenia rufa*	Shambaleta	Grass	Whole plant	Very high (young leaves preferred)
18	*Pennisetum purpureum*	Elefant	Grass		
19	*Chloris gayana*	Rodese	Grass	Whole plant (stems, leaves)	Very high (young leaves preferred)
20	*Chrysopogon zizanioides*	Wetiwere	Grass	Leaves, stems	High
21	*Pennisetum pedicellatum*	Desho	Grass	Leaves	Moderate (less preferred)
22	*Medicago sativa*	Alfalfa	Legumes	Leaves, stems	High (preferred by cattle)
23	*Lab-lab*	Lab-lab	Legumes	Whole plant	Very high
24	*Ensete ventricosum (Welw.) Cheesman*	Weese	Shrubs		
25		Muuze	Shrubs	Whole parts	High
26	Sugarecane	shonkoora	Shrubs	Whole parts	High
27	Indigenous grass	Hayisso	Grass	Whole parts	High
27	Concentrates	Firshika	silage	-	Very high

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The results of the (Table 2) revealed that there are a rich diversity of fodder resources utilized by smallholder farmers, reflecting deep indigenous knowledge and adaptation to local agro ecological conditions. A total of 26 plant species were identified and classified into trees, shrubs, grass and leguminous forages, based on their morphological characteristics and feeding roles. Fodder trees, in particular, dominate the landscape as the primary source of dry-season feed and protein supplementation. Indigenous tree species such as *Typha angustifolia* (locally known as Shisho) and *Millettia spp* (Hengedicho) were reported to have highly comfortable for chewing**,** especially their leaves are widely preferred by the cattle. These species are recognized for their resilience and ability to maintain green biomass during feed-scarce periods. Among the most valued fodder trees, *Grewia bicolor* (Soyama) and *Leucaena leucocephala* (Lusiniya) preferred by their leaves and pods. Farmers consistently reported that cattle exhibited strong preferences for these species, underlining their importance not only in nutritional value but also in voluntary intake. Other multipurpose trees such as *Cordia africana* (Wadicho**)**, *Vernonia amygdalina* (Hecho), *Ekebergia capensis* (Oloncho**),** and *Calliandra calothyrsus* (leguminous tree) were rated as moderate to high in palatability. Their use was often seasonal, with tender shoots and leaves being more desirable during early growth stages. The study also documented the widespread use of grass species, which are integral to the forage base in Aleta Wondo. *Tripsacum andersonii* (Guatemala) and *Pennisetum purpureum* (Elephant grass) were among the most preferred, especially their young leaves and soft stems, which are highly palatable and yield substantial biomass. *Chloris gayana* (Rhodes**)** and *Pennisetum pedicellatum* **(**Desho grass) followed closely, both recognized for their adaptability and nutritional contribution. Although *Chrysopogon zizanioides* (Vetiver) was listed, its palatability was reported as moderate**,** making it less preferred for direct feeding, though it plays an important role in soil conservation. Leguminous forages were also part of the feed inventory, with *Medicago sativa* (Alfalfa**)** being particularly prized for its very high palatability and protein content, making it ideal for lactating animals and young stock. *Lablab purpureus* **(**Lablab**)** was mentioned as a leguminous option, though detailed usage data was limited. In addition to conventional fodder species, farmers in Aleta Wondo use a range of alternative feed **sources** such *Ensete ventricosum (Welw.) Cheesman* (false banana), *Musa accuminata Colla*, and *Saccharum officinarum L*. These crops are incorporated into feeding regimes during dry season while the livestock faced feed shortage as they keep their moisture content. Their high palatability ensures good intake, particularly when other forages are scarce. Furthermore, silage provision**,** specifically purchasing from local market to the young and milking cow during very dry and very wet season on which milking cows need additional supplements (Firshika**)**. Overall, the findings demonstrate that farmers in Aleta Wondo employ a multifaceted feeding strategy, combining indigenous trees, improved grasses, legumes, and alternative biomass sources to support their livestock throughout the year.

Farmers Perceptions on Livestock Feed Palatability and their preferences

Understanding farmers' perceptions of livestock feed palatability and their preferences are crucial for identifying the most suitable fodder options and improving livestock productivity. Farmers' perspectives are shaped by their observations of livestock feeding behavior, feed intake, and the resulting performance of animals in terms of health, milk production, and weight gain (Table 3).

Table 3: A Five Point Likert Scale for Farmers Perceptions on Livestock Feed Palatability and choice

No.	Statement	1	2	3	4	5	Total value	Weighted Mean	Rank
1	Avocado (*Persea americana*) is a palatable and preferable feed for my cattle.	10	22	10	85	17	144	3.53	19
2	Typha angustifolia is a palatable and preferable feed for my cattle.	18	20	10	80	16	144	3.39	24
3	*Millettia spp.* is a palatable and preferable feed for my cattle.	3	5	15	86	35	144	4.0	14
4	*Cordia africana* is a palatable and preferable feed for my cattle.	14	20	15	80	15	144	3.43	22
5	*Vernonia amygdalina* is a palatable and preferable feed for my cattle.	4	6	24	84	26	144	3.85	15
6	*Ekebergia capensis* is a palatable and preferable feed for my cattle.	14	21	10	85	14	144	3.44	21
7	*Olea capensis* is a palatable and preferable feed for my cattle.	16	18	24	74	12	144	3.33	26
8	*Grewa bicolar* is a palatable and preferable feed for my cattle.	13	14	17	78	22	144	3.57	18

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9	*Calliandra calothyrsus* is a palatable and preferable feed for my cattle.	15	19	26	70	14	144	3.34	25
10	*Sapium ellipticum* is a palatable and preferable feed for my cattle.	36	20	18	55	15	144	2.95	27
11	*Acacia spp*. is a palatable and preferable feed for my cattle.	10	18	26	70	20	144	3.5	20
12	*Sesbania sesban* is a palatable and preferable feed for my cattle.	3	4	5	82	50	144	4.19	9
13	*Leucaena leucocephala* is a palatable and preferable feed for my cattle.	1	4	7	86	46	144	4.19	9
14	*Moringa stenopetala* is a palatable and preferable feed for my cattle.	22	14	13	70	25	144	3.43	22
15	*Tripsacum andersonii* is a palatable and preferable feed for my cattle.	1	2	1	92	48	144	4.28	5
16	*Hyparrhenia rufa* is a palatable and preferable feed for my cattle.	0	1	3	88	52	144	4.33	1
17	*Pennisetum purpureum* (Elephant grass) is a palatable and preferable feed for my cattle.	1	2	0	91	50	144	4.30	3
18	*Chloris gayana* is a palatable and preferable feed for my cattle.	0	5	1	88	50	144	4.27	7
19	*Chrysopogon zizanioides* is a palatable and preferable feed for my cattle.	1	3	2	87	51	144	4.28	5
20	*Pennisetum pedicellatum* (Desho grass) is a palatable and preferable feed for my cattle.	0	1	5	86	52	144	4.31	2
21	*Medicago sativa* (Alfalfa) is a palatable and preferable feed for my cattle.	0	2	3	88	51	144	4.3	3
22	*Lab-lab* is a palatable and preferable feed for my cattle.	1	3	4	90	46	144	4.23	8
23	Weese is a palatable and preferable feed for my cattle.	2	4	10	87	41	144	4.12	12
24	Muuze is a palatable and preferable feed for my cattle.	13	5	16	90	20	144	3.68	17
25	*Saccharum officinarum L.* is a palatable and preferable feed for my cattle	15	10	9	80	30	144	3.69	16
26	Indigenous grass is a palatable and preferable feed for my cattle	4	4	3	95	38	144	4.1	13
27	Silage is a palatable and preferable feed for my cattle	5	0	7	88	44	144	4.15	11

******* 1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree**

The top 10 most preferred and palatable feeds for cattle highlight a mix of highly nutritious grasses and legumes (Table 3). *Hyparrhenia rufa* (97.2%) ranked first, favored by farmers for its palatability and adaptability, followed closely by *Pennisetum pedicellatum* (Desho grass) (96.5%), known for its superior nutritional value. Legumes like *Medicago sativa* (Alfalfa) (95.8%), *Pennisetum purpureum* (Elephant grass) (95.2%), and *Chrysopogon zizanioides* (95.1%) were also highly rated due to their high productivity, resilience, and ease of cultivation. Additionally, *Tripsacum andersonii* (95.2%) and *Chloris gayana* (95.8%), both drought-tolerant and nutrient-rich grasses, were valued as essential components of livestock feed systems. Legumes such as *Sesbania sesban* (91.7%), *Lab-lab* (94.4%), and *Leucaena leucocephala* (91.7%) were preferred for their high protein content and ability to complement other feeds while improving soil fertility. Farmers' selection of these top feeds showcases a clear preference for sustainable and locally adaptable options, which can enhance livestock productivity and reduce reliance on external feed inputs. The findings emphasize the importance of promoting diverse forage resources to support smallholder farming systems effectively.

Fodder Tree Species Selection by Households

A survey of 144 households was conducted to identify the primary criteria influencing their selection of tree species. The results, presented in the chart below, reveal a clear hierarchy of preferences, with a strong emphasis on trees that provide direct and tangible benefits for livestock and long-term farm resilience.

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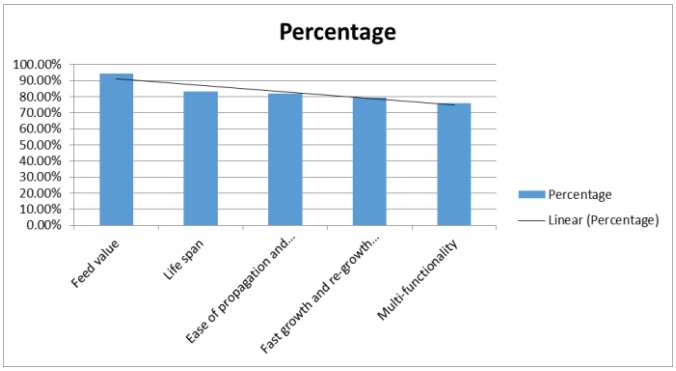

Figure2: The selection criteria of Fodder trees by the community

The analysis of tree species selection criteria reveals a clear and strategic prioritization by farmers, centered on maximizing livestock productivity and ensuring long-term farm resilience (figure 2). The overwhelming majority of households (94.4%) identified Feed Value encompassing palatability and improvements to animal health, growth, and milk yield as their primary consideration, establishing it as the non-negotiable cornerstone of their agroforestry system. This focus on immediate livelihood support is balanced by a forward-looking emphasis on sustainability, with Life Span (83.3%) being the second most critical factor, indicating a strong preference for perennial species that provide a reliable, long-term resource. Practical management concerns are also paramount, as evidenced by the high importance placed on Ease of Propagation and Accessibility (81.9%) and Fast Growth and Re-growth Potential (79.2%), which ensures that trees can be established easily and provide a quick, sustainable return on labor. Furthermore, farmers demonstrate a clear preference for versatile and resilient species, with Multi-functionality (75.7%) and Adaptability (72.2%) being highly valued, ensuring trees provide a suite of benefits like timber, soil fertility, and drought resistance alongside their primary role as fodder sources. In essence, the ideal tree is not defined by a single trait but is a multi-purpose, resilient, and easily managed asset that sustainably supports the core initiative of animal husbandry**.** The FGDs unanimously confirmed that the highest priority for farmers is the Feed Value of a tree species. Participants extensively discussed and ranked species like *Sesbania sesban and Vernonia amygdalina* as top choices precisely because of their observed positive impact on palatability, animal body condition, and milk yield, directly aligning with the 94.4% preference from the survey.

Furthermore, the discussions provided deeper insight into the high ranking of Life Span (83.3%) and Multi-functionality (75.7%). Species such as *Cordia africana and Ficus vasta* (not in a table) were frequently praised not only for their longevity but for their multiple uses including shade, timber, and soil improvement which makes them foundational "keystone" assets on the farm. The FGDs also elaborated on the practical importance of Ease of Propagation and Fast Re-growth, with farmers explaining how these traits in species like *Leucaena leucocephala* reduce labour and ensure a sustainable, year-round fodder supply, thus confirming the high scores of 81.9% and 79.2% for these criteria respectively.

Fodder growing niches and sources of seeding

The table below describes fodder growing niches and sources of seedlings. For fodder growing, the most common niche is "On the boundary of the farm" with a frequency of 74, which is equivalent to 51.4%. Regarding seedling sources, most people follow "both collecting from mother tree and using propagation" with a frequency of 82 and 56.9%. The table also shows methods for how to establishing the grass. Thus, both "By cutting and transplanting" take the highest figure, with a frequency of 67 and a percentage of 63.8%. This means majority of the people establish their grass by both cutting and transplanting (Table 4).

Table 4: Fodder Growing Niches, Seedling Sources, and Grass Establishment Methods (n=144)

Category	Options	Frequency	Percentage (%)
Fodder Growing Niche	On the boundary of the farm	74	51.4
	Home garden	42	29.1
	Farm land	28	19.5
Source of Seedlings	By propagating	18	12.5
	Seed from mother tree	44	30.6
	Both from mother tree and by propagating	82	56.9
Grass Establishment Method	By cutting	46	32
	By transplanting	31	21.5
	By cutting and transplanting	67	46.5

Management Practices of Tree Species

This pie chart richly illustrates the management practices for multipurpose fodder trees, emphasizing their role in sustainable agroforestry systems (figure 3). The integration of compost application and silvicultural activities takes the lead at 36%, indicating the synergy of these practices in enhancing tree health, soil fertility, and fodder productivity (Singh et al., 2024). Silvicultural activities alone such as weeding, pruning, thinning, and pollarding contribute significantly at 34%, highlighting their importance in maintaining the vitality and growth of fodder trees (Figure 3). Organic enrichment methods, including the application of compost, cow dung, leaves, ash, and Ensete ventricosum (Welw.) Cheesman debris, account for 28%, demonstrating the critical role of nutrient

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recycling in improving tree and fodder quality (Teklay, 2005). Meanwhile, unmanaged trees represent a mere 2%, underscoring the necessity of active management practices. These findings provide valuable insights for scholars, advocating for integrated and sustainable management approaches to optimize the productivity and ecological benefits of multipurpose fodder trees.

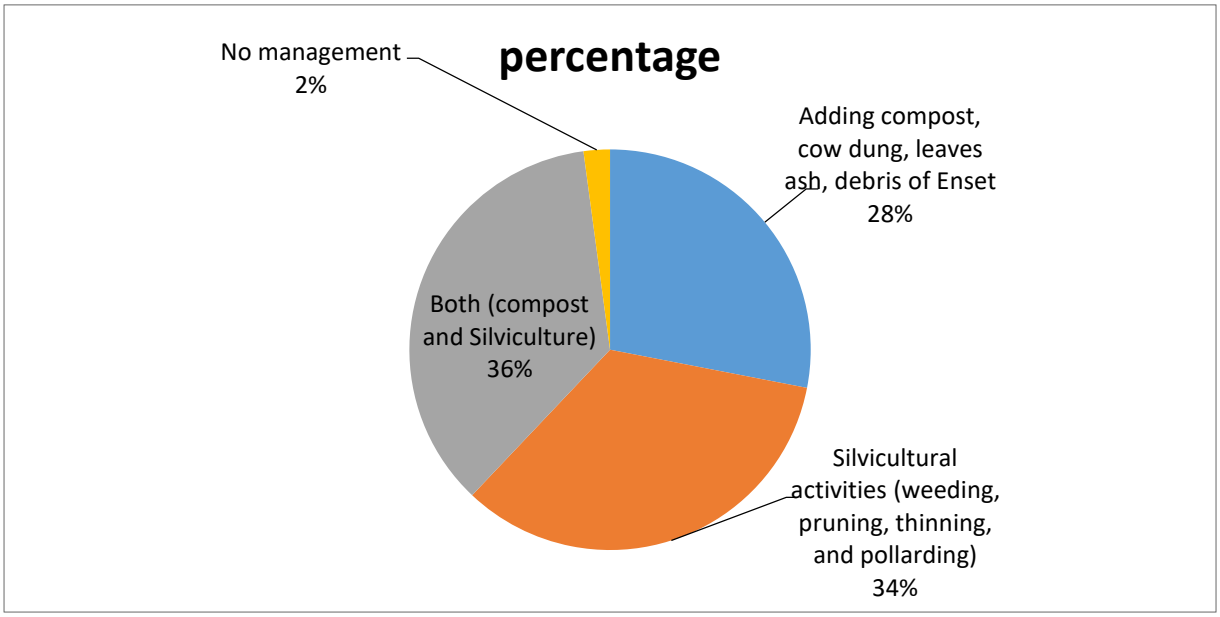

Figure 3: Farmers' Management Practices of Multipurpose Fodder Trees

The data on tree management practices reveals that farmers are highly engaged in actively maintaining their trees, with a clear preference for combined and intensive management strategies. The vast majority of households reported using at least one form of tree management. The most common approach, employed by households is a combined strategy (figure 3) that integrates both fertilization (e.g., adding compost, cow dung) and silvicultural practices (e.g., weeding, pruning). This indicates an understanding that optimal tree growth requires both nutrient input and physical form management.

Level of Harvesting Intensity for Feed

The awareness on the "Level of Harvesting Intensity for Feed" provides a comprehensive overview of the extent to which fodder resources are utilized for livestock feed. The deep understanding on the different harvesting intensities helps to reflect the balance between meeting immediate feed demands and ensuring the sustainable management of fodder trees (Table 5).

Table 5: The Level of Harvesting Intensity of fodder trees for feeding the cattle

How much the level of harvesting intensity for the feed	**Frequency**	**Percentage**
¼ parts of the canopy from shade trees	42	28.6%
½ parts of the canopy from shade trees	24	16.3%
¼ parts from some trees and ½ parts from others	32	21.8%
¼ parts from some trees and 1/3 parts from others	36	24.5%
Only the lower parts of the branches	10	6.8%
Total	144	100%

The most common strategy, employed by over 28.6% of households, is the harvesting of one-quarter (¼) of the canopy from shade trees. This is closely followed by farmers who use a mixed strategy, combining ¼ and ⅓ harvesting on different trees (24.5%), and those who mix ¼ and ½ harvesting (21.8%). Together, these three categories, all centered on partial canopy harvesting, account for a combined 74.9% of all practices (Table 5). This demonstrates a dominant belief of sustainability, where farmers intentionally leave a significant portion of the tree intact to ensure its survival and continued growth (Roothaert, 1999). In contrast, the more intensive practice of taking half (½) of the canopy is less common, used by only 16.3% of households. The most conservative approach, harvesting only the lower parts of the branches, is the least common strategy at 6.8%, likely applied to specific tree species or to maintain a clear understory.

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Binary Logistic Regression Results

The table below presents the results of a binary logistic regression model, analyzing the key factors influencing the adoption and management of multipurpose fodder trees (MPFTs). The variables included in the model range from socioeconomic aspects, such as income and education level, to institutional support and environmental factors like soil quality and rainfall patterns (Table 6). By examining the coefficients, odds ratios, and statistical significance (p-values), the table provides valuable insights into the relative importance and impact of these factors.

Table 6: Factors influencing adoption of multipurpose fodder trees and grasses

Variable	Coefficient (β)	Standard Error	p-value(α)	Odds Ratio (e^β)
Income	0.55	0.13634	0.045	1.73
Education Level	0.40	0.15723	0.012	1.49
Access to Extension Services	0.65	0.14957	0.073	1.923
Access to Seeds/Seedlings	0.76	0.23410	0.024	2.981
Gender	0.57	1.72123	0.289	1.723
Interest	1.32	2.45561	0.786	2.134
Land Size	0.25	0.16512	0.016	1.284
Family Size	0.41	1.43154	0.480	1.324
Knowledge of MPFTs/Grass Species	0.45	0.18967	0.025	1.570
Number of Livestock Population	0.30	0.17089	0.034	1.352
Soil Quality	0.10	2.12358	0.380	1.113
Value of the fodder trees	1.67	0.98797	0.764	1.607
Motivations for Planting	0.56	1.67453	0.07	1.932
Rainfall Patterns (Stable)	-0.15	0.20549	0.450	0.865
Market Access	0.05	0.14551	0.740	1.054
Institutional Support	0.56	1.41238	0.023	3.234

The binary logistic regression model provides convincing information about the factors influencing the adoption and management of multipurpose fodder trees (MPFTs). Among the variables analyzed, access to seeds/seedlings (p = 0.024) and institutional support (p = 0.023) emerge as the most significant determinants, demonstrating their strong positive influence on adoption rates. These findings highlight the critical role of seed availability and institutional backing in promoting the integration of MPFTs into agroforestry systems. The finding is in lined with Franzel et al. (2001); determinants influencing the adoption of agroforestry practices, focusing on fodder trees and shrubs. Meaning that, Farmers who had better access to planting materials and extension services were significantly more likely to adopt multipurpose tree species. Similarly, income (p=0.045), education level (p = 0.012), and knowledge of MPFTs/grass species (p = 0.025) also exhibit a statistically significant impact, underlining the importance of socioeconomic and informational factors in driving sustainable fodder tree management. The finding highlights that the role of education and knowledge in equipping farmers with the skills and awareness necessary for successful implementation of agroforestry practices. Variables such as land size (p = 0.016) and number of livestock population (p = 0.034) motivations for planting (p = 0.07) show a positive statistical significance and further emphasize the link between resource availability and fodder tree adoption. Study conducted by Pattanayak et al. (2003) supports the role of income and land size in influencing adoption decisions. In contrast, variables like gender, family size, rainfall patterns, and market access, knowledge on the value of fodder trees exhibit no statistically significant influence, suggesting limited or inconsistent effects on MPFT management.

CONCLUSION

This study offers critical insights into the adoption patterns, species preferences, and management practices of multipurpose fodder trees among smallholder farmers in Aleta Wondo. The results highlight that adoption is not merely a function of awareness but is deeply rooted in resource availability, institutional support, and socio-economic conditions. Majority of people have a deep understanding of which fodder trees and grass species work best for their land and livestock feed. However, not all farmers are using these multipurpose fodder trees. Farmers who adopt MPFTs typically possess more land, better education, and stronger livestock assets positioning them to earn the benefits of improved animal nutrition and sustainable forage supply.

The palatability rankings and species preferences reflect a sophisticated combination of indigenous knowledge and practical experience. Farmers prioritize species that offer high nutritional benefits, are easy to propagate, and fit seamlessly into existing agroforestry systems. The widespread use of grasses like *Hyparrhenia rufa* and legumes like *Alfalfa* illustrates a strategic approach to year-round feed availability, especially during dry season. Moreover, the strong emphasis on sustainable harvesting practices and organic inputs reflect a growing environmental awareness among farmers. Notably, the study establishes that institutional support particularly access to quality seedlings and extension services are a powerful lever for scaling adoption. Policies and programs aimed at strengthening these support systems, while promoting awareness and training, will greatly enhance the integration of MPFTs into smallholder farming systems. Ultimately, empowering farmers with the right knowledge, inputs, and incentives will contribute not only to improved

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livestock productivity but also to the broader goals of food security, environmental sustainability, and rural resilience.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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