**Original Research Article**

**Participatory Evaluation and Demonstration of improved Forages in the case of Jarati District, Somali Regional State**

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# Abstract

*A participatory study was conducted at Jarati Woreda with main objective to evaluate biomass yield of Improved Forage technology under the rain Fed cultivation for three improved forage species; Rhodes grass and Buffle Grass were evaluated in Mean compares with four replications. Data on growth yield and yield related parameters were collected and analyzed using SAS software. The result indicated that the plant height, and fresh biomass yield (qt/ha) were significantly different (P< 0.05) among the tested improved forage Grass The biomass yield production potential of tested species under rain fed condition in to the study area were 6.1 and 4.6 t/ha for Rhodes, Buffle Grass respectively. Regarding the parameters such as forage recurrent capacity biomass per area, palatability, drought tolerant, disease and pest resistance early maturity, easy management, height at harvesting as evaluated by the research participant PAPRAGs members, Rhodes grass ranked first followed by Buffle grass on farmer perception Based on this data, the researcher came to the conclusion that farmers in Jarati Woreda and other areas with similar agro ecologies are recommended to plant Rhodes grass than other variety. Further adaptation trials across more locations and years are of paramount importance.*

**Key Words***: Agronomic performance*, biomass accumulation, stakeholder appraisal, comparative prioritization, *perception and pairwise ranking*

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#  Introduction

Livestock feeding remains one of the most expensive inputs in livestock production globally. Recent research emphasizes that the introduction and development of improved forage crops, coupled with the establishment of sustainable forage seed production systems, can unlock significant economic opportunities for pastoralists and agro-pastoralists. These advancements are critical for improving livelihoods, enhancing productivity, and fostering resilience in pastoral systems.

Establishing reliable forage production systems heavily relies on the availability of quality forage seeds and cuttings. Recent studies highlight that local seed production not only ensures sustainability but also reduces costs, making it an essential strategy for scaling up forage-based interventions. Despite increasing demand, a critical shortage of high-quality forage seeds persists at national and regional levels, hampering efforts to expand improved forage adoption (FAO, 2021; **Dereje** et al., 2024). Addressing this gap is vital for ensuring the success of forage development initiatives.

Somali regional state (SRS) is one of the administrative regions of Ethiopia, which is occupied by large population of pastoralists and Agro-pastoralists. The region has huge livestock potential and wide range of geographical coverage for livestock rearing (IPS, 2002). According to the land use system in the region, livestock grazing and browsing constitutes about 44% (13,950,000 ha) of land mass (IPS, 2002). Similar to the other pastoral areas of the country, livestock keeping has been the main practice of the Somali pastoral and agro-pastoral community who occupy almost all the rangelands of the SRS. Pastoralist is pre-dominant land use management system in the semi-arid and arid lands covering extensive areas of the rangelands in southern and south eastern part of the SRS. Due to different factors like seasonality, poor animal and human health, place enormous stress on the traditional pastoral and land management practices. As a result, the productivity and economic contribution of the huge livestock population do not definitely much their number.

.Recent environmental assessments reveal that ongoing environmental degradation, water scarcity, population growth, and expansion of crop cultivation have significantly reduced both the quantity and quality of rangelands, threatening pastoral livelihoods (Mganga KZ, Musimba NKR, Nyariki DM, Nyangito MM, Mwang'ombe AW (2015). These challenges necessitate innovative forage management strategies to sustain livestock productivity.

Seasonality heavily influences forage availability, with the wet season traditionally providing ample fodder. However, recent studies indicate that land degradation, encroachment, and climate change are diminishing forage resources even during peak seasons, leading to persistent feed shortages (Nandi L A. and Haque I. (1986).). During the dry season, forage scarcity becomes more severe, characterized by low protein and high fiber content, which causes weight loss and decreased milk production These compounded stresses, along with poor animal and human health, exert enormous pressure on traditional pastoral and land management systems, resulting in livestock productivity that does not match their potential (FAO, 2021).

Recent research underscores the potential for increasing both the quantity and quality of available fodder in Ethiopia through the adoption of improved forage varieties. Studies demonstrate that these forages are highly productive, Biomass, palatable, and nutritionally superior, making them promising options for sustainable livestock production systems (Habib G, Akmal M, Luqman Z, Ahmad N (2007). Integrating improved forages can enhance resilience, improve feed security, and contribute to sustainable livelihoods in pastoral communities

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##  Objectives

* To evaluate biomass yield and biomass related component of different varieties under rain feed condition.
* To assess and evaluate the pastoralist perception towards the technologies

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#  Expected Output

Increased Productivity: Improved forages are designed to be more productive, providing higher yields and better nutritional value

#  MATERIALS AND METHODS

## Description of study areas

The project was implemented in Jarati District, one of the woredas in the Somali Region of Ethiopia, within the Afder Zone. The study area is geographically located at approximately 5.34° North latitude and 41.88° East longitude, with an altitude of 291 meters (954.72 feet) above sea level. Jarati is bordered to the west by Gora-Baqaqsa, to the north by Elkare, to the east by Hargele, and to the south by the Liban Zone. According to the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), Jarati District has a total population of 912,286. The district is known for its rich livestock resources, especially goats.

Jarati, also known as Weyib, is named after its major town, Melka Chireti. As part of the Afder Zone, it is bordered on the southwest by the Ganale Dorya River, which separates it from the Liben Zone, on the west by Goro Bekeksa, on the north by Elekere, on the east by Afder, and on the southeast by Dolobay. The altitude within the woreda varies between 750 and 1700 meters above sea level. Other notable rivers in the area include the Mena and Weyib rivers. In May 2006, severe flooding in Chereti destroyed around nine villages and displaced more than 870 households. The flood also resulted in the loss of over 4,500 shoats.

According to the 2007 CSA Census, Chereti woreda has a total population of 94,295, consisting of 53,341 men and 40,954 women. Urban inhabitants account for 5,152 people (5.46%), while pastoralists represent 53,715 individuals (56.97%). The population is predominantly Muslim, comprising 99.3% of residents.

# Farmer selection and site and land preparation

##  Establishment of PAPREGs

Based on the results of investigation assessment selection of target pastoralists and agro pastoral was carried out. Target groups was selected purposively based on their interests to be included in the study activities; engaged mainly on livestock production and having potential role to share findings to other pastoralists and agro-pastoralists. The target group may include experienced livestock keepers and pastoral and agro pastoral community leaders. Hence, ten farmers from district (i.e., a total of twenty-five farmers, eight were females) were included in this study. Then forage sites were selected purposively based on proximity to infrastructure. Experimental land was cleared, ploughed, and made to be suitable for cultivation

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## Experimental Design and Data collection

### **Site selection**:

The trial was conducted at PAPREG sites in Jarati District, specifically in Sanqodar-Kebele. A one-hectare plot was designated for farming and selecting through discussion with Farmer’s members and based on their willingness and interest Consider factors like accessibility, land tenure, and existing vegetation cover and ensure that the sites are enough to accommodate multiple experimental plots for each species.

##  Treatments and materials

Assign two improved forage grass species into multiple plots for demonstration of mean compared Two improved forage Grass obtained from the Gode Agricultural research center this two-introduced species were selected further evaluated using participatory variety selection. Two Grasses were used in our investigation; the grasses are listed in This design allows for a demonstration of mean comparison between the two differences Grasses.

The treatments were four treatments and four replications, the size of the plot were10m\*5m, the spacing between plots and replications were 1m and 1.5m, respectively. The spacing between rows were 40cm. Fertilizer at the rate of 100 kg/ha of Di-ammonium phosphate (DAP) was applied during sowing and Seeding rate for each experimental crop is 10kg/ha for Rhodes and 10kg/ha for Befell Grass

Land preparation, planting, weeding, and harvesting and related management practices were applied according to standard practice for the grass during planting and after establishment based on the materials like Acquire high-quality seeds of the selected forage species., equip yourself with necessary tools for planting, maintenance, fertilizers and pesticides for sustainable growth, Data collection tools such as measuring tapes, pH meters, and training general forage production practices, and management were farmers have involved in all stage of experiment with two improved forage .

Multidisciplinary approaches were implementing, monitor and collect all the necessary data. Like planting date, Germination date (50%), Flowering date (50%), Seed collected Harvesting date, Biomass yield, Seed yield and Resistance to pest and disease

###  Training

Research Team: Train researchers on experimental protocols, data collection methods, and safety procedures and Participants Conduct workshops to train farmers and stakeholders on forage cultivation, management practices, and the importance of the study.

###  Field Visits

Monitoring the Scheduled periodic visits to the experimental site to assess plant growth, health, and any issues that may arise. Data Collection: Train researchers to collect data on forage yield, quality, pest/disease incidence, and environmental conditions

###  Field days

The Purpose of Organize field days to showcase the experimental setup, share preliminary results, and interact with stakeholders, conduct live demonstrations on forage management practices, data interpretation, and best farming techniques and Collect feedback from participants to improve future experimental designs and extension activities

Accordingly, biomass yield, palatability, early maturity, drought tolerance, disease and pest resistance, easy of management, ands regeneration capacity were set as the main criteria to select the best performing forage varieties at the close supervision and recommendation of the researchers. The trials were managed by the pastoralists and visit and serious follow-up of the researchers and DAs to evaluate and collect data. Observation and pastoralists’ preference ranking data was taken using pair wise ranking matrix.

# Roles of pastoralists/agro-pastoralists, extension workers and researchers

###  Role of actors

All farmer groups, extension workers, experts and researchers were involved at plantation and regular field evaluation, and each group were the following responsibility: -

**Farmers: -**were expected to provide land for trial, managed trials, weeding, and discuss progress among PAPREGs member farmers, keep recorded and encouraged visit by others.

**Extension workers:** - was expected to mobilize resource, facilitate activities among farmers, linking other farmers and PAPREGs member farmers and keep activity recorded encourage other farmers to visit the plot, arranged farmers meeting, flow up the trial.

**Researchers:** - were expected to listen what are the farmers comment, provided appropriate technical information, help farmers analyzing situations and trial and process the data to verify the result an d providing training to the PAPREGs member farmers.

Data analysis:

Agronomic data were collected and exposed to statistical analysis using the SAS computer program, version 9.0 (SAS, 2002). The homogeneity of the individual variances was verified using the Gomez KA, Gomez AA (1984) before the combined analysis. Then the combined analysis of variance over the years was done by the SAS statistical package. Mean separation was conducted using the Least Significance Difference (LSD) To identify and decide on farmers' selection criteria on the grass procedures such as pairwise ranking and direct matrix were applied. Test of mean separation was employed depending on the significance of analysis of variance separation was done using Duncan’s Multiple Range Test to discriminate the forage grass species and identify superior ones based on the collected parameters and trait of interest

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# RESULTS AND DISCUSSIONS

## Objectives of Training

A practical training program on improved forage technology was conducted to educate farmers and relevant stakeholders on the benefits of cultivating improved forage grass species and adopting sustainable management practices. The objective of the training was to promote best practices in sustainable agriculture, soil health management, and rural economic development. In addition, participants received informational materials emphasizing the importance of improved forage crops for productivity and resilience.

To maximize outreach and impact, the initiative was carried out in collaboration with local agricultural extension services, was leveraged to enhance targeted engagement and raise awareness among broader rural communities.

The training was delivered through on-farm, hands-on sessions at the trail site, focusing on strengthening the participants' knowledge and practical skills in agronomic and field management practices related to forage grass species. Participants included agro-pastoralists, kebele administrators, and a development agent (DA).

A total of 29 individuals took part in the training, comprising 25 agro-pastoralists, 3 kebele administrators, and 1 development agent. Gender distribution among the participants revealed that approximately 69% were male and 31% were female, reflecting an encouraging level of inclusivity, particularly among agro-pastoralists and local leaders.

Among the agro-pastoralists, 17 were male (68%) and 8 were female (32%), indicating active female participation in agricultural development efforts. From the kebele administration, two males and one female attended, representing 66.7% and 33.3% respectively. However, the DA group had only one participant, who was male, highlighting a gap in female representation within technical roles.

Overall, the training initiative not only enhanced participants’ technical capacities but also demonstrated a moderate level of gender inclusion. Future efforts should aim to further promote female participation, especially in professional and technical agricultural positions. As The table 1 is summarizing Participants on improved forage technology.

 **Table 1; Participants on improved forage technology training**

|  |  |  |  |
| --- | --- | --- | --- |
| Participants | Sex Participants on Training | Numbers |  percentage% |
| PAPRAG | Male  | 17 | 68 |
| Female  | 8 | 32 |
| Administration | Male  | 2 | 66.7 |
| Female  | 1 | 33.3 |
| DA | Male  | 1 |  100 |
| Female  | 0 |   |
| Total |   | 29 |   |

## Biomass Yield of Experimental Forage Grasses

A comparative field experiment was conducted to evaluate the performance and farmer perceptions of two improved forage grass varieties: Rhodes grass and Buffle grass. The study focused on key agronomic traits such as germination date, flowering period, plant height, days to maturity, and total biomass yield per hectare. The primary objective was to identify the variety best suited to local agro-ecological conditions and farmer requirements.

The biomass yields of the two grasses showed significant differences in productivity. Rhodes grass produced an average biomass yield of 6.1 tons per hectare, notably outperforming Buffle grass, which yielded 4.6 tons per hectare. This 1.5-ton difference represents a considerable increase in forage availability for livestock feeding. As in the bale 2 indicates The fresh biomass yields of 6.1 tons per hectare for Rhodes grass and 4.6 tons per hectare for Buffle grass were recorded from a single harvest. The participatory variety trial and demonstration confirmed that Rhodes grass (Chloris gayana) produced significantly higher biomass (P < 0.05) than Buffle grass (Cenchrus ciliaris).

The superior biomass yield of Rhodes grass is attributed to its enhanced growth characteristics, including taller plant height and faster maturation. Such traits make Rhodes grass an attractive option for farmers seeking to maximize forage production on limited land and resources. These yield differences were statistically significant, underscoring the reliability of the findings.

Practically, the higher biomass yield of Rhodes grass provides more abundant and sustainable feed resources, especially vital in regions prone to feed shortages. Farmers expressed positive perceptions of Rhodes grass’s productivity, which aligns with the empirical data demonstrating its superior biomass output compared to Buffle grass. in the Gambella region, Rhodes Grass yields have been reported to range from 7 to 25 tons of dry matter (DM) per hectare annually, depending on variety, soil fertility, environmental conditions, and cutting frequency. Similarly, studies conducted on farmers’ fields in the central highlands of Ethiopia reported average Rhodes Grass herbage yields of 8.74 to 9.1 tons DM/ha per year under rain-fed conditions (Cook, 2005; CASCAPE, 2015; HARC, 2004).

##  Plant Height and Phenology.

In terms of vegetative growth, Rhodes grass demonstrated a clear advantage in plant height, reaching an average of 160 cm, while Buffle grass attained a shorter height of 137 cm. This significant difference of 23 cm (P = 0.0076) suggests that Rhodes grass exhibits more vigorous above-ground growth, contributing to its higher overall biomass potential. The greater plant height of Rhodes grass reflects better adaptation and possibly more efficient resource utilization under the experimental conditions.

Regarding phonological development, Rhodes grass also showed superior performance. It germinated earlier, with an average germination time of 8.33 days, compared to 11.33 days for Buffle grass. Early germination is critical for rapid establishment, especially in semi-arid regions where moisture availability is limited. Furthermore, Rhodes grass flowered earlier, at 54.33 days, while Buffle grass reached flowering at 62.33 days. This 8-day difference is statistically significant (P = 0.0118) and indicates a faster progression through developmental stages.

When it comes to maturity, Rhodes grass again had a slight advantage, maturing in 79 days, compared to 80 days for Buffle grass. While the difference is minimal in days, it is statistically significant (P = 0.0046), reinforcing Rhodes grass’s tendency toward quicker lifecycle completion. This can be particularly beneficial for areas with short rainy seasons, enabling farmers to harvest earlier and prepare for subsequent cropping or grazing cycles. In contrast, the average plant height of Rhodes Grass in this study differs from that reported by James et al. (2008), who found an average of 139.1 cm, and by Yesihak (2008), who observed heights ranging from 100.7 to 121 cm at eight weeks after sowing in the savannah regions of Ethiopia. The variation in plant height observed in the current study is likely due to genetic differences among cultivars and variations in soil fertility. These findings affirm the robust growth potential of these forages when grown under favorable agro-ecological conditions.

The Biomass yield, plant height and maturity date, at Jarati District

***.***

***Figure 1: Germination day, flowering day, plant height, Maturity day and Biomass yield of, Rhodes grass, buffle Grass***

##  Table 2 Farmer perception towards the experimental grasses

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variety** | **Germination Date** | **Flowering Days** | **Plant Height cm** | **Maturity Days** | **Biomass Yield ton/h** |
| Rhodes Grass | 8.3333 | 54.3333 | 160 | 79 | 6.1 |
| Buffell Grass | 11.3333 | 62.333 | 137 | 80 | 4.6 |
|  |  |  |  |  |  |
| LSD | 2.3896 | 7.0887 | 0.1309 | 4.868 | 59.978 |
| CV | 12.48 | 5875 | 4.2245 | 2.84 | 13.925 |
| F-value | 13.9 | 14.59 | 18.5 | 24.06 | 10.57 |
| P- value | 0.0129 | 0.0118 | 0.0076 | 0.0046 | 0.0211 |
| *P-value F-value, LSD50%; GD, FD, PH, MD, BMY (qt/ha); biomass yield quintal per hecta* |

All pastoralist members involved in the research actively participated in selecting the most suitable forage species. Based on several key criteria including forage yield, palatability, early maturity, drought tolerance, ease of establishment, harvest height, and management Rhodes grass was consistently ranked as the top choice, followed by Buffle grass.

This preference was shaped by farmers’ direct observation during field trials and practical demonstrations. Rhodes grass demonstrated superior performance in several aspects: it germinated more quickly, exhibited vigorous early growth, and attained greater height at harvest. Its early flowering and faster maturity made it especially valuable for areas with short growing periods. Most importantly, its higher biomass yield provided a tangible benefit more feed for livestock.

In comparison, Buffle grass was perceived as slower to establish and less productive under similar environmental conditions. As a result, the pastoralist community regarded Rhodes grass as more appropriate for forage production, particularly in arid and semi-arid agro-pastoral zones where rapid establishment and high productivity are critical. This report is line with repot of (Sotomayor-Ríos A, Pitman WD 2001) In various agro-ecological contexts, farmers tend to prioritize forage species that offer high biomass yield, early maturity, drought resistance, and ease of management. For instance, Similarly, Mekuria and Worku (2019) reported that farmers preferred Rhodes Grass for its good palatability and ease of establishment, although they recognized its relatively also Ali, et, el., 2025 reported

**The following figure shows the pastoralist selection of experimental grass**

**Figure 2:** Pastoralists’ preference ranking of different grass species for different selection criteria in Jarati District

## Pairwise Ranking of Farmer Preferences for Experimental Grasses

Farmers participating in the evaluation of experimental forage grasses were asked to compare Rhodes grass and Buffle grass based on several key performance traits, including germination rate, early establishment, plant height, maturity time, and biomass yield. Utilizing a pairwise ranking method, farmers expressed their preferences by selecting the superior variety for each trait.

The results demonstrated a clear and consistent preference for Rhodes grass across all evaluated parameters. Farmers appreciated Rhodes grass for its faster germination and earlier establishment—traits especially vital in areas with limited rainfall and short growing seasons. Additionally, Rhodes grass grew taller and reached maturity sooner than Buffle grass, offering greater flexibility in forage management practices.

Biomass yield was a decisive factor in this preference, with Rhodes grass producing significantly more biomass, thereby providing increased feed availability for livestock. These combined advantages in growth rate, height, maturity, and yield underpin the widespread consensus among farmers that Rhodes grass is the superior forage species. the pairwise ranking exercise confirms that Rhodes grass is better suited and more adapted to local agro-ecological conditions from the perspective of the farmers. This strong preference supports recommendations to prioritize Rhodes grass in future forage development and extension programs.

In addition, pastoralists conducted a pairwise ranking of selection criteria to identify the most important traits for future forage improvement. Pastoralists voluntarily compared and ranked criteria by importance, with drought tolerance emerging as the top priority, closely followed by palatability. These traits are therefore critical considerations for the community’s forage development goals.

. This was supported by Mganga *et al*.2015) biomass yield ranked the first followed by early maturity, palatability third and fourth Regeneration capacity respectively, similarly Mekuria and Worku (2019) reported that farmers preferred Rhodes Grass for its good palatability and ease of establishment, although they recognized its relatively later maturity compared to Rhodes grass. Also reported similar Ali, et, el.2025)

# Conclusion and Recommendations

The study conducted in Jarati District of the Somali Regional State, Ethiopia, demonstrates that introducing improved forage grass varieties specifically Rhodes grass and Buffle grass can substantially enhance the availability and quality of livestock feed for pastoral and agro-pastoral communities. Among the two, Rhodes grass showed a significantly higher biomass yield, averaging 6.1 tons per hectare compared to 4.6 tons per hectare for Buffle grass in one harvesting time. establishing it as the more effective option for boosting forage production under rainfed conditions.

A participatory approach involving local farmers, extension workers, and researchers was central to the study. This collaboration ensured that the evaluation and selection of forage varieties were closely aligned with community needs and the local agro-ecological context.

The research also emphasized the importance of practical training and capacity building, which enhanced the technical skills of participants and encouraged moderate gender inclusion. However, the study identified a need to increase female participation in technical and decision-making roles to promote greater gender equity. Based on this finding the following recommendation is forwarded;

* Expand Rhodes Grass Cultivation and Local Seed Systems: Promote Rhodes grass for its superior yield and invest in local seed production to ensure affordable, reliable access for farmers
* Strengthen Training and Gender Inclusion: Provide practical training on sustainable forage management while actively increasing women’s participation in technical and decision-making roles.
* Enhance Climate Resilience and Participatory Approaches: Integrate drought-tolerant forage species into management plans and maintain community involvement in research and impact monitoring for adaptive solutions.

##  Important Lessons Drawn:

* Integration with Local Practices: Successful adoption of improved forages requires integration with local farming practices and addressing specific local challenges.
* Education and Training: Providing farmers with the necessary skills and knowledge is crucial for the effective use of improved forages.
* Engaging pastoral communities in forage improvement initiatives can not only enhance ownership but also ensure the sustainability of these interventions
* Utilizing technology such as drought-resistant forage species, satellite mapping for pasture management, and mobile apps for information dissemination can greatly enhance forage productivity.
* Investing in training programs to build the capacity of pastoralists in sustainable land management practices, including rotational grazing and water conservation techniques

##  Future Focus:

* Promote the cultivation of a diverse range of forage species that are well-adapted to local climatic conditions, providing resilience to changing environmental factors.
* Agricultural Transformation: Acceptance tools and connectivity to improve agricultural productivity and sustainability is a key focus area for the future.
* Decarbonization: The agricultural sector is looking towards reducing its carbon footprint and adopting practices that are more environmentally friendly.
* Implement water harvesting techniques such as building small dams, ponds, and rainwater collection systems to ensure water availability for forage production during dry seasons.

#  Challenges

* Pastoral areas are already vulnerable to the impacts of climate change, with unpredictable rainfall patterns and increasing drought frequencies affecting forage availability.
* Uncontrolled grazing practices can lead to degradation of pastures and a decline in the quality and quantity of available forage.
* Pastoral communities often lack resources for implementing sustainable forage management practices, such as access to improved seeds, proper irrigation, and technical knowledge.
* Unclear land tenure systems can result in overgrazing and the degradation of communal grazing lands, further exacerbating forage shortages
* Livestock diseases can spread from pastoralists to wildlife populations, especially when pastoralists encroach into unfenced national parks.

### Opportunities

* Technological Improvements: The adoption of new technologies and offers significant opportunities for improving efficiency and productivity.
* Biodiversity and Ecosystem Services: Protecting biodiversity and ensuring the sustainability of ecosystem services are becoming increasingly important.

These insights reflect a comprehensive view of the current state and future direction of agriculture, particularly in the context of improved forages and grasses. It’s important to continue monitoring these trends and adapting strategies to ensure the long-term viability and success of agricultural practices.

Disclaimer (Artificial intelligence)

Option 1

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

# REFERENCE.

.

FAO. (2021). Global status of forage seed systems and challenges in developing countries. Food and Agriculture Organization of the United Nations. <https://doi.org/10.4060/cb5748en>.

Gomez KA, Gomez AA (1984) Statistical procedures for agricultural research. John Wiley & Sons.

Habib G, Akmal M, Luqman Z, Ahmad N (2007) Biomass production and feed quality of three summer fodder species planted under two nitrogen levels. Sarhad Journal of Agriculture 23: 1145.

.

.Mganga KZ, Musimba NKR, Nyariki DM, Nyangito MM, Mwang'ombe AW (2015) The choice of grass species to combat desertification in semiarid Kenyan rangelands is greatly influenced by their forage value for livestock. Grass and Forage Science 70: 161-167.

Nandi L A. and Haque I. (1986). Forage legume cereal systems: Improvements of soil fertility and Agricultural production with special reference to sub-seharan Africa, pp.145-187, In: Haquel

Sotomayor-Ríos A, Pitman WD (2001) Tropical Forage Plants: Development and Use. CRC Press. Farmers’ preference

Ali, Abdimawlid, Fosiya Hussein, Mahamed dol Ateye, and Abdiseid Muhumed Hassen. 2025. “Evaluation of Improved Forage Production Technologies under Irrigation in Korra, Denan District, Shebelle Zone, Somali Region, Ethiopia”. Advances in Research 26 (3):412-21. <https://doi.org/10.9734/air/2025/v26i31358>.

CASCAPE (2015). Capacity building for Scaling up of evidence-based practices in Agricultural Production in Ethiopia.

Cook BG, Pengelly BC, Brown SD, Donnelly JL, Eagles DA, Franco MA, et al. (2005). Tropical forages. CSIRO DPI&F(Qld). InterAmerican center of tax administrators and Brisbane, Australia: ILRI.

HARC (Holetta Agricultural Research Center). Feed resources development and utilization: possible options and recommendations under Ethiopia condition; 2004.

James K, Mugendi DN, Verchot L, Kungu J. Combining Napier grass with leguminous shrubs in contour hedgerows controls soil erosion without competing with cropsAgroforestry Systems. 20.

Yesihak k. Effect of seed proportion of rhodes grass (chloris gayana kunth) and white seed clover (melilotus alba) at sowing on agronomic characteristics and nutritional quality. Livestock. 2008.