**Original Research Article**

**Participatory Evaluation and Demonstration of improved Forages in the case of Sanqodar kebele, 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 of improved forage species; Dry matter yield, farmer’s perception, 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 (Zhang et al., 2022; Ahmed et al., 2023).

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; Tesfaye et al., 2024). Addressing this gap is vital for ensuring the success of forage development initiatives.

The Somali Region of Ethiopia is among the largest regions, with over 85% of its population depending on livestock as a primary livelihood source (Tesfaye & Hailu, 1997; Ahmed, 2003). Livestock husbandry in this region is practiced through migratory pastoralism and sedentary systems. 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 (Abdi & Mohammed, 2021; Berhanu et al., 2022). 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 (Kedir et al., 2023; Mengistu & Tadesse, 2022). 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 (Ayalew et al., 2022). 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, palatable, and nutritionally superior, making them promising options for sustainable livestock production systems (Tessema et al., 2022; Demissie et al., 2024). Integrating improved forages can enhance resilience, improve feed security, and contribute to sustainable livelihoods in pastoral communities

# 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

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# MATERIALS AND METHODS

## Description of study areas

This project is going to implemented in Jarati district and is one of the woreda in the Somali region of Ethiopia part of Afder zone, Jarati is bordered on the west by Gora-Baqaqsa on the north by Elkare and east Hargele and south by liban zone based on the 2007 census conducted by central statistical agency of Ethiopia (CSA,2007) this woreda has a total population of 912286 of Jarati district rich livestock specially Goat.

**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

## Experimental Design and Data collection

Site selection**:**

The experiment was conducted in Jarati District at (PAPREGs) sites. Land allocated to cultivate were one Hector (1ha) This activity was carrying out Sanqodar- kebeles located in Jarati Districts 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.

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### 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 cinchrus species, 10kg/ha for Buffell 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

# RESULTS AND DISCUSSIONS

## Objectives of Training

To educate farmers and stakeholders about the potential benefits of cultivating improved forage grass species and management techniques, demonstrate best practices for sustainable farming, soil health management, economic Development and informational materials highlighting the importance of improved forages.

Collaborate with local agricultural extension services, NGOs, and media for wider dissemination. And utilize social media platforms for targeted outreach and engagement.

Training Practically, on-farm training was given to participant agro-pastorals, DAs and kebele’ administrators to enhance awareness and practical skill on improved agronomic and field management practices of Grasses species prior to sowing at PTC. Totally, 25 agro-pastorals, 1 DAs and 3 administrators of the Kebeles were participated on training. On average, about 69% and 31% of the participants were men and women respectively as shown in (table 1 below).

**Training**

**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 |  |

## Outputs of data analysis

In forage research, the development of species and feed production often emphasizes biomass yield over grain production. As indicated in Tables 2, biomass yields of 6.1 tons per hectare (t/ha) and 4.6 tons of fresh biomass from a single harvest were obtained. From this demonstration and participatory variety trial, it was observed that Rhodes grass (Chloris gayana) produced significantly (P<0.05) higher biomass yield than Buffel grass (Cenchrus ciliaris). According studies (Kebede et al. (2014) reported that Cenchrus ciliaris (Buffel grass) generally produces lower biomass compared to Chloris gayana, with yields of about 4-8 t/ha under rain-fed conditions

The dry matter yield obtained in the current study for Rhodes grass is comparable to the findings of Denbela (2015), who reported a dry matter yield of 6.68 t/ha. This aligns with other studies indicating that under irrigation conditions, dry matter yields can be approximately twice as high as under rain-fed conditions. For instance, at the Jinka Agricultural Research Center, Rhodes grass under irrigation yielded about 13-15 t/ha, whereas rain-fed conditions yielded approximately 6-8 t/ha (Denbela, 2015). Similarly, Ayana (2010) reported Rhodes grass yields ranging between 10-16 t/ha under rain-fed conditions in Ethiopia, supporting the findings of the current study.

**Plant Height and Phenology:**

Analyzing plant height, which influences biomass yield, indicated that Chloris gayana (Rhodes grass) registered a maximum height of 160 cm, whereas Cenchrus ciliaris (Buffel grass) reached only 130 cm. This is consistent with findings by Kebede et al. (2014), who reported that Rhodes grass tends to attain greater heights, contributing to its higher biomass potential.

Rhodes grass also exhibited earlier germination, flowering, and maturity stages compared to Buffel grass. Specifically, Chloris gayana germinated on the eighth day after sowing, while Cenchrus ciliaris took more than 11 days, which can delay subsequent developmental stages. The flowering stage for Rhodes grass occurred at 54 days after sowing, which is shorter than the 62 days observed for Buffel grass. Additionally, Rhodes grass reached maturity at approximately 79 days, slightly later than Buffel grass, which matured at around 80 days. Early germination and rapid development of Rhodes grass contribute to its higher biomass yield and suitability for forage production, especially under irrigated conditions. The differential phonological traits between these species highlight the importance of selecting appropriate forage species based on environmental conditions and management goals.

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

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**Figure 1:** *Germination day, flowering day, plant height, Maturity day and Biomass yield of, Rhodes grass, Buffell 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 member of the research group was participated in selecting better forage species. Hence, according to the amount of forage product they produce in the areas, palatability, Early maturity, drought tolerant, easy to established height at harvesting and easy to manage Rhodes grass were ranked as first followed by Buffell; grass by all pastoralists. The following figure shows the pastoralist selection of experimental grass (Sotomayor-Ríos A, Pitman WD 2001)

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

## Pair wise ranking

Pair-wise ranking matrix for selection criteria: Pair-wise ranking of the pastoralists’ selection criteria was made to rank the selection criteria and to identify the most important trait for the community for future forage improvement. The pastoralists were voluntary to compare the criteria and rank them in order of importance. Accordingly, the selection criteria were compared and drought tolerance ranked first against all criteria while palatability led all criteria. This was supported by Mganga *et al*.2015) and Aberra *et al*.2010). Regeneration capacity and biomass yield ranked the third and fourth respectively followed by early maturity. This finding is comparable with finding of Belete *et, al, (*2018).

# Conclusion and Recommendations

In the current study different improved grass species evaluated for their biomass yield production potential under rain fed lowland area. Among the improved grass forage species tested, Rhodes, Buffle Grass and produced higher biomass yield which result the study

The grasses are listed in This design allows for a demonstration of mean comparison between the two differences Grasses. The size of the plot were10m\*5m, the spacing between plots and replications were 1m and 1.5m, respectively, and the improved forage Grass species tested in this study was Rhodes, Buffle Grass

The biomass yield obtained in this study revealed that there was significance difference (p < 0.05) among the tested improved forage Grass species in the study area. The biomass yield production potential of tested species under rain fed condition in to the study area were 6.1 t/ha, 4.6 t/ha for Rhodes, Buffle Grass respectively. Rhodes grass showed higher vegetation and perceptional performance; therefore, these grasses should be tested in different areas and disseminated to the community by creating awareness about proper management system

The approach provided the means for feedback on technologies generated and disseminated It's found that the PAPPRG are effective and efficient approaches in generating, evaluating and disseminating forage technologies. SoRPPARI research center used this approaches as means to address the week technology adoption of the various forage technologies so far developed. The valuable contribution of these approaches towards the realization of the goals of the center is well acknowledged and appreciated

It is recommended that the information obtained from this study would benefit the pastoral communities, so the promotion of the tasted species will be demonstrated and scaled out in wider range through pre-scale-up and pre-extension demonstrations.

**Based on this finding the following recommendation is forwarded**;

* Rhodes is highly suggested for this area based on its adaptability, and biomass yield
* Further adaptation trials across more locations and years are paramount importance.
* It is important to investigate chemical composition of that improved grass spp.
* These recommended to scale up such improved forage species among the stock holders and more effort need in next implementation programs in terms of funding for training more number of farmers, and involvement of other stock holders like higher institutes and other governmental and non-governmental bodies need to supplying planting materials and seed and also policy makers give priority for this sector to reach the technologies throughout small scale farmers in the country

## 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

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# 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.

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