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ISSN: 2641-3094 DOI: https://dx.doi.org/10.17352/gje

Research Article

Demonstration of Rhodes grass (*Chloris gayana* Kunth) varieties at selected highland and midland agro-ecologies of Guji zone, Oromia, Ethiopia

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Received: 18 July, 2023
Accepted: 26 July, 2023
Published: 27 July, 2023

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Keywords: Rhodes grass; Demonstration; Livestock feed; Agroecology

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Abstract

Guji zone has different agro-ecologies suitable for livestock production. However, grazing land was shrinking for the production of feed which is the most pre-request for livestock production. As a result, farmers used pasture and crop residues which are insufficient and not available during the dry season. Hence, there was a feed shortage at different agroecologies. Rhodes grass is used as livestock feed, soil, and water conservation but improved Rhodes grass varieties were not intensively produced by farmers and hence feed shortage is affecting the supply of livestock products for household consumption. Improved Rhodes grass is the possible solution for feed shortage due to it is intensively harvested throughout the year and ensures feed availability for livestock. Therefore, a demonstration of Rhodes grass is needed on a farmer's field. The objective of this study was to evaluate the performance of Rhodes grass on farmers' plots. Adola Rede (midland agroecology) and Ana Sora (highland agroecology) were selected based on their livestock and Rhodes grass production potential. Masaba and ILRI-7384 Rhodes grass varieties were demonstrated on a 50 m^2 plot area. Descriptive statistics were used to analyze the data. Accordingly, the Masaba variety was highly performed in plant height (108.6 cm), fresh biomass (4.24t/ha), and survival rate (83.4%) than ILRI-7384 accession at both agroecologies. Except in seed yield at the highland area in all traits, the Masaba variety was well performed than ILRI-7384. The result of one-way ANOVA revealed that across agroecology fresh biomass yield and survival rate of Masaba was a statistically significant difference at 10% and 5% respectively. Farmers liked to produce Rhode grass varieties. Fresh biomass and survival rate was important trait obtained from the Masaba variety in both agro-ecologies. Thus, the Masaba variety was recommended for livestock feed at highland and midland agro-ecologies of the Guji zone.

Introduction

Ethiopia has the largest livestock population among African countries [1] and the 10th largest in the world [2]. The function of livestock in the country ranges from livelihood for smallholder farmers to the contribution to the Gross Domestic Product (GDP) of the nation. Nevertheless, livestock production and productivity per head of the animal are very low because of various barriers such as a lack of good quality and adequate feed [3-5] as well as fluctuating feed supplies with seasonal variation [6].

Livestock production is increasing throughout Sub-Saharan Africa, driven by population growth, urbanization, and rising living standards which increase demand for livestock products [7] and therefore demand for feed. In 2018, feed needs for Ethiopia were approxmetly130 m tons with a negative absolute feed balance [8]. Indeed, land availability decreased by 18.1% as natural pasture was replaced with croplands [9]. As a result, most Ethiopian dairy farmers practice cut-and-carry systems without grazing, with only a few combining the systems [10].

The best grass varieties for supporting the country's future livestock production in a potentially sustainable manner must be chosen [11,12]. Amongst those recommended for improved management practices, Rhodes (Chloris gayana Kunth) grass is the most common [13]. Some Ethiopia smallholders used Rhodes grass for cattle fattening which is associated with higher milk yields [14]. However, the highland and midland districts Guji zone were not using these grasses due to a lack of promotion of improved varieties in the zone. This calls demonstration of improved varieties in the zone.

Citation: Kebede B, Bobo T (2023) Demonstration of Rhodes grass (*Chloris gayana* Kunth) varieties at selected highland and midland agro-ecologies of Guji zone, Oromia, Ethiopia. Glob J Ecol 8(2): 058-063. DOI: https://dx.doi.org/10.17352/gje.000083

Rhodes grass (Chloris gayana Kunth) is a perennial grass of tropical and subtropical Africa where it remained one of the main C4 forage grasses. Rhodes grass can be used as pasture, hay, and ley crop [15]. Pasture leys were able to dramatically improve soil organic matter contents in the upper 30cm and water infiltration rates into the soil profile and water holding capacity and its development lower soil temperature during summer [16]. Rhodes grass is salt-tolerant forage and can increase fodder production in degraded lands because it has the capacity to prevent salinity development by creating a mulching layer on the soil surface. This mulching layer prevents the upward capillary movement of water thereby forcing plants to use water from the lower layers of the soil through their root system. Rhodes grass can successfully produce good biomass yield in marginal soil and water conditions [17] and Rhodes grass remains the most suitable species for forage grass production in Ethiopia under future climate scenarios [18]. Therefore, the agricultural research system should focus on integrating Rhodes grass production into the livestock farming system of the country.

We human beings depend on livestock products such as meat, milk, butter, and cheese for our balanced diet. Livestock also depends on the availability of grass for their nutrition. In this interaction of the ecosystem, we cannot live without grasses. Hence, to get the maximum livestock product forage researchers and development partners have to help farmers in producing grasses for livestock feed as primary and ecological conservations ultimately.

The major feed resources in the Guji zone are natural pasture, crop residues (especially straw of barley, wheat, tef), *enset*, and some leaves which are low in nutrients required for livestock. In addition, these sources of feed were only available during the wet season and currently, the amount is not sufficient for livestock rearing [19]. Therefore, for sustainable feed production, it is important to improve the availability of good quality pasture feed and the use of fast-growing varieties which can increase the amount and quality of feed for livestock. In addition, to overcome feed shortage extension services should focus on the promotion of improved forage varieties by demonstration methods. The objectives of this study were to evaluate the performance of improved Rhodes grass in the highland and midland areas of the Guji zone, to improve the knowledge and skills of farmers on Rhodes grass production, and to assess farmers' feedback for further development of Rhodes grass.

Research methodology

Description of study districts

Adola Rede district is located in the Southern part of Oromia, Ethiopia, at a distance of 468 km from Addis Ababa, the capital of Ethiopia. The district is located between 5°44'10"- 6°12'38" latitudes and 38°45'10"-39°12'37" longitudes. The district is characterized by three agro-climatic zones, namely humid, sub-humid, and dry arid zones. In terms of the agricultural calendar, the rainfall pattern of the district is bimodal for lowlands and midland areas and mono-modal for highland parts. The dry arid agro-climatic zones are attributed to little rainfall while the humid agro-climatic zones receive extremely high rainfall. Rain-fed agriculture is a common practice for many farm households in this district. However, a semi-nomadic economic activity is also practiced as a means of livelihood by some of its dwellers. Farmers produce cereals such as teff, wheat, barley, and maize, pulses such as haricot bean, and others such as fruits and vegetables. They also engaged in the production of coffee as means of livelihood [20].

Ana Sora district is situated at a distance of 410 km from Addis Ababa and 180 km from Negelle. Astronomically, the district is located between 6°20'30"-5°57'30" northing latitudes and 38° 39'30"-38° 57'30" easting longitudes. It is the most humid and sub-humid moisture condition, which has a relatively longer growing season. It comprises an annual rainfall of 1,750 mm and a mean temperature of 17.5-28 °C [21]. The district is well known for cattle and selling of milk was one of income generating activities in rural areas. Ana Sora district is also known for beekeeping as different honey is harvested from diverse vegetation and trees found in the district. After finishing the ploughing in the calendar year farmers of Adola and Ana Sora districts focus on fattening their cattle as income generating activities.

Sites and farmers' selection procedures

Adola Rede and Ana Sora districts were selected from the midland and highland respectively. The districts were selected purposively due to their large livestock population, suitable for Rhodes grass production and convenient for supervision. From the selected district one kebele was selected and at each kebele, 15 farmers were selected for Rhodes grass demonstration based on their interest and ownership of land. There were nine hosting (experimental) farmers for this activity in both districts while others were grouped under the hosting farmers. A Farmers Research Group at each kebele was established to share knowledge and skill on Rhodes grass production between the members.

Research materials and methods

Masaba and ILRI-7384 were demonstrated on a 50 m^2 plot of nine experimental farmers during 2021/22 and 2023 year. The grasses were drilled with recommended packages of 15 kg/ha of seed, 100 kg/ha of NPS fertilizer, and 20 cm inter-row spacing. Land preparation and management practices were done by the farmers with technical support and follow-up of researchers and development agents who were assigned at Kebele. The training was organized to enhance farmers' knowledge and skill on Rhodes grass production and utilization. The mini field day was also organized for further information dissemination on Rhodes grass importance, production, and dissemination.

Methods of data collection and analysis

For this demonstration, agronomic data such as plant height, plot cover, fresh biomass yield, seed yield, and survival rate were collected. Plot cover was measured in the form of a

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scale (1 - 5 where 1 stands for least in covering the plot area and 5 rated as highly covered the plot. This was the response of farmers given by observing the performance of Rhodes grass varieties on their plots. Survival rate which was expressed in terms of percentage was the reply of farmers after harvesting of Rhodes grass varieties. Plant height was taken from 5 random plants where the demonstration plot (50 m^2) was divided into two parts 25 m^2 for fresh biomass and 25 m^2 for seed yield data collection. The data was converted to hectare for analysis purposes. The interview was used to assess farmers' feedback on demonstrated Rhodes grass varieties. Agronomic-related data were analyzed by descriptive statistics and one-way ANOVA was used to identify the mean difference of Rhodes grass trait and variety across agro-ecologies. The narration was used to explain farmers' feedback on Rhodes grass in the study areas.

Results and discussions

Capacity building on Rhodes grass demonstration

The role of agricultural extension is important in transferring research output to the end user. There are many methods used to promote agricultural research technologies/varieties to the end users. Hence, proven agricultural varieties conducted on farms should be promoted by appropriate extension methods. This study used training and mini-field day as promoting Rhodes grass varieties in the selected areas of districts. During production years 88 farmers, 15 development agents, and 13 experts were trained on Rhodes grass production and dissemination. The participants were also trained on how to harvest and use Rhodes grass. Moreover, participants were trained on transferring knowledge from station research to on-farm through demonstration. Agricultural production needs knowledge and skills to create confidence in farmers on research conducted in their field and exercise research-based problem-solving in rural areas. This training was initiated by farmers to produce Rhodes grass on their land to reduce feed shortage for livestock production. The mini field day was also organized to popularize Rhodes grass in the community. Many participants have observed the performance of Rhodes grass on selected plot areas of experimental farmers at Kiltu Sorsa and Raya Boda kebeles. Demonstrated Rhodes grass varieties were likened by participants indicating that Masaba and ILRI-7384 Rhodes grass varieties were used as a source of animal feed, environmental protection, and decoration of home areas. During the event, the feedback between researchers and participants was discussed on the way of production and promotion of Rhodes grass in the midland and highland agro-ecologies of the Guji zone (Table 1).

Performance of Rhodes grass on farmers' land

The result of the demonstration showed that more plant height was obtained from the Masaba variety (108.60 cm at midland and 98.75 cm at highland) than the ILRI-7384 variety (102.20 cm at midland and 87.75 cm at highland). This was similar to the study of [22] who studied the Rhodes grass based on altitude (lowland, midland, and highland) and reported that

Table 1: Number of participants in Rhodes grass promotion.

Promotion Approach	Number of participants											
	Development agents			Experts			Farmers			Others		
	M	F	T	M	F	T	M	F	T	M	F	T
Training	12	3	15	12	1	13	61	27	88	6	-	6
Mini field day	12	2	14	9	1	10	70	17	87	4	-	4
Total	24	5	29	21	2	23	131	44	175	10	-	10

M=Male, F=Female, T=Total.

in midland there was more height of Rhodes than in highland areas. Height is an important trait that can increase the amount of herbage feed for livestock. From this study, the Masaba variety can give more feed to livestock due to its higher height compared to the ILRI-7384 accession (Table 2). Contrary to this study [23] mentioned that more plant height was obtained from ILRI-7384 (138.04 cm) than Masaba (135.52 cm) at Kamashi. However, their study at the Asosa site was similar to the current study as the Masaba variety was taller than the ILRI-7384 accession. The good standing of Rhodes grass was obtained in midland areas than highland. The plant height of the Masaba variety at midland in this study was higher than the result of [24] who obtained 98.95 cm of Masaba under supplementary irrigation. This indicated that the midland of Guji was potential for Masaba variety production compared to other locations.

Masaba also covers plots more than ILRI-7384 accession at both agro-ecologies. This showed that Masaba can cover the land more quickly than ILRI-7384 to give sufficient feed for livestock. This might be due to the high number of tillers from the Masaba variety. Once it was harvested new tillers would arise and cover the plot so that there was a high population of feed from the plot. Rhodes grass can be harvested many times depending on moisture availability and management. During this demonstration varieties were harvested two times in the year. Good variety generates feed multiple times from the small area. There is small land holding in many rural areas. Hence, the production of Rhodes grass was possible for small land-holding farmers, and livestock can be benefited from Rhodes grass production. The combined result of two-time harvesting showed that the Masaba variety provide a fresh biomass of 4.24 t/ha compared to 4.08 t/ha of ILRI-7384 accession at midland and the variety also had more fresh biomass yield (3.45 t/ha) than 3.45 t/ha of ILRI-7384 accession. This demonstration showed that there was abundant green feed from the Masaba variety (Table 2).

At the midland district, the seed yield of the Masaba variety was 1.42 qt/ha while 1.19 qt/ha was obtained from the ILRI-7384 accession. However, the seed yield of Masaba was lower than ILRI-7384 accession at highland areas. This might be Masaba variety does not fully flower at the highland to give the seed rather it provides fresh biomass grass. The result of this study was similar to [25] as more yield was obtained from ILRI-7384 than Masaba and the seed yield of Rhodes grass production on farmers' land can be 0.6-6.5 qt/ha [26].

The survival of grass is the most important trait of livestock feed. In this study survival rate is the ability of grass to generate

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Table 2: Performance of demonstrated Rhodes grass.

Agro-ecology	The district where activity done		Rhodes grass varieties											
			Masaba						ILRI-7384					
			Plant height (cm)	Plot cover (scale 1 - 5)	Fresh biomass from 50 m^2 (kg/ha)	Fresh biomass (t/ha)	Seed yield (qt/ha)	Survival rate (%)	Plant height (cm)	Plot cover (scale 1-5)	Fresh biomass from 50 m^2 (kg/ha)	Fresh biomass (t/ha)	Seed yield (qt/ha)	Survival rate (%)
Midland	Adola Rede	Mean	108.60	3.20	21.20	4.24	1.42	83.40	102.20	3.00	20.40	4.08	1.19	75.00
		N	5	5	5	5	5	5	5	5	5	5	5	5
		Std. Dev.	18.366	.837	2.387	.477	.475	8.820	14.114	.707	3.507	.701	.451	9.539
Highland	Ana Sora	Mean	98.75	2.75	17.25	3.45	.89	71.00	87.75	2.50	16.25	3.25	1.00	67.50
		N	4	4	4	4	4	4	4	4	4	4	4	4
		Std. Dev.	10.308	.500	3.304	.661	.266	4.546	2.630	.577	2.217	.443	.001	4.203
Total		Mean	104.22	3.00	19.44	3.89	1.18	77.89	95.78	2.78	18.56	3.71	1.11	71.67
		N	9	9	9	9	9	9	9	9	9	9	9	9
		Std. Dev.	15.344	.707	3.358	.672	.467	9.453	12.657	.667	3.575	.715	.335	8.231

the feed throughout the year. The grass which was survived adverse drought and frost is needed by farmers. Rhodes grass has the ability to survive diverse climate conditions so farmers need such variety in their uncertain climate conditions. Farmers rated the survival of demonstrated varieties on their land during the demonstration. Accordingly, Masaba was more survival rate than ILRI-7384 accession at midland agro-ecology . Midland areas of the Guji zone were affected by moisture stress; hence having an 83.40% survival rate of Rhodes grass was important during the dry season. Masaba variety also has more survival rate than ILRI-7384 accession at highland areas. Highland districts of the Guji zone were affected by high rainfall which leads to soil erosion and Masaba survived 71%. Such characteristics of the Rhodes grass variety indicated that it was important grass across agro-ecologies as drought tolerant, frost tolerant, and soil erosion control in addition to livestock feed. From this study, the Masaba variety had more survival rate and can be used as livestock feed during dry and wet seasons.

Performance of Rhodes grass trait based on agro-ecologies

The result of ANOVA showed that there was no mean difference in plant height of the Masaba variety across agro-ecologies. This result was contrary to [22] where the plant height of Rhodes grass was affected by agroecological settings where more plant height was obtained from lowland than midland and highland agro-ecologies. However, there was a significant difference in plant height of ILRI-7384 accession across agro-ecologies. This finding was contradicting the result of [23] who reported that the plant height of Masaba and ILRI-7384 of Rhodes grass varieties were not significant at Asosa and Kamashi agro-ecologies of Benishangul Gumuz. Although there was variation in number there was no statistical difference in plot cover of varieties across agro-ecology . Fresh biomass yield and seed yield of the Masaba variety was a statistically significant difference at 10% while the survival rate was significant at 5%. There was fresh biomass variation of ILRI-7384 accession across agro-ecology (Table 3). The nonsignificance of traits of variety showed that the interaction of genotype and environment was stable so that varieties can be evaluated further for wider agro-ecologies.

Farmers' feedback on Rhodes grass production

The farmer's feedback was assessed on whether demonstrated varieties were accepted or not for production in rural areas. Accordingly, there was positive feedback from farmers regarding Rhodes grass demonstrated on their land. Farmers liked both varieties due to their good palatability, fast-growing (regeneration capacity after harvest and feed), drought tolerant, easily harvested by farmers and eaten by calve to oxen. Rhodes grass stayed during dry and wet seasons so that varieties served as feed sources during wet and dry seasons to supplement feed quantity and quality for livestock. Such advantages of varieties motivate farmers to further the production of Rhodes grass in their livestock husbandry.

Conclusions and recommendations

Rhodes grass is multifunctional in agriculture. It is mainly used as livestock feed in different agro-ecologies. Rhodes grass is also important as soil erosion control in highland agro-ecology and salinity control in midland agro-ecology . Therefore, the livestock extension service should focus on the demonstration of Rhodes grass on farmers' land. Masaba and ILRI-7384 accession were demonstrated on farmers' land. Masaba variety was highly performed in plant height, plot cover, fresh biomass, and survival rate than ILRI-7384 accession at both midland and highland agro-ecologies of the Guji zone. However, more seed yield was harvested from 7384 accessions than Masaba at highland areas. Beyond the agronomic data, farmers preferred both Masaba and ILRI-7384 accession as livestock feed due to their being palatable for small to large cattle and fast growing after harvesting. Moreover, demonstrated Rhodes grass varieties used for livestock feed during wet and dry seasons and hence a solution for the shortage of feed for livestock at different agro-ecologies. The most significant trait in Rhodes grass production was its fresh biomass yield and survival rate on farmer's land. Based on fresh biomass, survival rate, and farmer's feedback Masaba variety was recommended for livestock feeding at midland and highland agro-ecologies of the Guji zone. Therefore, the Masaba variety was recommended for large-scale promotion in the midland and highland agro-ecologies of the Guji zone.

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Table 3: Performance of Rhodes grass trait based on agro-ecologies.

Variety	Traits of variety		Sum of Squares	df	Mean Square	F	Sig.
Masaba	Plant height * agro-ecology	Between Groups	215.606	1	215.606	.905	.373
		Within Groups	1667.950	7	238.279		
		Total	1883.556	8			
	Plot cover * agro-ecology	Between Groups	.450	1	.450	.887	.378
		Within Groups	3.550	7	.507		
		Total	4.000	8			
	Fresh biomass * agro-ecology	Between Groups	1.387	1	1.387	4.369	.075
		Within Groups	2.222	7	.317		
		Total	3.609	8			
	Seed yield * agro-ecology	Between Groups	.630	1	.630	3.956	.087
		Within Groups	1.115	7	.159		
		Total	1.745	8			
	Survival rate * agro-ecology	Between Groups	341.689	1	341.689	6.409	.039
		Within Groups	373.200	7	53.314		
		Total	714.889	8			
ILRI-7384	Plant height * agro-ecology	Between Groups	464.006	1	464.006	3.973	.086
		Within Groups	817.550	7	116.793		
		Total	1281.556	8			
	Plot cover * agro-ecology	Between Groups	.556	1	.556	1.296	.292
		Within Groups	3.000	7	.429		
		Total	3.556	8			
	Fresh biomass * agro-ecology	Between Groups	38.272	1	38.272	4.189	.080
		Within Groups	63.950	7	9.136		
		Total	102.222	8			
	Seed yield * agro-ecology	Between Groups	.084	1	.084	.719	.424
		Within Groups	.814	7	.116		
		Total	.897	8			
	Survival rate * agro-ecology	Between Groups	125.000	1	125.000	2.098	.191
		Within Groups	417.000	7	59.571		
		Total	542.000	8			

Acknowledgments

The authors would like to thank Oromia Agricultural Research Institute for financing this research. Farmers who implemented this activity and provided their land for the completion of this activity were heartily acknowledged.

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