MULTIDISCIPLINARY SCIENTIFIC RESEARCH

BJMSR VOL 8 NO 1 (2023) P-ISSN 2687-850X E-ISSN 2687-8518

Available online at https://www.cribfb.com
Journal homepage: https://www.cribfb.com/journal/index.php/BJMSR
Published by CRIBFB, USA

EVALUATION OF GENOTYPES WITH ENVIRONMENTAL INTERACTIONS OF LABLAB (PURPUREUS L.) AND IT IS DRY MATTER YIELDS STABILITY IN THE MIDLAND OF GUJI ZONE, SOUTHERN OROMIA, ETHIOPIA

Teshale Jabessa [(a)1] *Getachew Tesfaye* [(b)] *Ketema Bekele* [(c)]

[(a)] *Animal Feed Researcher, Oromia Agricultural Research Institute, Ethiopia; E-mail: teshalejabessa@gmail.com*
[(b)] *Animal Feed Researcher, Oromia Agricultural Research Institute, Ethiopia; E-mail: getchtesfaye48@gmail.com*
[(c)] *Animal Feed Researcher, Oromia Agricultural Research Institute, Ethiopia; E-mail: ketamabekele@gmail.com*

ARTICLE INFO

Article History:

Received: 24th August 2023
Revised: 29th November 2023
Accepted: 22nd December 2023
Published: 31st December 2023

Keywords:

Dry Matter, Environment, Interactions, Lablab, Stability

JEL Classification Codes:

F25, Q35, W22, M83

ABSTRACT

Animal feed is one of the main challenges facing livestock producers, due to inadequate nutrition, particularly during the dry season. The aim of this study was to identify Lablab genotypes performance in different midlands areas of Guji zones. A 3mx2m plot was used to seed twelve genotypes of Lablab purpureus, which were obtained from the International Livestock Research Institute Gene Bank, and a tick registered variety from Bako Agricultural Research Centre. During the main cropping rainy season in 2021-2022, three locations Dufa, Gobicha, and Kiltu sorsa, Adola subsite, and on farms in two (2) consecutive years, respectively were studied using randomized complete block designs (RCBD) with three replications. Information was gathered regarding the establishment, duration of various physiological stages, dry matter yield of fodder, chemical compositions, and additional relevant factors. AMMI and the SAS statistical analysis programmer, version (2002), were used to perform an analysis of variance on the gathered data. The list significant difference test was used to compare the means. The results of the AMMI analysis of variance for forage dry matter yield showed that there were substantial ($P<0.01$) variations in genotype and environment, but not in the effects of the G x E interaction. Both the representative testing site and the testing conditions (Adola woyu and Kiltu sorsa) were quite good at differentiating genotypes. The combined analysis of the data revealed that non-significant ($P>0.05$) differences for plant height and thousand seed weight, but significant ($P \leq 0.05$) differences for days to flowering, days to maturity, number of branches, leaf to steam ratio, number of pods, and number of seeds across the tested environments. The results showed that, out of all the examined locations, G-11620 (15.43 t/ha) and G-14486 (11.12 t/ha) had the highest forage dry matter production. It was observed that the leaf to steam ratio was higher in both G-11486 and G-11620. All chemical compositions across the tested genotypes were found to be significantly different ($p \leq 0.05$) among parameters, with the exception of DOMD and IVDMD, which did not showed significant ($p >0.05$) variations among genotypes. The recorded CP content ranged from 21.15% for G-14486 to 23.50% for G-11620, with the lowest value coming from typical cheek Gabis 10.8%. The highest and the lowest NDF were recorded from G-11620 (11.2%) and Gabis (22.23%) respectively. Generally the mean performance, yield and stability of the G-11620 and G-14486 were high and stable across the tested locations. Therefore, genotypes (G-14486 and G-11620) were promoted to variety verification for further evaluation and possible for release.

INTRODUCTION

Animal feed is one of livestock producers' most significant issues (Mohamed, 2017). Like other tropical countries, Ethiopia's smallholder crop-livestock farmers face substantial challenges due to inadequate nutrition, particularly during the dry season when pastures and crop leftovers are scarce and of low nutritional value (Tolera et al., 2000). Introducing improved types of highly productive forage plants with good dietary quality is crucial given the enormous activities at fodder production (Tekalign, 2014).

Among cultivated plants in the Leguminosae family, Lablab (Lablab purpureus (L) Sweet) is a primarily self-fertile herbaceous forage crop with chromosomal number 2n 22 (Kshirsagar et al., 2018). Due to its higher forage yields than cowpea and adaptability to various agroecologies, it has tremendous potential as a species of forage crop (Adebisi et al., 2004). Lack of agronomic practices, genetic erosion, limited research focus, absence of improved varieties, poor

[1]Corresponding author: *ORCID ID: 0000-0003-2936-2374*

https://doi.org/10.46281/bjmsr.v8i1.2169

To cite this article: Jabessa, T., Tesfaye, G., & Bekele, K. (2023). EVALUATION OF GENOTYPES WITH ENVIRONMENTAL INTERACTIONS OF LABLAB (PURPUREUS L.) AND IT'S DRY MATTER YIELDS STABILITY IN THE MIDLAND OF GUJI ZONE, SOUTHERN OROMIA, ETHIOPIA. *Bangladesh Journal of Multidisciplinary Scientific Research*, *8*(1), 34-43. https://doi.org/10.46281/bjmsr.v8i1.2169

management practices and improvement, and variations in climate patterns have all contributed to the decline in lablab production patterns (Bhatt et al., 2019). Lablab is multipurpose fodder, and various plant parts, including seeds, young grains, green beans, leaves, and biscuits, can be eaten (Davari et al., 2018).

Lablab purpureus forage is a short-lived, upright perennial herbaceous crop frequently planted annually (Kikafunda et al., 2004). It is recommended because of its high nutritional content, palatability, and strong forage production. Furthermore, Lablab purpureus is a good candidate for intercropping. It is shade-tolerant and has been cultivated in dry and semiarid environments because of its drought tolerance (Aganga & Tshwenyane, 2003).

Nowadays, one of the main fodder crops used as green manure and leguminous is Lablab purpureus. Nevertheless, the forage yield is significantly lower than its potential because of several biophysical and socioeconomic limitations and a limited variety selection. Therefore, one of the most significant ways to reduce those production constraints is to cultivate forage crop varieties that are resistant to substantial biotic and abiotic stress and that improve adaptation to changing environments and in different agro-ecologies Therefore, the present study was initiated to estimate the magnitude of genotype, environment and genotype by environment interaction for forage yield and yield components of Lablab yield stability across different environments.

LITERATURE REVIEW

Lablab is a high-yielding forage legume which can be grazed, harvested for hay or silage, or used as a green manure and break crop in sub-tropical and tropical farming systems (Chakoma et al., 2016). It is commonly used as a supplementary feed (Tulu et al., 2018) for intercropping with cereal crops (Mpairwe et al., 2002). It is considered to have significant potential for the sustainable intensification of smallholder crop/livestock production systems (Miller et al., 2018). It tolerates acid soil conditions (Mugwira & Haque, 1993) and addresses soil fertility decline. Lablab is also used to control insect pests (Qureshi et al., 2016) and in ethno-veterinary medicine. Lablab forage yields range from 6-9 tonnes of dry matter (D.M.) per hectare. Forage has an average crude protein content of about 16% D.M., which can vary from 8-33% in sub-Saharan Africa, depending on local conditions and stage of harvest. The crude protein levels in the leaves range from 21-38%, in the stem 7–20%, and in the grain 20-28%. The digestibility of leaves ranges from 55-76% (Mudunuru et al., 2008). The latest research findings report the effectiveness of lablab bean extracts in impeding infections of viral diseases such as influenza and SARS-CoV-2, which has been described as a world pandemic (Liu et al., 2020). The crop also greatly ensures income security among smallholder farmers, especially in dryland and semi-dryland ecosystems (Rai et al., 2018). This demonstrates the necessity of improving its production and utilization. Lablab is a multipurpose crop. Several plant parts can be consumed for human consumption (Rana et al., 2021) and animal feed (Minde et al., 2021).

Lablab is a drought-resilient crop with multiple benefits (Naeem et al., 2020). It is popularly regarded as a grain legume, vegetable, and fodder, rich in protein (comparable with soybean), nutrients, and vitamins (Minde et al., 2020). Its ability to thrive when rainfall resumes after drought has led to its greater resilience compared with other legumes such as common beans (Phaseolus vulgaris), soybeans (Glycine max), cowpeas (Vigna unguiculata), and pigeon peas (Cajanus cajan) (Miller et al., 2018). Phenotypic plasticity in plants refers to the changes in physiological responses that contribute to their adaptability to the new environment (Alpert & Simms, 2002). Morphologically, the mechanisms include glabrous and trailing stems, a vigorous extension of shoots, shifting of leaf inclinations to reduce sun rays, decrease in leaf sizes and structures, changes in chlorophyll contents and greenness of the crop, alterations in stomatal behaviour, and their distribution to control evapotranspiration as well as deep root penetration (2 m) to the soil (Chakoma et al., 2016)

MATERIALS AND METHODS

Description of the Study Locations

The experiment was conducted at three locations (Adola et al., 2021), sorsa on the farm in the Guji zone of southern Oromia for two consecutive years. The areas under examination cover the sub-humid mid-altitude primary crop-growing region with an altitude range from 1450 to 1900 meters above sea level. The area's first and most significant rainy season falls between April and August, while the second rainy season falls between September and November. The area has bimodal rainfall. The district receives 1084 mm of rainfall annually and is divided into three agroecologies: lowland (60%), midland (29%) and highland (11%). The research site's average annual lowest temperature is 15.93 °C, while its average yearly maximum temperature is 9.89 °C. The primary soil types of the area are basaltic soil (Nitisols) and Orthic Aerosols (Etefa & Dibaba, 2011).

Approaches and Design of Experiments

Twelve Lablab genotypes, including standard checks (Gabisa-17 and Beresa-55), were included in the genetic materials and examined at six different locations throughout the study period between two years (2021 to 2022). A randomized complete block (RCBD) with three replications was used in each location. With a 2 m length, 1.8 m width, and 30 cm inter-row spacing, each genotype was seeded in six rows. When planting, 20 kg ha-1 of seeds and 100 NPS kg ha-1 of fertilizer were applied.

Sources of Planting Materials

The International Livestock Research Institute (ILRI) first provided the planting materials used in this investigation. Based on their performance in terms of herbage yield and other agronomic parameters, the Lablab genotypes aside from the check (Gabisa-17 and Beresa-55) assessed in the presented study were chosen from those previously adapted to the environment.

Methods of Data Collections

The agronomic data like date of 50% flowering, Number of branches per plant, Number of leaves per plant, Leaf to stem ratio, plant height (cm), dry matter yield (t/ha), number of pods per plant, number of seeds per pod, seed yield (kg/ha) and thousand seed weight (g) was carefully collected. Forage sampling was collected at the 50% flowering stage, and seed sampling was conducted at the maturity stage of the plant. In all plots, sampling was done from the middle four rows, excluding the border rows.

Biomass Yield Determination

A delicate balance was used in the field to weigh the herbage yield, which was harvested 10 cm above the ground. Fresh subsamples will be independently obtained from each plot, weighed, and chopped into pieces ranging from 2 to 5 cm to determine the dry matter content. The weighed fresh sub-samples (FWss) were oven-dried at 60^0C for 72 hours and re-weighed (DWss) to estimate dry matter yield.

The dry matter yield (t/ha) = (10 x TotFW x DWss / HA x FWss)) (Tarawali *et al.*, 1995). (1)

Where: TFW = total fresh weight from the plot in kg DWss = dry weight of the sample in grams
FWss = fresh weight of the sample in grams. H.A. = Harvest area in meter square, and 10 is a constant for the conversion of yields in kg m^2 to tone/ha

Analysis of Chemical Compositions

The methods outlined by AOAC (1990) were used to determine the total ash and crude protein content levels. The methods drawn by Van Soest (1988) were used to analyze acid detergent lignin (ADL), neutral detergent fiber (NDF), and acid detergent fiber (ADF).

Methods of Data Analyzing

Before doing the combined analysis, Hartley's test (F-max test) was performed to evaluate the homogeneity of error variance (Hartley, 1950). The entire variation was then divided into components remaining to genotype (G), environment (E), and genotype with environment (G x E) interaction effects using pooled analysis. The SAS statistical programmed version (2002) was used to compute the ANOVA for each location and the total ANOVA over locations. The AMMI and GGE bi-plots were created using GenStat (2012).

RESULTS AND DISCUSSIONS

AMMI Analysis of Variance

The AMMI analysis of variance for forage dry matter yield showed significant (P<0.01) variations in genotype and environment but not in effects of the G x E interaction. While genotype and genotype by environment interaction captured 15.95% and 1.31% of the overall variation, respectively, the environment captured 18.73%. The strong impact of environments on the forage dry matter yield performance of lablab genotypes was revealed by a more significant total variance caused by environment. Accordingly, different authors have documented significant yield variations of Lablab genotypes because of observed environments (Arega et al., 2023). This suggests that the tested Lablab genotypes exhibit a significant degree of different reactions to modifications in the growing areas and a differential discriminating capacity in the test conditions.

Additional y AMMI analysis showed that the robust G x E interaction impact could be broken down into principal component analysis (PCA). With the first IPCA accounting for 73.83% and the second accounting for an extra 13.1%, the first two IPCAs accounted for 86.92%, with IPCA1 being the only important one. Various researchers, Amare and Tamado (2014) and Temesgen et al. (2014) suggested that the first two IPCAs may be used to determine the correct model for AMMI. The genotypes are more stable or adaptable across all environments sampled when the IPCA scores are closer to zero. According to the study authors, there was a substantial difference in dry matter yield for each genotype in the various areas (Arega et al., 2023; Oliveira et al., 2014).

Table 1. AMMI ANOVA for forage dry matter yield of 12 lablab genotypes evaluated at 6 locations over two consecutive years.

Source of variation	D.f	SS	MS	% Explained			P- values
				Total variations	G X E	G X E cumulative	
Total	215	134.16	0.624				
Genotypes	11	38.65	3.513**	15.95			<0.001
Environments	5	44.84	8.969**	18.73			<0.001
G x E Interactions	55	15.85	0.288NS	1.31			0.1086
Blocks (Envts)	12	5.75	0.479**	2.17			0.0163
IPCA 1	15	6.43	0.428*	1.94	73.83		0.0241
IPCA 2	13	4.55	0.35NS	1.59	13.1	86.92	0.0956
Residuals	27	4.88	0.181	0.82			0.7192
Error	132	29.07	0.220				

D.f= degree of freedom, SS= sum of square, MS= mean sum of square, GXE= Genotype with environment

The Genotypes' Mean Dry Matter Yield Performances

The significant relationship between environment and genotypes suggested that various genotypes reacted differently to changing environmental conditions. Out of all the investigated genotypes, G-11620 (15.43 t/ha) and G-14486 (11.12 t/ha) had the highest forage dry matter yield (Table 2). Compared to the standard checks Beresa-55 and Gabis-17, the dry matter yield advantage was 129.9% and 61.2%, respectively. This variation may result from the genotypes' genetic potential. There was a significant genotype by environment interaction in terms of dry matter yield, as observed by the variations in yield rank of lablab genotypes across tested areas.

Table 2. Lablab genotypes performance for dry matter yields (t/ha) across locations and over the year

Genotypes	Dry matter yield (t/ ha^{-1})					
	2021			2022		
	Adola-woyu	Kiltu-sorsa	Gobicha	Adola-woyu	Kiltu-sorsa	Gobicha
18622	4.31b	7.96bcd	4.51c	1.64b	11.03a	5.54cd
Gabis	1.33b	1.07e	1.07d	0.33c	2.27b	1.60d
10979	4.42b	5.41d	4.52c	1.92ab	10.1a	6.57bc
10953	4.62b	8.74bcd	4.52c	2.26ab	9.41a	4.86cd
11620	14.8a	14.63a	17.2a	3.11a	14.0a	16.3a
Beresa	4.12b	5.65cd	5.61c	1.55b	12.94a	6.77bc
11630	4.01b	6.93cd	4.6c	1.82ab	9.72a	6.03bcd
14489	4.2b	8.34bcd	5.11c	1.99ab	10.83a	5.43cd
14486	12b	11.2b	9.47b	2.42ab	12.67a	10.13b
11612	4.82b	9.05bc	5.12c	1.72b	10.5a	7.37bc
14465	5.32b	5.35d	4.92c	1.66b	10.89a	6.18bc
14474	4.2b	8.3bcd	5.91c	1.98ab	8.48a	5.98bcd
MEANS	5.68	7.72	6.05	1.86	10.23	6.89
LSD (5%)	4.05	3.09	2.46	1.16	4.87	4
CV (%)	4.21	27	2.4	36.8	2.81	3.43

Means in a column within the same category having different superscripts differ ($p<0.05$); D.M. t/ha-1 = dry matter yield tone per hectare; LSD=Least Significance difference; CV=coefficient of variations.

Composite Agronomic Trait Performances of the Genotypes

The combined analysis of variance for the genotypes of Lablab purpureus tested across locations for assessed agronomic parameters is shown in (Table 3). Except for non-significant differences in plant height and thousand seed weight, the genotypes showed significant differences in days to flowering, days to maturity, plant height, number of branches, leaf-to-steam ratio, number of pods, and number of seeds across the investigated settings.

Days to 50% flowering were significant ($P<0.05$) among the genotypes tested. Table 3 shows no variation in the plant height at fodder harvest and thousand seed weight between genotypes ($P>0.05$). This could be because of the environment's impact on fodder crops' physiological growth and development. The standard control variety, Gebis-17, took longer (111.6 days) to reach physiological maturity than the seed from genotype 11620, which was the shortest (97 days). The observed differences could be related to differences in number of days taken to flowering. Early flowering results in early physiological maturity for seed harvest. In line with this, KC et al. (2016) reported that lablab genotypes took (81-130) with 50% flowering, whereas Kankwatsa (2018) reported a shorter number of days and 50% flowering (52 to 69 days).

The genotypes under-tested had composite mean dry matter yield tones/hectare ranging from 1.44 to 15.43t/ha-1 in various environments. The reported dry matter yields were 1.44 t/ha, 11.12 t/ha (G-14486), and 15.43 t/ha (G-11620), respectively. The most extensive yield advantages over the standard checks, Beresa-55 and Gebisa-17, are shared by two genotypes, 11620 and 14486, with yield advantages of 129.9% and 61.2%, respectively. The current study's conclusion is consistent with Ogedegbe et al. (2011) earlier report, which stated that the maximum dry matter yield ever recorded was 10.2 t/ha. Muir (2002) also noted that rainfall significantly influences the dry matter yields of warm-season legumes. However, the dry matter yields of the Lablab that were observed in this investigation fell within Mihailovic et al.'s (2016) published range of values (1.8-12.9 DM t ha-1). However, lower dry matter yields of 6.8 and 6t ha-1 for various Lablab species were recorded (Hidosa et al., 2016). Similarly, Lablab's sub-humid climate in western Oromia recorded a forage dry matter yield of 5.4 t ha-1 (Tulu et al., 2018).

The leaf-to-stem ratio significantly impacts the forage's nutritional quality because leaves have lower fiber content and higher nutrient levels than stems. Leaf-to-steam ratios ranged in mean from 0.38 to 0.91. The leaf-to-steam ratio was found to be higher in both G-11620 and G-14486. The leaf-to-stem ratio significantly impacts diet choice, forage intake, and quality (Zailan et al., 2018). The observed variations among the genotypes examined may be attributed to probable genetic variations resulting from environmental interactions.

Table 3. Mean dry matter yields agronomic traits for Lablab genotypes tested in regional variety trials combined at 6 locations (Adola et al., 2021) over two years, 2021 and 2022.

Genotypes	Days to		Plant height (cm)	Number of branches	Leaf-to-steam ratio	Number of pods per plant	Number of seeds per pod	1000 seed weight (g)	DMY t/ha	DMY yield advantage over check (Barasa-17)	DMY yield advantage over check (Gabis-55)
	Flowering (days)	Maturity (days)									

18622	101.56cb	175.2b	96.97	5.3abc	0.573cde	57.4ab	3.79ab	1.66b	6.65c		
Gabis	111.6a	183.4a	100.69	4.de	0.38e	52.9 a	3.8 ab	0.36c	1.44d		
10979	100.7cb	175.7b	100.26	4.7b-e	0.75abc	57.1ab	4.08ab	1.62b	6.45c		
10953	100.5cb	176.6b	95.92	5.3abc	0.66bcd	55.6 ab	3.6a	1.72b	6.86c		
11620	97c	154.3c	100.88	6.48b	0.85ab	87.86b	4.1b	2.26a	15.43a	129.9	971.6
Barasa	107.7ab	181.6a	99.79	3.8e	0.53de	54.2a	3.79ab	1.62b	6.87c		
11630	102.06cb	177.2b	97.38	4.6b-d	0.68bcd	55.2ab	3.79ab	1.75b	6.43c		
14489	101.8cb	176.9b	100.58	5.3bcd	0.69bcd	56.3ab	3.92ab	1.72b	6.98c		
14486	101.5cb	175.6b	99.63	5.83ab	0.91a	73.4ab	3.97ab	1.82ab	11.12b	61.2	672.2
11612	101.2cb	176.7b	97.72	4.3cde	0.74a-d	53.6a	3.75ab	1.64b	7.28c		
14465	102.7cb	175.1b	94.37	4.5cde	0.73a-d	51.3a	3.75ab	1.67b	6.55c		
14474	100.8cb	176.3b	100.07	4.7b-e	0.71a-d	56.7ab	3.75ab	2.03ab	6.87c		
Mean	102.4	175.4	98.7	4.9	1.06	59	4	1.6	7.4		
C.v	7.2	2.24	17.3	23.4	4.98	35.8	7.8	4.31	3.84		
LSD	4.8	2.6	11.22	0.76	3.4	19.9	0.3	0.47	1.87		

Means in a column within the same category having different superscripts differ (p<0.05); D.M. t/ha=dry matter yield tone per hectare; LSD=Least Significance difference; CV=coefficient of variations.

Ammi Bi-Plot Stability Analysis of Dry Matter Yield

Thus, the GGE bi-plot has been applied in crop genotype trials to efficiently determine the genotype or genotypes that perform best across environments, to determine the best genotypes for the delineation of specific environments so that particular genotypes can be recommended to particular environments, and to assess genotype stability and yield (Yan & Kang, 2003). Because they were closer to the biplot's centre, G-14486, G-11630, and G-11620 exhibited extensive adaptability throughout the settings. The mean genotypes exhibit consistent responses to environmental changes, with a small value of IPCA1. Environment: Because the examined materials had longer vectors (possible environments), Kiltu-Corsa was considered highly discriminating.

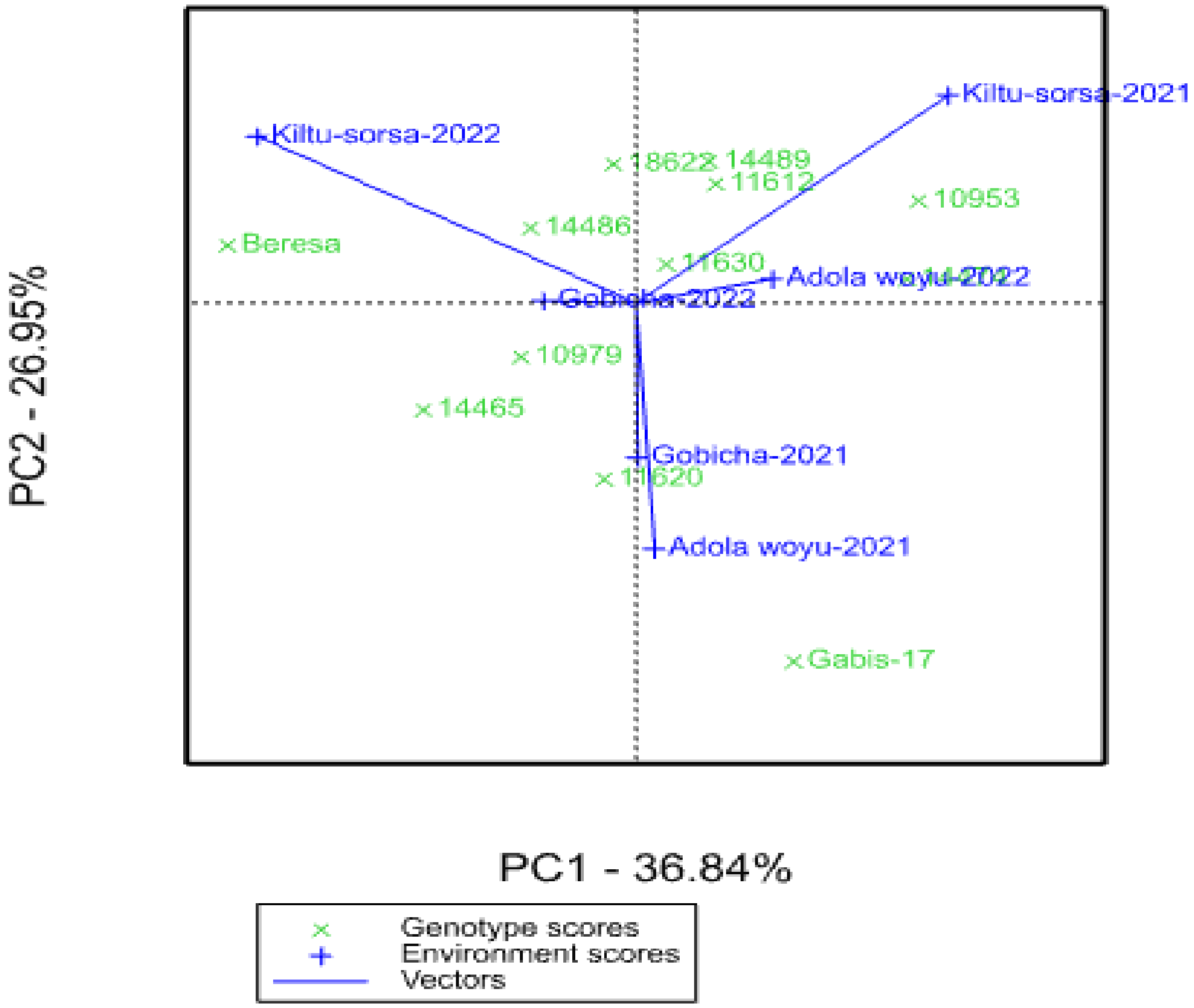

Figure 1. AMMI 2 bi-plot for IPCA 1 against IPCA 2 scores for 12 genotypes and seven environments

GGE Bi-Plot Analysis

In the mega-environments (MGE), the genotypes near the polygon's vertices either had the best or worst performance. The polygon view of the GGE bi-plot was the most effective method for identifying winning genotypes and visualizing the patterns of interaction between genotypes and environments by Yan et al. (2000) and Yan and Kang (2003). The vertex (winning genotypes) in the sector where environments were placed in the MGE sector were genotypes G-11620, G-14486, and G-11612. The bi-plot analysis displayed various mega-environments.

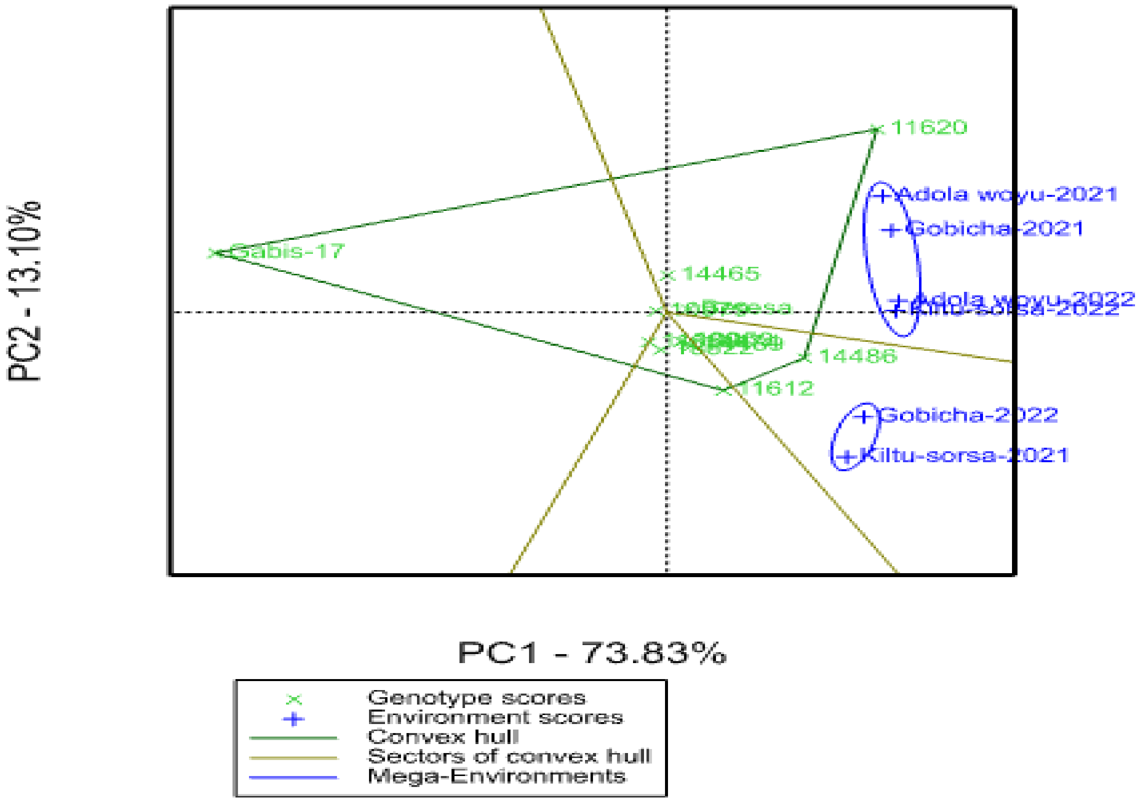

Figure 2. The GGE-bi-plot for which -won -where the pattern for genotypes and environments

Evaluation of Genotypes

The optimal genotypes for stable and increased dry matter production ability were G-11486 and G-11620, located in the centre of concentric circles. Furthermore, the genotypes G-11612 and G-14465, situated on the subsequent concentric circle, are also desirable. Compared to other genotypes, genotypes far from the first and second concentric circles such as Gabisa-17 and others were undesired. Different writers, Arega et al. (2023) on Lablab and Dabessa et al. (2016) on various crops, obtained similar results.

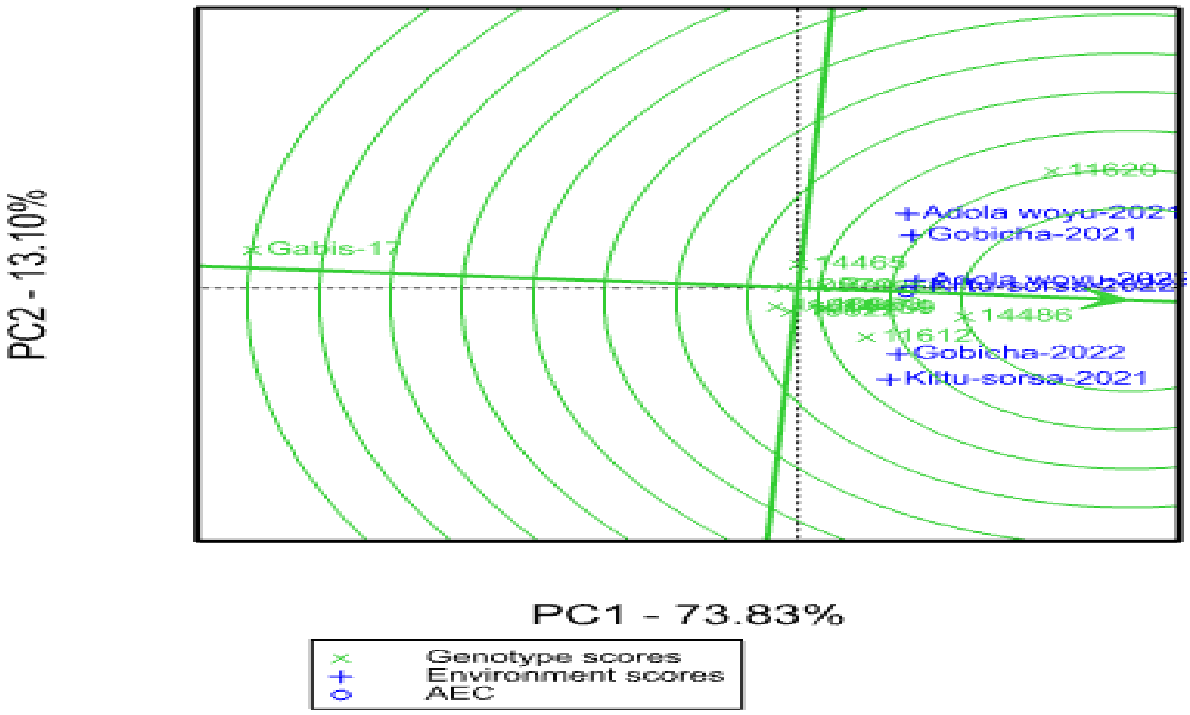

Figure 3. GGE-bi-plot based on genotype-focused scaling for comparison of the genotypes

Discriminating and Representativeness of Test Environments

The centre of the concentric circles, or the ideal test environment, can distinguish between genotypes in terms of the genotypic main effect and can also better depict the various habitats. The representative testing site and the testing conditions (Adola et al., 2021) were quite good at differentiating genotypes.

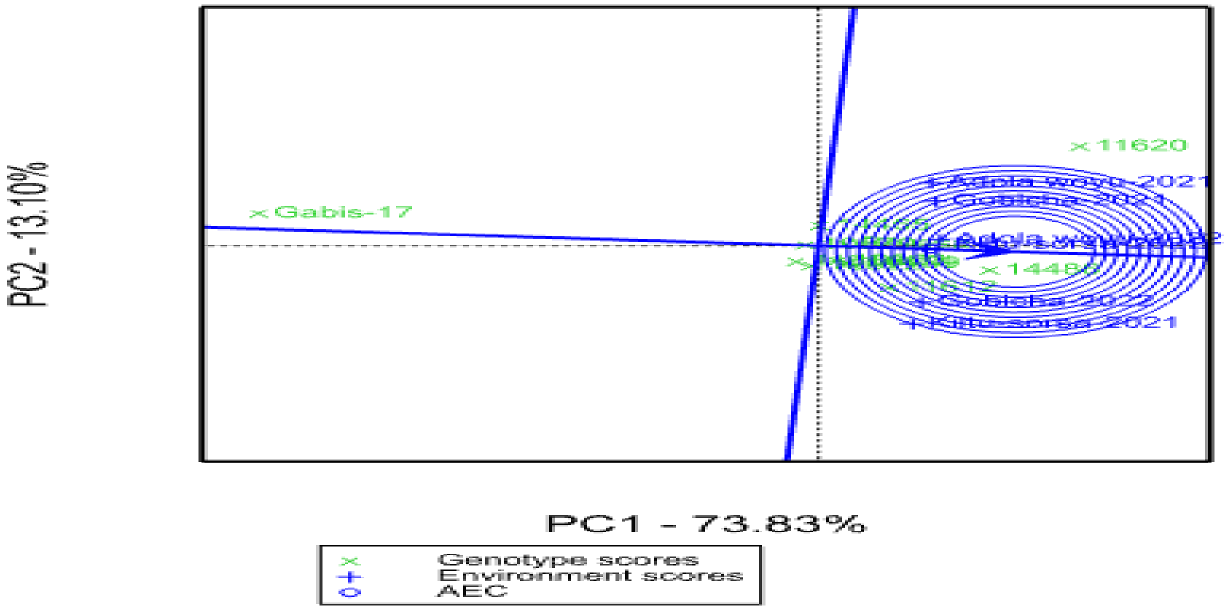

Figure 4. GGE-bi-plot based on environment-focused scaling for comparison of the environments.

Mean Performance and Stability of Genotypes

The most stable genotype in all circumstances is one with a shorter absolute projection length in either of the two AEC ordinate directions (positioned closer to AEC). This genotype indicates a lower propensity of the G x E interaction. According to their mean performance and stability, high-yielding and stable genotypes were G-14486 and G-18622.

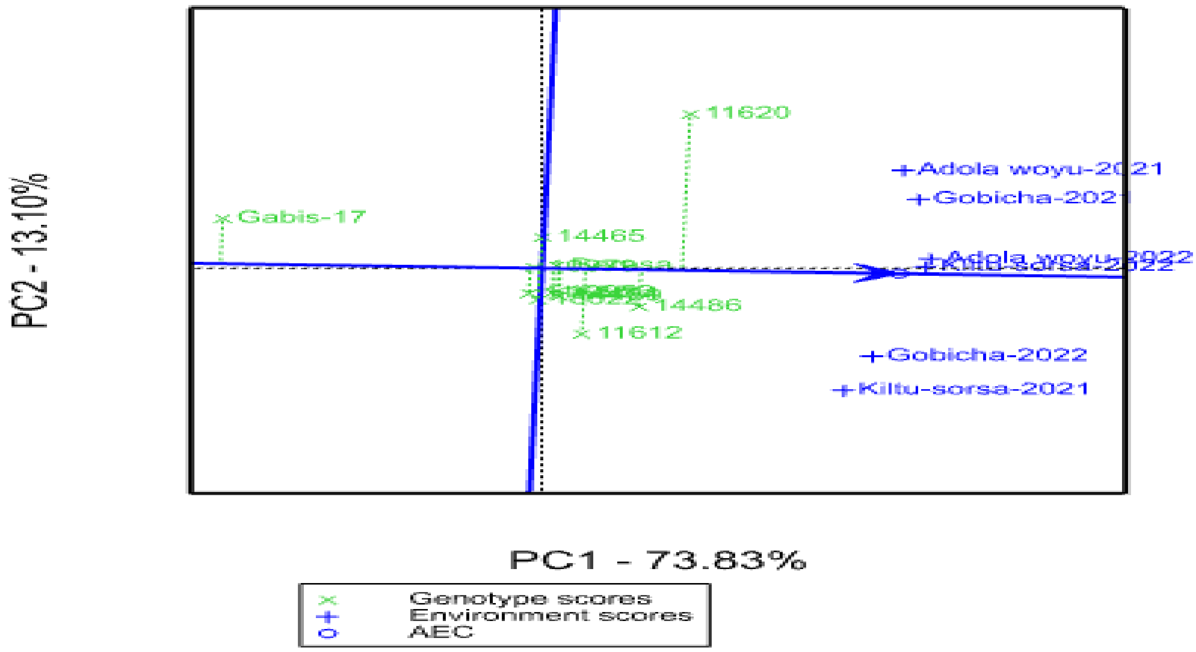

Figure 5. GGE ranking bi-plot shows means performance vs stability

Chemical Composition

All chemical compositions among the tested lablab genotypes demonstrated substantial ($p < 0.05$) changes, according to the combined analysis of variances, except DOMD and IVDMD, which did not show significant ($p > 0.05$) differences (Table 4). The lowest C.P. content was found in standard cheek Gabis at 10.8%, while the highest and lowest C.P. contents were found in G-11620 and G-14486, respectively, at 23.5 and 21.15. Within the 15-30% range, Hector and Jody (2002) reported a higher C.P. content in lablab fodder. Murphy and Colucci (1999) found a lower range value of 14.8 to 21.0%. In general, the crude protein values observed in this study could satisfactorily supply the crude protein acquirement of the animals' ruminants. Therefore, Lablab has a high C.P. value, which can supplement low-quality roughages which could not attain the C.P. requirement of ruminant livestock like natural pasture, Rhodes grass, and crop residues with very low C.P., which is in line with different authors (Abebe *et al*., 2015; Asmare *et al*., 2017).

Cell wall components (NDF, ADF, and ADL) showed significant change across genotypes at (P<0.05). Similar studies on and other legume species have been reported in the literature. This suggests that the genotypes under test were of excellent quality when compared to the bulk of widely used feed supplies in the study area. However, according to Kazemi et al. (2012), who identify feeds with NDF (47 to 53%) and ADF (31 to 40%) content as high-quality feeds, all of the genotypes under investigation could be regarded as good-quality feed resources and appropriate as a supplement for ruminants consuming low-quality feed. The difference observed could be due to soil structure and condition variations and genotype differences.

Table 4. Pooled mean chemical compositions of Lablab genotypes tested in regional variety trial from 6 locations (Adola et al. 2021)

Genotypes	D.M. %	O.M. %	ADL %	ADF %	C.P. %	NDF %	IVOMD	IVDMD
18622	92.1b	82.85a	6.57bc	13.05a-c	15.53cde	15.47ab	42.26	52.66
Gabis	71.85c	55.1b	12.35ab	21d	10.8e	22.23a	48.36	57.08
10979	93.65b	83.75a	5.28c	15.68b-d	16.82bc	19.05ab	49.91	58.69
10953	92.8b	83.7a	4.53c	14.48a-c	13.6c-e	13.6ab	48.76	56.39
11620	**96.55a**	**83.75a**	**3.42c**	**10.4ab**	**23.5a**	**11.2b**	**45.41**	**49.93**
Beresa	73.7c	56.95b	14.75a	17.58cd	10.75e	16.15ab	51.26	62.54
11630	92.35b	83.75a	7.79bc	14.25a-c	14.51cde	20.9ab	49.02	59.02
14489	92.9b	82.6a	7.5bc	14.0abc	11.4de	18.8ab	46.87	56.63
14486	**94ab**	**84.3a**	**3.6c**	**9.25a**	**21.15ab**	**11.44b**	**50.40**	**62.40**
11612	92.05b	83.6a	3.9c	12.88a-c	17.35bc	18.23ab	47.47	55.02
14465	92.25b	82.55a	7.2bc	15.54a-c	18.23bc	18.23ab	48.06	60.14
14474	92.65	83.85a	6.39bc	11.6a-c	16.09b-d	16.39ab	47.42	57.17
Mean	89.74	78.92	6.94	14.14	15.81	16.8	48.17	57.7
LSD	2.8	5.7	6.12	5.6	4.6	8.47	11.7	15.1
CV	1.5	3.3	41	18.6	13.4	23	10.6	12.1

Means in a column within the same category having different superscripts differ (p<0.05); D.M. = Dry Matter; C.P. = Crude Protein; OM= Organic matter; NDF =Neutral detergent fiber; ADF = Acid Detergent Fiber; Ash= Total ash; ADL= Acid detergent lignin; IVOMD = *In vitro* Organic Matter Digestibility; IVDMD=*In-vitro* dry matter digestibility CV=Coefficient of variation; LSD=Least Significance difference.

CONCLUSIONS

The combined analysis of variance showed that the tested Lablab's dry matter yield performances were significantly influenced by the environment and genotypes but not by genotype, environments and their interaction (GEI). This suggested that different genotypes may react differently to a given environment or that specific genotypes might not function uniformly under various environmental conditions. The substantial influence of the environment and genotype interaction on dry matter yield raises the possibility of sustained genotype selection with superior dry matter yield performance. The current findings suggested that genotype and environment impacted lablab genotype yield and yield components. Consequently, the genotypes G-14486 and G-11620, which demonstrated a high dry matter yield and consistent performance, were selected for the variety verification trial for additional assessment and potential to release.

Author Contributions: Conceptualization, T.J.; Methodology, T.J., G.T. and K.B.; Software, T.J.; Validation, G.T., T.J. and K.B.; Formal Analysis, T.J.; Investigation, T.J., G.T. and K.B.; Resources, T.J., G.T. and K.B.; Data Curation, T.J.; Writing – Original Draft Preparation, T.J.; Writing – Review & Editing, T.J., G.T. and K.B.; Visualization, T.J., G.T. and K.B.; Supervision, T.J., G.T. and K.B.; Project Administration, T.J. and K.B.; Funding Acquisition, T.J. Authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement: Ethical review and approval were waived for this study because the research does not deal with vulnerable groups or sensitive issues.

Funding: The authors received direct funding from the Oromia Agricultural Research Institute.

Acknowledgements: Oromia Agricultural Research Institute was acknowledged as a funding source for this activity. Holeta Agricultural Research Center is also acknowledged for doing chemical compositions.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

Abebe, Y. E. N. E. S. E. W., Tafere, M., Dagnew, S., Tolla, M., Gebre-Selassie, Y., Amane, A., & Molla, D. (2015). Best fit practice manual for Rhodes grass (Chloris gayana) production. *BDU CASCAPE*, 17-22.

Adebisi, A. A., & Bosch, C. H. (2004). Lablab purpureus (L.) sweet. *Plant resources of tropical Africa (PROTA*), 2, 343-348.

Aganga, A. A., & Tshwenyane, S. O. (2003). Lucerne, Lablab and Leucaena leucocephala Forages: Production and Utilization for Livestock Production. *Pakistan Journal of Nutrition*, *2*(2), 46-53. http://dx.doi.org/10.3923/pjn.2003.46.53

AOAC, A. (1995). Official methods of analysis 16th Ed. Association of Official Analytical Chemists. Washington DC, USA. Sci. Educ.

Arega, A., Ahmed, M. R., Anne, A. A., & Dabesa, A. (2023). Yield Stability Analysis of Late Set Pigeon Pea (Cajanus cajan L.) Genotypes, *American Journal of Pure and Applied Biosciences*, *5*(5), 130-136. https://doi.org/10.34104/ijavs.023.01300136

Asmare, B., Demeke, S., Tolemariam, T., Tegegne, F., Haile, A., & Wamatu, J. (2017). Effects of altitude and harvesting dates on morphological characteristics, yield and nutritive value of desho grass (Pennisetum pedicellatum Trin.) in Ethiopia. *Agriculture and Natural Resources*, *51*(3), 148-153. https://doi.org/10.1016/j.anres.2016.11.001

Alpert, P., & Simms, E. L. (2002). The relative advantages of plasticity and fixity in different environments: when is it good for a plant to adjust?. *Evolutionary Ecology*, *16*, 285-297. https://doi.org/10.1023/A:1019684612767

Adola, S. G., Degavi, G., Edwin, S. E. K., Utura, T., Gemede, U., & Kasimayan, P. (2021). Assessment of factors affecting practice towards COVID-19 among health care workers in health care facility of West Guji zone, South Ethiopia, 2020. *Pan African Medical Journal*, *39*(1), 1-16. https://doi.org/10.11604/pamj.2021.39.53.27798

Bhatt, L., Samota, M. K., & Nautiyal, M. K. (2019). Potential of underutilized, neglected or untrapped vegetables. *Journal of Pharmacognosy and Phytochemistry*, *8*(2), 1650-1653. Retrieved from https://www.phytojournal.com/archives?year=2019&vol=8&issue=2&ArticleId=7910

Chakoma, I., Manyawu, G. J., Gwiriri, L. C., Moyo, S., & Dube, S. (2016). The agronomy and use of Mucuna pruriens in smallholder farming systems in southern Africa. *ILRI extension brief*.

Dabessa, A., Alemu, B., Abebe, Z., & Lule, D. (2016). Genotype by environment interaction and kernel yield stability of groundnut (Arachis hypogaea L.) varieties in Western Oromia, Ethiopia. *Journal of Agriculture and Crops*, *2*(11), 113-120.

Davari, S. A., Gokhale, N. B., Palsande, V. N., & Kasture, M. C. (2018). Wal (Lablab purpureus L.): An unexploited potential food legumes. *Int. J. Chem. Stud, 6*(2), 946–949.

Etefa, Y., & Dibaba, K. (2011). Physical and socioeconomic profile of Guji zone districts. Bureau of Finance and Economic Development. The National Regional Government of Oromia, Finfinne.

GenStat (2012) Introduction to GenStat for Windows 16th ed VSN International Hemel Hempstead Hertfordshire HPI IES UK

Hartley, H. O. (1950). The use of range in analysis of variance. *Biometrika, 37*(3/4), 271-280. https://doi.org/10.2307/2332380

Hector, V., & Jody, S. (2002). Green Manure Crops: Lablab CTAHR Lablab, Cooperative Extension Service University of Hawaii Sustainable Agriculture Green Manure Crops.

Hidosa, D., Brehanu, T., & Mengistu, M. (2016). On-farm evaluation and demonstration of improved legume forage species in irrigated lowlands of BenaTsemay woreda, South Omo zone. *International Journal of Research and Innovations in Earth Science*, *3*(2), 39-43. Retrieved from http://www.ijries.org/index.php/issues?view=publication&task=show&id=47

Kankwatsa, P. (2018). Agronomic performance and sensory evaluation of Lablab (Lablab purpureus L. Sweet) accessions for human consumption in Uganda. *Open Access Library Journal, 5*(3), 1-23. https://doi.org/10.4236/oalib.1104481

Kazemi, M., Tahmasbi, A. M., Naserian, A. A., Valizadeh, R., & Moheghi, M. M. (2012). Potential nutritive value of some forage species used as ruminants feed in Iran. *African Journal of Biotechnology, 11*(57), 12110-12117. https://doi.org/10.5897/AJB12.286

KC, R. B., Joshi, B. K., & Dahal, S. P. (2016). Diversity analysis and physico-morphlogical characteritics of indigenous germplasm of lablab bean. *Journal of Nepal Agricultural Research Council,* 2, 15-21. http://dx.doi.org/10.3126/jnarc.v2i0.16116

Kikafunda, J., Bogale, T. T., Mmbaga, T. E., & Assenga, R. H. (2004). LEGUME FALLOWS FOR MAIZE-BASED CROPPING SYSTEMS IN EAST AFRICA: SCREENING LEGUMES FOR ADAPTABILITY, BIOMASS AND NITROGEN PRODUCTION. In Integrated Approaches to Higher Maize Productivity in the New Millennium: Proceedings of the Seventh Eastern and Southern Africa Regional Maize Conference, Nairobi, Kenya, 5-11 February 2002 (p. 319). CIMMYT.

Kshirsagar, J. K., Sawardekar, S. V., Sawant, G. B., Devmore, J. P., & Jadhav, S. M. (2018). In vitro regeneration study in lablab bean and dolichos bean (Lablab purpureus (L). Sweet) Genotypes. *Journal of Pharmacognosy and Phytochemistry*, *7*(1), 2782-2789. Retrieved from https://www.phytojournal.com/archives?year=2018&vol=7&issue=1&ArticleId=3049&si=false

Liu, Y. M., Shahed-Al-Mahmud, M., Chen, X., Chen, T. H., Liao, K. S., Lo, J. M., ... & Ma, C. (2020). A Carbohydrate-Binding Protein from the Edible Lablab Beans Effectively Blocks the Infections of Influenza Viruses and SARS-CoV-2. *Cell reports*, *32*(6), 108016. https://doi.org/10.1016/j.celrep.2020.108016.

Mihailovic, V., Mikic, A., Ćeran, M., Ćupina, B., Đorđevic, V., Marjanović-Jeromela, A., ... & Vujic, S. (2016). Some aspects of biodiversity, applied genetics and agronomy in hyacinth bean (Lablab purpureus) research. *Legume Perspectives*, *13*, 9-15. Retrieved from https://fiver.ifvcns.rs/handle/123456789/2962?locale-attribute=en

Miller, N. R., Mariki, W., Nord, A., & Snapp, S. (2018). Cultivar selection and management strategies for Lablab purpureus (L.) Sweet in Africa. *Handbook of Climate Change Resilience*, *2*, 1-14. https://doi. org/10.1007/978-3-319-71025-9_102-1

Minde, J. J., Venkataramana, P. B., & Matemu, A. O. (2021). Dolichos Lablab-an underutilized crop with future potentials for food and nutrition security: a review. *Critical Reviews in Food Science and Nutrition*, *61*(13), 2249-2261. https://doi.org/10.1080/10408398.2020.1775173

Mohamed, A. A. (2017). Food security situation in Ethiopia: a review study. *International journal of health economics and policy*, *2*(3), 86-96.

Mudunuru, U., Lukefahr, S. D., Nelson, S. D., & Flores, D. O. (2008). Performance of growing rabbits fed Lablab purpureus forage with molasses mini-blocks and restricted commercial pellets. In *9th World Rabbit Congress–June* (pp. 10-13).

Mpairwe, D. R., Sabiiti, E. N., Ummuna, N. N., Tegegne, A., & Osuji, P. (2002). Effect of intercropping cereal crops with forage legumes and source of nutrients on cereal grain yield and fodder dry matter yields. *African Crop Science Journal*, 10(1), 81-97. https://doi.org/10.4314/acsj.v10i1.27559

Mugwira, L. M., & Haque, I. (1993). Screening forage and browse legumes germplasm to nutrient stress: II. Tolerance of Lablab purpureus L. to acidity and low phosphorus in two acid soils. *Journal of plant nutrition*, *16*(1), 37-50. https://doi.org/10.1080/01904169309364513

Muir, J. P. (2002). Hand-plucked forage yield and quality and seed production from annual and short-lived perennial warm-season legumes fertilized with composted manure. Crop Science, 42(3), 897–904. https://doi.org/10.2135/cropsci2002.8970

Murphy, A. M., & Colucci, P. E. (1999). A tropical forage solution to poor quality ruminant diets: A review of Lablab purpureus. *Livestock Research for Rural Development*, *11*(2), 96-113.

Naeem, M., Shabbir, A., Ansari, A. A., Aftab, T., Khan, M. M. A., & Uddin, M. (2020). Hyacinth bean (Lablab purpureus L.)–An underutilised crop with future potential. *Scientia Horticulturae*, *272*, 109551. https://doi.org/10.1016/j.scienta.2020.109551

Ogedegbe, S. A., Ogunlela, V. B., Olufajo, O. O., & Odion, E. C. (2011). Herbage yield of Lablab (Lablab purpureus L. Sweet) as influenced by phosphorus application, cutting height and age in a semiarid environment, Nigeria. *International Journal of Agricultural Research, 6*(11), 789-797.

Oliveira, E. J. D., Freitas, J. P. X. D., & Jesus, O. N. D. (2014). AMMI analysis of the adaptability and yield stability of yellow passion fruit varieties. *Scientia Agricola,* 71, 139-145.

Qureshi, A. I., Palesch, Y. Y., Barsan, W. G., Hanley, D. F., Hsu, C. Y., Martin, R. L., ... & Yoon, B. W. (2016). Intensive blood-pressure lowering in patients with acute cerebral hemorrhage. *New England Journal of Medicine*, *375*(11), 1033-1043. https://doi.org/10.1056/NEJMoa1603460

Rai, K. K., Rai, N., & Rai, S. P. (2018). Investigating the impact of high temperature on growth and yield of Lablab purpureus L. inbred lines using integrated phenotypical, physiological, biochemical and molecular approaches. *Indian Journal of Plant Physiology, 23*, 209-226. https:// doi.org/10.1007/s40502-018-0364-x

Rana, R., Sayem, A. S. M., Sabuz, A. A., Rahman, M., & Hos-Sain, A. (2021). Effect of lablab bean (Lablab purpureus L.) seed flour on the physicochemical and sensory properties of biscuits. *Int J Food Sci Agric*, *5*(1), 52-57. https:// doi.org/10.26855/ijfsa.2021.03.008

Tarawali, S. A. (1995). Methods for the evaluation of forage legumes, grasses and fodder trees for use as livestock feed (Vol. 1). ILRI (aka ILCA and ILRAD).

Tekalign, E. (2014). Forage seed systems in Ethiopia: A scoping study. ILRI project report.

Temesgen, A., Mammo, K., & Lule, D. (2014). Genotype by Environment Interaction (G x E) and grain yield stability analysis of ethiopian linseed and niger seed varieties. *Journal of Applied Biosciences*, *80*, 7093-7101. https://doi.org/10.4314/jab.v80i1.1

Tolera, A., Merkel, R. C., Goetsch, A. L., Sahlu, T., & Negesse, T. (2000). Nutritional constraints and future prospects for goat production in East Africa. *Proceedings of the opportunities and challenges of enhancing goat production in East Africa*, 10-12.

Tulu, A., Khushi, Y. R., & Challi, D. G. (2018). Supplementary value of two Lablab purpureus cultivars and concentrate mixture to natural grass hay basal diet based on feed intake, digestibility, growth performance and net return of Horro sheep. *International Journal of Livestock Production*, *9*(6), 140-150. https://doi.org/10.5897/IJLP2017.0444

Van Soest, P. J. (1988). Effect of environment and quality of fibre on the nutritive value of crop residues. *Plant breeding and the nutritive value of crop residues. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia*, 71-94.

Yan, W., & Kang, M. S. (2003). GGE biplot analysis: A graphical tool for breeders, geneticists, and agronomists. CRC press.

Yan, W., Hunt, L. A., Sheng, Q., & Szlavnics, Z. (2000). Cultivar evaluation and mega-environment investigation based on the GGE biplot. *Crop Science*, *40*(3), 597–605. https://doi.org/10.2135/cropsci2000.403597x

Zailan, M. Z., Yaakub, H., & Jusoh, S. (2018). Yield and nutritive quality of Napier (Pennisetum purpureum) cultivars as fresh and ensiled fodder. *JAPS, Journal of Animal and Plant Sciences*, *28*(1), 63-72.