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Registration and Releasing of *"Bareda"* Oat (*Avena sativa L.*) Variety for Mid and Highland of West Hararghe Zone, Oromia, Ethiopia

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Abstract

The fodder oat variety named as Bareda (Acc. No. 5450) was selected and released in 2020 by Mechara Agricultural Research Center for the West Hararghe highland, mid land and similar agro-ecologies. This variety was tested for two environments (mid land and high land) at ten locations ((Mechara on station and one farmer, Gelemso (Bareda FTC) and one farmer, Chiro (Arba. Rakate FTC) and two farmers, GaraKufa FTC and two farmers for one year 2019/2020 cropping season with the objectives of to release the top performing oat genotype(s) in major agronomic traits and nutritional quality and develop most stable genotypes for in the study areas. Bareda oat Variety, due to its superior performance, it was selected, verified and released for forage production. The variety was characterized by growth habit of erect and moderate tuft at basal. The seed color of Bareda is pale brown. It performed better in grain yield, dry matter and green fodder yield and other most important agronomic parameters than its respective checks. Bareda variety on average has a grain yield of 33.4 quintal/ha under research condition and 24 quintal/ha at farmer's field and, the variety produce on average 9.0 t/ha of dry matter, 47.47 t/ha green fodder yield, 93% plot cover and reach seed maturity in 126 days. It was also better tolerant to major oat diseases and have good nutritional quality. On the other hand, the experimental farmers and developmental agent's gave the first rank for Bareda variety than the others tested. So, the introduction of this newly released forage variety could contribute in relaxing the scarcity of feed resource which is common among the small-scale farmers in West Hararghe and elsewhere in the country.

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Bareda, Hararghe, Highland and Midland, Mechara, Oat, Variety.

Introduction

The success and prosperity of livestock production is determined by adequate, quality and timely availability of feed. The green forages are major and the most economical source to fulfill the dietary needs of livestock. The insufficient fodder supply is characterized as major constrain of low animal performance for milk and meat production (Rana *et al.*, 2014, Ahmad *et al.*, 2014).The national feed resources potential includes natural pasture (fodder, forage), cultivated forage, concentrates, crop residues, stubble grazing, brewery and winery by-products, oilseed by-products, molasses, sugarcane tops, other feed resources, such as foliage and pods, maize or sorghum thinning, cactus pear, etc (Shapiro *et al.*, 2017).

In Ethiopia, there are large potential areas with diverse altitude, climate, soil type and farming systems for the production of diverse forage species seeds (Alemayehu *et al.,* 2016). Among the different forage crops recommended for various agro-ecological zones of Ethiopia, common Oats (*Avena sativa*) is abundantly grown in the central highlands of Selale and some parts of west Shewa like Meta-Robi and Galessa areas of Dendiworeda, Arsi, Bale and Gojjam. Production of Oats in different parts of the country dates back at least three decades. The study conducted in north shewa evident that, farmers are highly interested in growing Oats for various reasons among which, feed, roof thatching (straw), source of income and its better performance on poor soils without any inputs. Oats on the other hand has been well acknowledged for its ability to grow on wider range of soil types and resistance to biotic and abiotic stresses (Gezahagn *et al.,* 2016).

West Hararghe, one of the most icons of livestock production areas of the county, there is no sufficient animal feed technology which is tested in the study area and no information on forage nutritional quality due to the remoteness of the area. The zone has a great opportunity for cattle production due to the availability of good fattening weather, good indigenous knowledge of fattening, and the popularity of fattened Harar bull in the country. But cattle fattening requires both quality and quantity feeds. In contrast to this, feed shortage accounts for 75.7%, Animal health (4.8%) and feed cost (3%) (Abdi *et al.,* 2013). Previous studies in various parts of West Hararghe Zone (Fekede *et al.,* 2016; Fikadu and Asfaw, 2017 and Muleta *et al.,* 2017) revealed that the major constraints of cattle keepers are feed shortage which ranked first. The major feed resources of livestock in West Hararghe such as grasses, trees, and shrubs obtained from enclosed forest area and backyard forage production (Fikadu and Asfaw (2017).

Though, enclosed forest area and backyard forage production is the major source of livestock feed in West Hararghe, its share per household gradually decreasing because of increasing human population and expansion crop production. This and other feed resources related problems became initiating forces for the need of improved forage germplasm introduction and evaluation (like Avana sativa).Oats is used mostly for animal feeding and to some extent as human food. It is favorite feed of animals and its straw is soft and superior to wheat and barley. The oat grain is valuable feed for almost all categories of animals (Zaman *et al.,* 2006). Oat is a fast growing and produces a significant amount of fresh fodder within short period (55 to 65 days) with adequate nutritional qualities. Thus, newly released bared oat variety was selected from one hundred forty four (144) Avena sativa genotypes introduced and evaluated in different breeding stages at Mechara Agricultural Research Center for the years according to standard forage releasing procedures. At the end releasing committee evaluated approved only one oat variety with high performance against standard check across tested environments. The activity was conducted for a year with the objective to develop the top performing oat variety (ies) in major agronomic traits and nutritional quality in the study areas and similar agro- ecologies

Materials and Methods

Description of the study area

The study was conducted in West Hararghe zone two high land districts (Chiro and Tulo) and two mid land districts (DaroLebu and Habro) for one year of the main cropping season (2018/19 G.C). Western Harargheis located on about 325 km East of the capital city of Ethiopia, Addis-Ababa, and on longitude and latitude of 40°03’413” to 41°09’00” E and 7°52’15” to 9°28'43”N. The zone is bordered on the south by the Shebelle River which separates it from Bale, on the southwest by Arsi, on the northwest by the Afar region, on the north by the Somali region and on the east by East Hararghe. West Hararghe has about fourteen (14) districts with total population of 2,164,115 (West Hararghe's, (Agriculture and rural development office annual Report of 2016, unpublished) Most of west Hararghe districts were lies in the semi-arid to most highland agro climate. Their annual average rainfall ranges between 500-1300 mm and rainfall distribution in the area is bimodal with short rainy of spring season from February to April and main rainy of summer season from July to September. April, July and August are months of high rainfall and May, June, March, September and October are months of low rainfall. Rainfall in the area is characterized by intense and showery, low in amount and do not start on time. The temperature is usually very hot in winter. Its annual average temperature is 15 ^{o}C and 30 ^{o}C in summer and winter respectively. Mixed farming (crop production and livestock rearing) is the predominant source of livelihood for the majority of the population in the area. During spring season staple crops (maize and sorghum) and haricot bean are the major crops sown followed by summer season, planting *teff*, barley, finger/pearl millet and chick pea and short season matured maize. Sandy loam clay is the dominant soil type in this zone.

Experimental design and layout

The experiment was conducted under field conditions in selected districts of West Hararghe zone. Accordingly, four districts, which include DaroLebu, Habro, Chiroand Tulo were selected. These districts were purposively selected based on agro-ecology: high land (Tulo and Chiro) and mid land (Habro and DaroLebu). A total of ten locations were sown to verify the oats genotypes. Two oats genotypes considered for this study were 5442 and 5450 and two checks Bonsa and Bate. The genotypes were planted in 10 m x 10 m plot size and 25cm between the rows. The seed rate was used 100kg/ha with fertilizer rate 50 kg/ha NPSB and 100 kg/ha of urea fertilizer were applied at a sowing time. The seed was sown through hand drilling techniques.

Data collection and measurements

Most important agronomic data like flowering date, maturity date, plant height, plot cover, disease reaction and occurrence, grain yield data were collected. The other data collected were farmers' preferences.

Statistical analysis

Agronomic data were compared by simple descriptive statistics like means and farmer's preferences were analyzed using garret ranking method.

Results and Discussion

Variety Evaluation

Fodder oats screening activities were started in 2013/2014 with the objectives to identify adaptable oats variety (ies) with high forage yield and disease resistance for the mid and high land of West Hararghe Zone. Accordingly, 144 genotypes of oats were collected from the International Livestock Research Institute (ILRI evaluated for their growth characteristics, tolerant to diseases at all breeding stage.

Then 48 genotypes oats were promoted to the advanced variety trial. From thus, 16 genotypes were passed to preliminary yield trial. At this stage, the genotypes were evaluated for their biomass and seed yield as well as for most crucial agronomic performances. Then 8 best performed genotypes were promoted to the regional variety trial. These genotypes were selected and evaluated in the regional variety trial for their adaptability and yield performance along with checks for two years (2016/2017-2017/2018) at four locations. The checks were *bonsa and* SRCPX80Ab2806. From 8 genotypes, acc.5450 (Bareda) and acc. 5442 were selected to promoted variety verification trials along with checks (Bonsa and Bate) for 1 year (2018/2019). Finally, *Bareda (acc. 5450)* was verified in 2020 with their respective checks and released with a plot size of 10 m by 10 m that were on-station and nine sites of farmers field for mid and high lands of West Hararghe zone.

Varietal Characters and Adaptation

The released variety, Bareda is characterized by growth habit of erect and moderate tuft at basal. Seed color of Bareda is pale brown. Bareda variety on average has a grain yield of 33.4 quintal/ha under research condition and 24 quintal/ha at farmers field.

On the average, Bareda needs 72 days to reach 50% of heading/flowering and 126 days to reach seed maturity stage. Bareda variety had plant height on average of 108 cm at physical maturity of harvest. The variety was released for the highlands and mid lands of West Hararghe and performed well within an altitude from 1550-2400 meters above mean sea level. This variety may perform very well with similar agro-ecologies and possible extend to this area.

Table.1 Garret ranking result for *farmer selection*

Accessions/Varieties	Total Score	Average Score	Rank
5442	848	84.8	3
5450	920	92	1
Bate	840	84	4
Bonsa	864	86.4	2

Table.2 Mean forage yield, agronomic traits and disease reaction of Bareda *and* adapted checks in multi-location tested

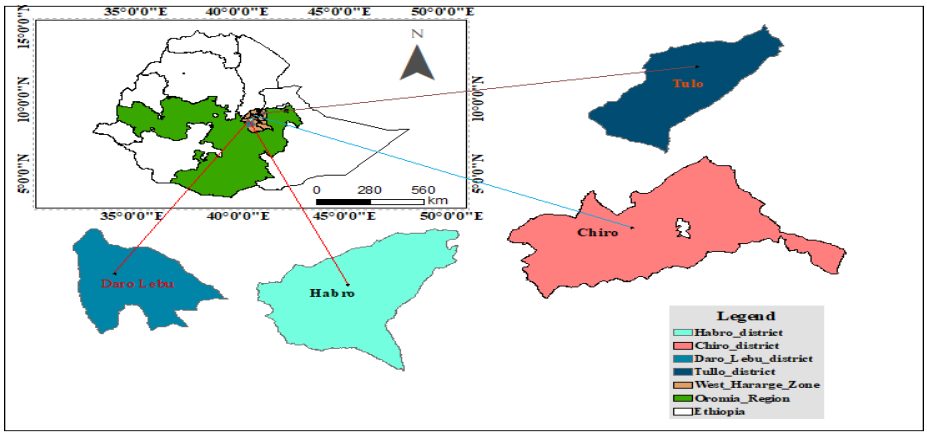
Variety	D 50%	DM (days)	Plh (cm)	DS	Sdyldqu		FBYt/ha		DM (t/ha)	LSR	FP	Lo	PC	DM	CP	NDF	ADF	IVDMD	ADL	OM
					ReF	FF	Re	FF												
Bareda (Acc.5450)	70.4	126.5	131.3	1.3	33.4	24	47.47	44.5	9.0	0.66	1	26	93	92.99	10.33	74.15	65.38	57.75	7.82	82.13
Bonsa	84.5	134.1	121.5	1.3	29	22	36.19	34.6	8.04	0.61	2.7	22	92	92.71	9.64	73.35	62.83	57.14	7.82	82.9
Bate	80.6	135	137.1	1.5	23	17	34.88	32.1	*	0.44	3.3	48	87	*	*	*	*	*	*	*
Means	78.5	131.9	130	1.37	28.3	21	39.51	39.1		0.57	2.3	32	90.67							

* = data is not available, D50% = date of 50% flowering, DS = diseases score, DM (days) = Date of maturity, Plh (cm) = plant height, Sdyldqu/ha = seed yield quintal per hectare, ReF = at research field, FF = at farmers field, FBYt/ha= fresh biomass yield tone per hectare, LSR = leaf stem ratio, FP = Farmers preferences, Log = lodging, DM = dry matter percentage, CP = crude protein, NDF= neutral detergent fiber, ADF = acid detergent fiber, IVDMD = invitro dry matter digestibility, ADL = acid detergent lignin, OM = organic matter, PC = plot cover percentage

Table.3 Agronomic/morphological characteristics of Oat variety, Bareda (Acc.5450)

Characteristics	
Variety Name	**Bareda**
Adaptation area	Mechara, Gelemso, Chiro, Tulo and similar agro ecologies
Altitude(m.a.s.l)	1550 - 2400
Rainfall(mm)	-
Fertilizer rate	
Nitrogen(kg N ha^{-1})	46
NPS(kg P_2O_5 ha^{-1})	19
Fertilizer application time	At sowing stage
Fertilizer application method	Row drilling
Planting or seeding	Row drilling
Planting date	Early July
Seed rate(kg ha^{-1})	100
Row spacing(cm)	30
Plant spacing(cm)	Drilling
Weeding frequency	Two week after sowing then each three weeks to 100% flowering
Days to flowering (days)	56-90
Days to Maturity (days)	87-155
Plant height(cm)	78-138
Inflorescence compactness	-
Seed color	pale brown
Crop pest reaction(1-5 scale)	
Leaf blight(Leaf rust)	2
Stem borer	1
Grain mold	1
Yield(Qt ha^{-1})	
Research field	27-39
Farmers' field	16-32
Year of release	2020
Breeder seed maintainer	Mechara Agricultural Research Center

Fig.1 Map of the study area



Source of the map: Ethio-GIS shape file, 2016

Fig.2 GGE biplot analysis of genotypes and environments for Dry matter yield

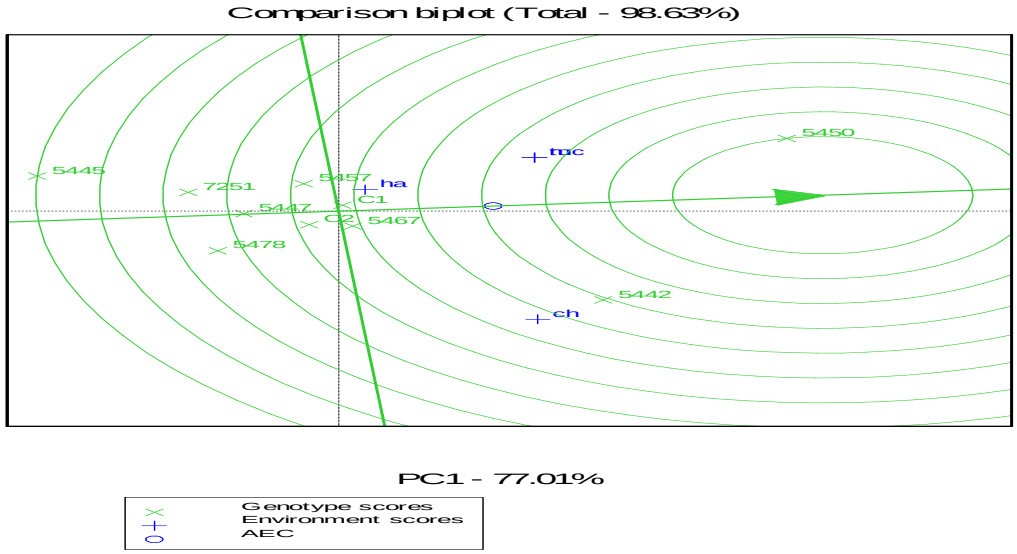
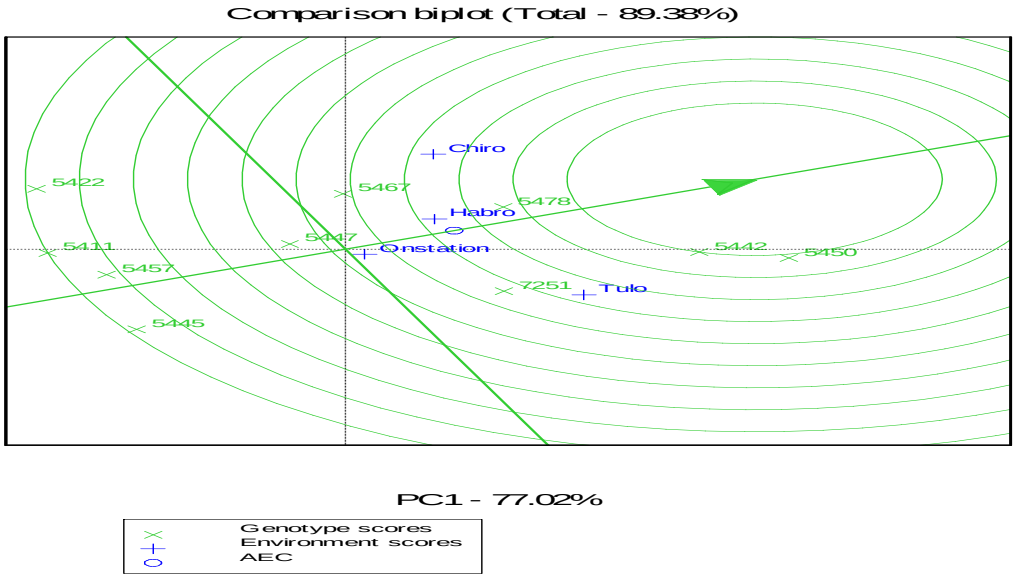


Fig.3 GGE biplot analysis of genotypes and environments for Green fodder yield



Forage Yield Performance

The average dry matter yield of Bareda were 9.00 t/ha. Bareda have dry matter yield advantages of 11.94 % over standard check (Bonsa). Bareda variety also has fresh biomass yield advantage over the check 31.2%.

Plant height also showed that Bareda variety were better that the checks that directly related to fresh biomass yield and dry matter yield. Data on the nutritional content of the variety also indicated that the released variety had crude protein contents of 10.33 which have 7.2% advantage over the check. The variety also contained comparatively lower fiber content (Table 2).

Farmers and DA's Preferences

Results from nine experimental farmers and six DA's were collected and analyzed through Henry Garrett ranking method. The result indicates that the perceived degree of importance of Bareda variety was ranked first based on the criteria's like leafiness, green fodder yield, standing vigor, plot cover, absence of lodging, disease tolerant, softness and fast growth.

The visual and hand evaluation of the farmers and DA's were very critical for ranking of this cultivars. Accordingly, the average rank showed that farmers and DA's gave the first score for Bareda variety followed by Bonsa (standard check) (table 1).

Stability of Performance/Adaptability

Forage yield stability parameters for tested oat genotypes for two years at four locations were studied. Analysis using the GGE biplot confirmed that genotype 5442 and Bareda (acc.5450) variety are most stable and desired genotype as compared to the other genotypes since the regression coefficients approximating to unity and had one of the lowest deviations from regression. This is implying that it has good general adaptability compared to the remaining tested genotypes in the test environments and similar agro-ecologies (fig.1 and 2).

Reaction to Disease and Pest

The most common diseases of oats are leaf rust, stem rest and crown rust. On 1-5 rating scale, *Bareda and Bonsa* scored a mean of 1.3 and Bate scored 1.5 for leaf rust diseases. Hence, the released varieties are characterized by more tolerant to the major diseases at all sites. The disease score results for the varieties and the checks are summarized in Table 2.

The released variety, Baread 'Acc. 5450' has better herbage dry matter yield performance, good general adaptability, stability, disease and pest tolerant from the tested as compared to other rested genotypes. The released variety also has better nutritional quality, especially dry matter, crude protein and organic matter. Therefore, smallholder farmers and other stakeholders who have engaged in animal production can utilize the Bareda variety as energy supplements for low quality feed resources.

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