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Faba Bean Variety Development for Quality and Disease Resistance for Potential Areas (Registration of a Faba Bean Variety Named '*Numan*')

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Abstract **– Faba bean (Vicia faba L.) variety named '*Numan*' with the pedigree designation of 'EH06007-2' has been released by Kulumsa agricultural research centre in Ethiopia. The variety is best adapted to altitudes ranging between 1800 to 3000 m.a.s.l. areas of Ethiopia and similar agro-ecologies. The variety was developed through hybridization between F5 generation (EH99037-5) and exotic material (ILB1563) and resulted in breeder id designation of 'EH06007-2'. It has been tested at Kulumsa, Asassa, Bokoji, Koffale, Holetta, Adadi, Jeldu, Adet, Shambuand Sinana, from 2012 to 2013 main cropping seasons. The seed weight of this variety is 36.5% heavier than the seed weight of the variety used as the standard check. Despite '*Numan*' showed relatively (-2.77%) less seed yield advantage across a range of environments and years than the standard checks Dosha and Tumsa in the National Variety Trials based on most stability measurement parameters. However, this variety is the seed size and moderately resistant to the major faba bean diseases such as chocolate spot and rust, and it could be cultivated across a number of locations in the mid and high-altitude areas of Ethiopia for increasing productivity of the crop and important variety for foreign export.**

Keywords **– Vicia Faba L., National Yield Trail, Preliminary Variety Trial, Grain Yield, Seed Size.**

I. INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important pulse crops in terms cultivated in Ethiopia. Presently, it is cultivated in about 427,696.80 hectares with an annual production of 878,010.88 tons, with a productivity of 2.053 tons ha^{-1} (CSA, 2016/17). Ethiopia is the first producer of faba bean in Africa and the second in the world next to the People's Republic of China (FAOSTAT 2017; Mussa and Gemechu, 2006). The crop is mainly cultivated in mid and high altitude areas, with an elevation ranging from 1800-3000 meters above sea level (Mussa and Gemechu, 2006).

Even if faba bean breeding in Ethiopia was started in the 1950s, its production in the country couldn't attain the maximum yield potential of the crop because of biotic and abiotic stresses that collectively cause great yield losses. Some of the major constraints to increased faba bean production are lack of improved varieties, chocolate spot (*Botrytis fabae*), root rot and rust, soil borne diseases, insect, pests, broadleaf and grass weeds, water-logging, drought and cold weather condition and currently faba bean leaf gall ((*Olpidiumviciae* (Kusano)) which is locally named 'Qormid' in Ethiopia (Abebe *et al*. 2013; Hailu *et al*. 2014). Special focus has been given for faba bean research programs to develop improved varieties that will have high yield, resistance or tolerance to major diseases and water-logging to increase production and productivities of the crop.

The current and the main objectives of faba bean breeding in Ethiopia are to improve its productivity through developing and promoting improved cultivars with high and stable yield, and resistant/tolerant to major biotic and abiotic stresses (Gemechu*et al.*, 2006). An exceptional focus has been given to improve grain yield, and

diseases and water-logging resistance or tolerance. Very recently, considerable attention has been remunerated to develop large-seeded faba bean varieties to meet the demand of the export-market for seed quality since large-sized seeds are preferred by consumers in the local market and fetch premium prices in the international market. In the view of the above fact, the objective of this paper is faba bean variety development for quality, seed size and disease resistance for potential areas.

II. MATERIALS AND METHODS

Table 1. Description of experimental site.

Location	Latitude	Longitude	Altitude (masl)	Mean annual rainfall (mm)	Tem (°c) (Min)	Tem(°c) (Max)	Soil texture	PH
Asassa	07°12'N	39°20'E	2300	620	5.8	23.6	Clay-loam	6.2
Kulumsa	08°05'N	39°10'E	2200	820	10.5	22.8	Dark-clay loam	6
Bekoji	07°05'N	39°30'E	2780	1010	7.9	16.6	Clay-loam	5
Holetta	08°58'N	38°14'E	2400	975.5	6.05	22.41	Red-clay	4.9
Koffale	7°00'N	38°45'E	2660	1211	7.1	18	Loam	5.1
Adadi	8°37'57"N	38°30'0"E	-	-	-	-	-	-
Shambu	9°34'00" N	37°06'00"E	2300	1100	5.7	23.3	Clay-loam	5.6
Sinana	07°06'12"N	40° 12'40"E	2400	812	9.3	22.9	Clay loam	6.5
Adet	11°16'00'N	37°29'00''E	2216	1271	8.8	25.2	Clayey	7.5

Sources: http://www.arari.gov.et ; http://www.iqqo.org **:** http://www.eiar.gov.et

Breeding Procedures

The crossing was done among diverse materials for different trait particularly seed size, including adapted faba bean variety 'EH99037-5', which was selected from the last stage of variety trial, with bean pure line (ILB1563) introduced from ICARDA at Holeta agricultural research center during 2002 cropping season. Screen houses were routinely used in the early generations, i.e., F1, F2, F3 and F4, of a breeding cycle to prevent bees from causing cross-pollination. During these phases, selection for traits with high heritability such as seed size, grain yielding ability, plant habit, time of flowering and resistance to major diseases such as chocolate spot and rust were undertaken. Twenty-one elite individual lines selected from the F5 generation were promoted and evaluated for yielding ability, large seed size, disease reaction and stability at in a preliminary variety trial (PVT) conducted during the 2010/11 cropping season at multi-locations. From this trial, 13 promising genotypes were promoted and evaluated in a national variety trial (NVT) along with two recently released standard checks 'Doshaand Tumsa' at multi-locations with RCBD design. The locations where the trials were conducted included Kulumsa, Asassa, Bokoji, Koffale, Holetta, Adadi, Adet, Sinana and Shambu from 2012 and 2013 main cropping seasons. The trials were replicated four times per location. Finally, 'EH06007-2' and 'EK02018-3' were selected as the most promising candidate varieties and evaluated along with two best standard checks (Tumsa and Gora) on 10 m x 10 m plots by the national variety verification release technical committee at 8 locations, each one on-station and two on-farm fields during the 2015 cropping season. Eventually, 'EH06007-2' was recommended for commercial production and named '*Numan*'.

Experimental Layout

The experimental layout was arranged in RCBD designs with 4 replications across the testing location. Each plot has 4 m row lengths. Spacing between blocks and plots were 1.5 m and 0.6 m respectively. The experimental plots have 4 rows and seeds were sown at the rate of 50 seeds per row with 8 cm spacing between plants and 40 cm row to row spacing, have a total of 6.4 m^2 plot area. Mean grain yield and other agronomic data were taken from the middle 2 rows of plot which is 3.2 m^2 net harvesting plot area. The sample mean grain yield of the Genotypes was adjusted to the recommended percent which is 11% of seed moisture contents and finally converted into hectare. Fertilizer was applied 18 kg N and 46 kg P_2O_5 per hectare in the form of DAP (Diamonium phosphate) only at planting time.

Statistical Analysis

The data were subjected to analysis of variance (ANOVA) using the proc GLM procedure of SAS version 9.3 (SAS Institute inc., 2010) to determine the existence of significant differences between faba bean genotypes.

III. Result and Discussion

Varietal Characteristics

The newly released faba bean variety 'Numan' is characterized by an indeterminate growth habit. Its flower color is white with black spots. The seed coat and cotyledon colors are light green and ceramic, correspondingly. The average number of days required by the variety to reach its 50% flowering and 95% physiological maturity were 56 and 143, respectively, with the average plant height being 133 cm (Table 2). The average number of pods per plant is 10.2 (Table 2). The appropriate planting date for this variety would range from early June to early July. For a better harvest, the variety must receive 46 kg P2O5 ha^{-1} and 18 kg ha^{-1} N at sowing.

Table 2. Mean agronomic performance of 15 faba bean genotypes tested over 15 environments during (2012-2013) cropping season.

Test Varieties	FLD	MTD	PLH	PPL	TSW(g)	GYLD (kg/ha)	CHS	Rust
Dosha	53.56	140.59	140.26	12.96	724	3846	5.38	3.59
EH00100-2	53.02	142.41	136.78	11.39	894	3859	5.39	3.58
EH00053-1	53.08	142.68	137.14	12.00	867	3641	4.81	3.81
EK02017-3	53.44	142.07	138.57	12.13	871	3868	4.99	3.38
EK02017-3	54.08	140.42	139.40	11.98	879	3841	5.00	3.63
EK02019-2	55.73	143.25	136.19	11.35	829	3796	5.03	3.44
EH00100-3	53.77	142.43	137.36	11.14	876	3811	5.31	3.74
EK02018-1	56.31	143.63	139.74	11.12	811	3712	4.66	3.52
EK02018-3	**54.10**	**143.11**	**140.10**	**11.31**	**915**	**3860**	**5.84**	**3.28**
EK02016-1	54.21	143.02	143.49	11.77	835	3799	4.95	3.33
EK02006-2	54.88	143.63	139.80	11.16	866	3789	4.83	3.26
EH06007-1	55.96	145.04	138.53	11.01	917	3547	4.49	3.06

Test Varieties	FLD	MTD	PLH	PPL	TSW(g)	GYLD (kg/ha)	CHS	Rust
EH06006-6	53.63	142.34	133.02	9.72	991	3432	5.31	3.78
EH06007-2	**55.83**	**143.29**	**132.87**	**10.19**	**1077**	**3758**	**4.82**	**2.97**
Tumsa	53.50	143.23	143.99	12.71	785	3850	4.92	2.94
Mean	54.34	142.74	138.48	11.46	876	3761	5.05	3.42
LSD(<0.05)	0.61	1.94	3.77	0.93	23.80	231.12	0.88	0.28
CV (%)	2.91	3.65	7.59	22.54	7.56	17.11	45.43	17.03

Abbreviations: FLD = Days to 50% flowering; MTD = Days to 95% physiological maturity; PLH = Plant height (cm); PPL = Number of pods per plant; TSW = 1000 seed weight (g); GYLD = Grain yield (kg/ha); CHS = Chocolate spot disease (1-9 scale score); Rust = Rust disease (1-9 scale score).

Yield and Quality Performance

The released variety '*Numan*' is mainly characterized by a heavier seed than the seeds of other all other released faba bean varieties in the country, which averages 1069 g per 1000 seeds. The seed of this newly released variety has weight advantages of 36.5% over the best standard checks 'Tumsa' variety (Table 4). In addition to this, the registered variety is the first in its kind of broad and export type with thousand seed weights leading to have around 300g and 125g seed size advantage over the best standard check 'Tumsa' and the recently released large-seeded variety 'Gora' respectively (table 5). In spite of its seed size advantage, the average grain yield of the newly released variety combined over locations and years, it is below the average yield of standard check 'Tumsa' by -2.77% (Table 3). The data on quality traits indicated in (Table 5) show that the released variety '*Numan*' has better quality (seed size) with those of the standard checks.

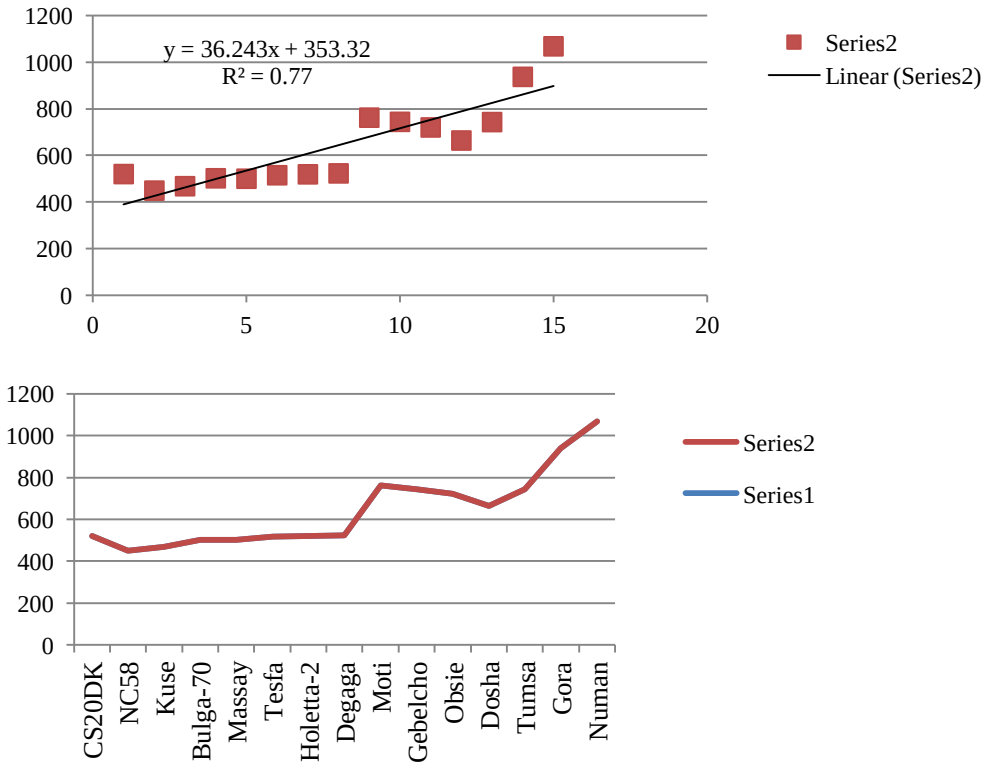

Fig. 1. Seed size achievement so far and particularly for 'Numan' Variety.

Table 3. Mean grain yield (kg/ha) of 15 faba bean genotypes tested over 15 environments during (2012-2013) cropping season.

Genotypes			Cropping season -2012								Cropping season-2013					Mean
	Kulumsa	Bekoji	Kofale	Holetta	Adadi	Adet	Shambu	Sinana	Kulumsa	Bekoji	Asassa	Koffale	Holetta	Adadi	Adet	
Dosha	1909	4762	3865	5047	3246	3198	3973	4162	4321	6019	3222	5561	2171	3720	2511	3846
EH00100-2	1973	4900	3319	4389	3089	3908	4064	4125	4185	5980	3642	4696	2836	4479	2305	3859
EH00053-1	1942	3644	3208	4615	3535	3545	2755	3940	4208	5486	3644	5186	2512	4336	2064	3641
EK02017-3	2216	4314	3749	5007	3485	3368	3263	4108	4037	5989	3758	5041	3000	3559	2247	3809
EK02017-3	2036	4605	3551	4947	3932	4675	3600	3154	3384	5848	3396	4884	3314	4108	2178	3841
EK02019-2	2540	4317	3810	4930	3621	2822	3890	3834	3775	5496	3331	5870	2412	4113	2173	3796
EH00100-3	1710	4426	4180	4886	3958	3188	3559	3680	3317	5447	3019	5094	2820	5811	2076	3811
EK02018-1	1864	4211	3730	5194	3300	2981	3673	3674	3959	5280	3677	5476	2602	4005	2055	3712
EK02018-3	**2257**	**4570**	**3584**	**4689**	**3593**	**3145**	**3578**	**3864**	**4367**	**5568**	**3569**	**5370**	**2769**	**4799**	**2174**	**3860**
EK02016-1	2264	4452	3575	4776	3607	4095	3849	3368	3596	5830	3572	4259	3179	4323	2234	3799
EK02006-2	2722	4402	3150	5406	3500	3438	4093	3719	4028	5153	4110	4655	2404	3930	2131	3789
EH06007-1	2254	3744	3174	5015	3358	3308	3691	3423	3602	5941	3031	4241	2386	2849	2482	3500
EH06006-6	1636	4321	2613	4169	3251	4908	3315	3535	3169	5542	2675	4729	1670	3512	2432	3432
EH06007-2	**2633**	**3932**	**2810**	**4063**	**3124**	**2711**	**3578**	**3498**	**4201**	**6121**	**3607**	**5761**	**2729**	**4348**	**2515**	**3709**
Tumsa	2279	4754	3195	4511	3552	3691	3519	4021	4717	5616	4038	5453	2673	3509	2224	3850
Mean	2149	4357	3434	4776	3477	3532	3627	3740	3924	5688	3486	5085	2632	4093	2253	3761
LSD(< 0.05)	530.2	946.3	1073	742.4	630.8	1423.2	995.6	874.5	729.8	924.5	643.1	1111.2	886.0	1264.8	566.2	231.12
CV (%)	17.29	14.84	21.89	10.89	12.71	27.55	19.24	16.38	13.03	11.39	12.93	15.31	23.59	21.07	17.61	17.11

Table 4. Mean 1000 seed weight (g) of 15 faba bean genotypes tested over 15 environments during (2012-2013) cropping season.

Genotypes			Cropping season-2012								Cropping season-2013					Mean
	Kulumsa	Bekoji	Kofale	Holetta	Adadi	Adet	Shambu	Sinana	Kulumsa	Bekoji	Asassa	Koffale	Holetta	Adadi	Adet	
Dosha	750	755	762	769	637	766	535	660	738	770	630	783	730	779	792	724
EH00100-2	973	919	957	914	821	878	721	859	930	978	750	935	889	923	964	894
EH00053-1	898	898	892	883	816	872	501	777	955	968	775	948	858	934	936	861
EK02017-3	900	951	901	921	807	863	636	797	910	928	788	928	862	874	1006	871
EK02017-3	873	995	868	852	830	864	550	816	930	928	790	935	864	980	944	868
EK02019-2	908	861	847	858	831	848	637	753	820	853	715	885	819	860	938	829
EH00100-3	880	955	947	924	878	885	562	862	828	958	788	905	889	925	952	876

Genotypes			Cropping season-2012								Cropping season-2013					Mean
	Kulumsa	Bekoji	Kofale	Holetta	Adadi	Adet	Shambu	Sinana	Kulumsa	Bekoji	Asassa	Koffale	Holetta	Adadi	Adet	
EK02018-1	838	848	816	859	813	852	537	797	845	858	728	860	810	818	893	811
EK02018-3	**960**	**976**	**1004**	**909**	**866**	**940**	**554**	**897**	**905**	**1018**	**860**	**1000**	**869**	**925**	**1039**	**915**
EK02016-1	875	930	845	887	794	915	592	840	825	900	723	868	823	830	888	835
EK02006-2	915	933	848	875	812	914	744	877	843	915	760	918	815	881	938	866
EH06007-1	1025	1007	939	908	886	938	605	924	1025	950	828	925	836	944	1010	917
EH06006-6	1055	1186	1037	998	1007	1109	596	977	993	1068	865	1040	895	1052	986	991
EH06007-2	**1308**	**1003**	**1343**	**1200**	**1100**	**1213**	**625**	**935**	**1158**	**1100**	**925**	**1120**	**987**	**1095**	**930**	**1069**
Tumsa	865	825	822	763	670	812	497	744	815	853	698	890	804	834	884	785
Mean	935	936	922	901	838	911	593	834	901	936	775	929	850	910	940	876
LSD (< 0.05)	93.02	54.63	72.17	55.73	51.33	81.01	3.60	80.81	98.47	61.42	72.87	59.64	84.88	72.55	147.01	23.80
CV (%)	6.97	4.09	5.49	4.33	4.29	6.23	25.02	6.79	7.66	4.60	6.59	4.50	7.00	5.52	10.96	7.56

Table 5. Mean grain yield, agronomic traits, quality parameters and disease reaction of '*Numan*' with two standard checks in 15 environments during 2015 cropping seasons at variety verification trails.

Genotypes	Agronomic traits						Disease Reaction (1-9)		Quality Parameters	
	DTF	DTM	PLH (cm)	NPPP	TSW (gm)	Grain Yield (Kg/ha)	ChS	Rust	ACP (%)	Soak-ability (%)
Gora	57	140	132	10	796	3802	28.2	27	26.19	96.75
Numan (EH06007-2)	55	143	134	10.2	1069	3781	35	24.9	26.5	99.75
Tumsa	52	133	143	11.9	785	3850	36	25	25.44	100

Keys; DTF = Days to 50% flowering; DTM = Days to 95% physiological maturity; PHT = Plant height; NPPP = Number of pods per plant; TSW = 1000 seed weight; ChS = Chocolate spot; ACP = Average crude protein.

The statistical analysis result shows that, grain yield, thousand seed weight and plant height parameters shows highly significant difference (P<0.01) between genotypes and locations, shown below in the ANOVA (Table 6). The interaction effect between genotypes and locations show highly significant difference (p<0.01) by mean grain yield and thousands seed weight. While no significant difference (ns) were observed between genotypes and locations interaction in plant height.

Table 6. ANOVA summary table of mean grain yield, 1000 seed weight, pod per plant and plant height parameters.

SV	Df	Mean square		
		TSW	GYH	PPL
Location	14	475971**	58123101**	462.62**

SV	Df	Mean square		
		TSW	GYH	PPL
Block (Location)	45	6202.9*	1449989.6**	28.99**
Genotypes	14	404276**	958882**	43.29**
Location x Genotypes	196	10325**	638787**	8.03ns
Mean		875.5	3761	11.46
CV (%)		7.56	17.1	22.54
R^2		0.84	0.8	0.7

Keys; TSW = Thousand seed weight, GYH = Grain yield per hectare, PPL = Pod per plant, SV = Sources of variation and Df = Degree of freedom.

Reaction to Major Diseases

Developing resistant or tolerant varieties to major diseases such as chocolate spot *(Botrytis fabae)* and rust *(Uromycesviciae-fabae)* is among the major objectives of the national faba bean breeding program. Chocolate spot and rust scores based on (1-9) scale were converted to pre-transformed percentage values, which were then used to determine the reaction of the released variety '*Numan*' to major diseases (Little and Hills, 1978). Consequently, the released variety '*Numan*' showed an average reaction of 35 and 24.9 for chocolate spot and rust, respectively (Table 5), and is characterized as moderately resistant to these major diseases.

The ANOVA table of major disease result shows that the chocolate spot shows highly significant difference ($p<0.01$) observed within location, while non-significant difference were shows within genotypes and interaction effect between location and genotypes. But rust disease result shows that all location and Genotypes effects, as well as interaction effect, shows that highly significant difference ($p<0.01$) were observed shown in the table below (Table 7).

Table 7. ANOVA summary table of mean grain yield, 1000 seed weight, pod per plant and plant height parameters.

SV		Mean Square	
	Df	CHS	RUST
Location	14	769**	134.5**
Block(Loc)	45	3.27^{ns}	4.1**
Genotypes	14	5.95^{ns}	2.6**
Loc X trt	196	4.66^{ns}	0.55**
Mean	-	**5.05**	**3.42**
CV (%)	-	**45.44**	**17.03**
R^2	-	**0.79**	**0.92**

CHS = Chocolate spot, CV = Coefficient of variation, R = Coefficient of determinations, SV = Sources of Variation and Df = Degree of freedom.

Table 8. Mean chocolate spot (1-9) score over 12 environments and rust diseases (1-9) scores over 7 environments of 15 faba bean genotypes tested during (2012-2013) cropping season.

Tested genotypes	Chocolate spot score (1-9) scale												Rust disease score (1-9) scale						
			Season-2012						Season-2013				Season-2012			Season-2013			
	Kulu-msa	Beko-ji	Kofa-le	Holet-ta	Adet	Sina-na	Kulu-msa	Beko-ji	Asa-ssa	Koffal-e	Hole-tta	Adadi	Kulu-msa	Kofa-le	Sina-na	Kulu-msa	Beko-ji	Asas-sa	Koffa-le
Dosha	4.50	4.00	4.00	4.25	3.00	4.75	5.25	3.75	5.75	4.00	5.50	3.50	2.25	4.25	6.25	3.75	2.50	5.25	3.50
EH00100-2	4.50	3.75	3.75	4.25	2.75	5.00	4.50	3.25	5.25	4.00	4.88	3.25	2.00	4.25	6.50	3.75	2.25	4.75	3.75
EH00053-1	4.00	4.25	3.75	4.50	3.00	5.25	4.00	3.75	5.75	4.25	5.25	2.75	2.00	5.00	7.25	3.50	3.25	5.00	3.50
EK02017-3	4.50	4.00	3.75	4.25	3.50	5.00	4.00	3.50	5.50	4.00	4.88	2.75	2.25	4.00	6.25	3.75	2.00	5.00	2.75
EK02017-3	4.50	3.50	3.75	4.00	2.75	5.00	5.25	3.25	5.50	4.50	5.25	2.50	2.00	4.50	7.00	3.50	2.25	5.00	3.75
EK02019-2	4.00	3.50	3.50	4.25	3.00	4.50	4.50	3.00	5.75	3.25	5.38	2.25	2.25	3.75	6.50	3.25	2.50	4.50	3.75
EH00100-3	5.00	3.75	3.50	4.25	4.25	5.50	5.25	3.75	6.25	4.50	5.38	3.25	2.25	4.00	6.00	3.50	2.75	5.50	4.00
EK02018-1	4.00	3.25	3.25	4.00	2.75	5.00	4.00	2.75	5.75	3.25	4.88	2.50	2.25	4.00	6.00	3.75	2.00	5.25	3.50
EK02018-3	**4.50**	**3.75**	**3.75**	**4.00**	**3.50**	**5.00**	**3.75**	**3.00**	**5.50**	**3.50**	**5.13**	**3.00**	**2.00**	**3.25**	**6.50**	**3.25**	**2.00**	**5.00**	**3.25**
EK02016-1	4.00	3.00	3.75	4.50	3.00	5.00	4.50	4.00	5.25	4.50	5.13	2.50	2.00	3.75	6.00	3.50	2.75	4.75	3.00
EK02006-2	4.00	3.25	3.50	4.00	2.75	5.00	4.50	3.50	5.50	3.75	5.00	2.75	2.25	3.50	6.25	3.00	2.25	4.25	3.50
EH06007-1	4.00	3.50	3.00	3.75	2.50	4.00	3.75	3.25	5.00	3.50	4.88	2.50	2.25	3.50	5.00	3.00	2.50	4.00	3.25
EH06006-6	4.25	4.00	3.25	4.25	2.00	5.25	4.50	3.75	5.25	4.00	5.00	2.50	2.25	5.25	6.50	3.75	2.75	5.00	3.75
EH06007-2	**4.00**	**3.50**	**3.00**	**4.25**	**3.25**	**4.25**	**4.00**	**3.75**	**5.25**	**4.00**	**5.13**	**3.00**	**2.50**	**2.75**	**5.00**	**3.00**	**2.50**	**4.25**	**2.75**
Tumsa	4.25	4.00	3.50	4.00	3.00	4.75	3.25	3.00	5.00	3.50	5.25	2.75	2.25	3.25	5.25	3.00	2.00	3.75	3.00
Mean	**4.27**	**3.67**	**3.53**	**4.17**	**3.00**	**4.88**	**4.33**	**3.42**	**5.48**	**3.90**	**5.13**	**2.78**	**2.18**	**3.93**	**6.15**	**3.42**	**2.42**	**4.75**	**3.40**
LSD(<0.05)	**0.63**	**0.91**	**0.69**	**0.82**	**0.71**	**0.73**	**1.06**	**0.72**	**0.8**	**0.76**	**0.49**	**0.93**	**0.57**	**1.09**	**1.07**	**0.66**	**0.84**	**0.92**	**0.9**
CV (%)	**10.29**	**17.44**	**13.62**	**13.82**	**16.5**	**10.43**	**17.06**	**14.68**	**10.24**	**13.63**	**6.68**	**23.35**	**18.38**	**19.46**	**12.21**	**13.5**	**24.23**	**13.58**	**18.45**

Performance Stability and Adaptation Domain

The variety '*Numan*' was released for the mid-altitude agro-ecologies of the country receiving 700 to 1100 mm average annual rainfall. It is well adapted to an altitude range of 1800 to 3000 meters above sea level such as Kulumsa, Holleta, Bokeji, Asassa, Jeldu, Kofele, Sinana, Adet, Shambu and similar agro-ecologies. Based on some stability parameters, '*Numan*' showed relatively comparable performance stability across a range of environments. For some of the univariate parametric methods like ASV, were identified '*Numan*' as the most attractive genotype (Table 9). The smaller the values of all the above mentioned non-parametric stability statistics, the more stable the variety is. Accordingly, Candidate variety - (EH06007-2) is also demonstrated comparable performance stability level as the best standard check in the trial.

Table 9. AMMI stability value and rank based non-parametric stability parameters for 15 faba bean genotypes evaluated across 15 test environments during 2011/2012 and 2012/2013 cropping seasons.

Genotypes	Grain yield (kg/ha)	ASV	RY	RASV	GSI	RANKSUM
Dosha	3846	16.25	5	6	11	14
EH00100-2	3859	8.61	3	1	4	7
EH00053-1	3641	10.38	13	3	16	18
EK02017-3	3880	12.42	1	5	6	2
EK02017-3	3841	29.29	6	13	19	18
EK02019-2	3796	21.12	9	11	20	16
EH00100-3	3811	41.95	7	15	22	22
EK02018-1	3712	17.46	12	7	19	15
EK02018-3	*3860*	*18.05*	*2*	*8*	*10*	*4*
EK02016-1	3799	20.88	8	10	18	14
EK02006-2	3789	9.87	10	2	12	20
EH06007-1	3566	25.82	14	12	26	27
EH06006-6	3432	38.94	15	14	29	29
EH06007-2	**3751**	**11.29**	**11**	**4**	**15**	**22**
Tumsa	3850	19.75	4	9	13	12

Abbreviations: GYLD = Grain yield in kg/ha; ASV = AMMI stability value; RY = Rank grain yield; RASV = Rank AMMI stability value; and GSI = Genotypic stability index.

Variety Maintenance

The breeder and foundation seed will be maintained in Ethiopia, by Kulumsa Agricultural Research Center for further promotion and extending this technology with the full package to the seed producer companies and farming communities.

IV. CONCLUSION

Grain yield is the primary trait of interest and a prime objective in faba bean breeding programs for many decades. However, also seed size has received a special attention recently. This is also what is happening at international and national levels in response to the current move to meet the export-market demand for seed quality particularly for the development of large-sized seeds that fetch high prices in the world market. Regardless of this, only a few varieties that combine both high yields with large seed sizes have been released since the inception of faba bean breeding program in the country. The recent variety, '*Numan*' has almost 36.5% seed size advantages over the widely cultivated Large seeded faba bean varieties, 'Tumsa' and 14.7% seed size advantage over the large-seeded variety 'Gora' with comparable seed yield productivity, respectively. Therefore, wide cultivation of '*Numan*' variety will boost productivity and market ability of the crop and plays a significant role in improving farmers' income.

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