biomass, 1000 seed weight and harvest index were recorded. Data for number of pod per plant, number of seeds per pod and plant height were collected from the average value of randomly selected five plants per plot. Whereas data on seed yield, total biomass and thousand seed weight were collected on plot basis. Analysis of variance was performed using Statistical Analysis Software [6]. Least Significant Difference (LSD) test at 5% probability level was used for mean comparison when the ANOVA showed significant difference.

Table 1: List of Improved Haricot Bean Varieties Used for the Experiment

S.No.	*Name of Variety*	*Use/Type*	*Breeder/ Maintainer*
1	Beshbesh	Food	MARC/EIAR
2	Cranscope	Food	MARC/EIAR
3	Batu	--------	----------
4	Awash Melka	Canning	MARC/EIAR
5	Nasir	Food	MARC/EIAR
6	Dimtu	Food	MARC/EIAR
7	Gobe Rasha	Food	MARC/EIAR
8	Anger	Food	BARC/OARI
9	Awash-1	Canning	MARC/EIAR
10	Deme	-----	MARC/EIAR
11	Local check	-----	----------

3. Results and Discussion

The combined analysis for number of pods per plant, number of seeds per pod, plant height, seed yield, total biomass, thousand seed weight, and harvest index for two years (2013 and 2014) at arbaya are presented (Table 2 and 3).

Pooled analysis of variance over years revealed significant difference ($p<0.01$) among the varieties for all the parameters recorded revealing that the varieties tested were highly variable. Seed yield, 1000seed weight and harvest index showed significant difference ($p<0.01$) among years. Number of pods per plant and 1000 seed weight showed significant difference ($p<0.01$) among year by variety interaction. Only 1000 seed weight showed significant difference ($p<0.01$) among varieties, years and their interactions showing inconsistence performance of the varieties for this trait (Table 2). The presence of non significance interaction for most of the traits studied including seed yield indicates the consistence performance of the varieties over years.

Number of pods per plant: Significant differences ($P<0.001$) were exhibited among haricot bean varieties for number of pods per plant. More numbers of pods/plant were recorded from the varieties Dimtu and Awash melka with a respective 19.33 and 18.50 pods per plant. On the other hand, the local check had the lowest number of pods per plant with pod number/plant of 9.3 (Table 3).

Number of seeds per pod: Haricot bean varieties were exhibited variation ($P<0.01$) for number of seeds per pod. The variety Beshbesh produces more number of seeds per pod (6.83) compared to the other varieties. On the other hand, Batu produces the lowest number of seeds per pod (4.00) (Table 3).

Plant height: Highly significant variation ($P<0.01$) was observed among the studied varieties for plant height. The variety Dimtu (70.00cm) was the longest variety while the variety batu (33.00cm) was the shortest variety (Table 3).

Seed yield: A significant variation ($p<0.001$) was observed among haricot bean varieties in their response to seed yield. The highest yield was recorded from the varieties Nasir and Dimtu with the values of 2866.8 and2709.3 $kgha^{-1}$, respectively. Batu on the other hand was the lowest yielder with the value of 678.2 kg/ha (Table 3). A yield advantage of 2003.1 and 1845.6 kg ha^{-1} was obtained from the varieties Nasir and Dimtu over the local check (863.7 kg ha^{-1}) with respective increment in yield of 331.9 and 313.7%.

The greatest yield of the varieties Nasir and Dimtu could be due to their inherent genetic potential. These two varieties are superior to most of the varieties studied for the traits number of pods per plant, number of seeds per pod, total biomass and harvest index. This result is in agreement with the finding of [7] who stated that the seed yield of bean is the result of many plant growth processes which ultimately influence the yield components such as pods per plant, seeds per pod, and unit weight of seed. The highest seed yields were obtained when all the above got maximized. According to [8], Nassir, a small pure dark red variety, is one of the most favored and most commercially accepted varieties within the red bean types. These two improved varieties were released in Ethiopia for all haricot bean production areas.

These food type varieties (Nasir and Dimtu), released in 2003, were found potential for small farmers. The varieties were good yielder in research stations (up to 2500kg/ha) compared to previous released ones and also have short maturity cycle (85 days), they pose an opportunity for the farmers who at times hardly wait too long to feed the family, especially in Belessa areas where moisture is a limiting factor for crop production.

Total biomass: Significant differences ($P<0.01$) were exhibited among haricot bean varieties for total biomass. The highest total biomass was recorded from Nasir (5968.7kg ha^{-1}) followed by Dimtu (5955.7kg ha^{-1}). The least biomass was recorded by Batu with the value of 2357.2kg ha^{-1} (Table 3).

Thousand seed weight: The haricot bean varieties tested had a significant variation ($p<0.001$) among each other for thousand seed weight. The variety Gobe Rasha produces the highest seed weight (539.52 gm). The variety Awash-1 was the least in seed weight (151.95) (Table 3).

Harvest index: Harvest index, the ratio of grain yield to total biomass yield, is a measure of the degree to which a crop partitions photo assimilate into grain. Significant variation ($p<0.01$) was observed among varieties evaluated for harvest index. The varieties Beshbesh (0.50) and Nasir

(0.48) recorded highest harvest index while the varieties Batu (0.28) and Deme (0.28) recorded lowest (Table 3).

4. Conclusion

The genetic and environmental factors can cause a different level of variation of the tested characteristics of haricot bean. In order to boost productivity of haricot bean in the study area, it is better to consider the characters of the best variety having high yield advantage by resisting different biotic and abiotic stresses. According to this study varieties differ significantly in their yield and yield component performances recorded. This highly significant difference indicates considerable amount of variation among the tested genotypes for each trait which creates an opportunity for direct selection. The average means performance of the study area across the seasons did not differ, indicating the consistency of varieties across seasons.

Based on the combined analysis result, the varieties Nasir and Dimtu offered better performance over the other varieties regarding seed yield. These two varieties have also large number of pods per plant, longest plant height, high total biomass and large harvest index as compared to other varieties. Accordingly these two varieties are recommended for the study area and similar agro ecologies. The local check is out performed by all the improved varieties tested for the traits studied.

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Author Profile

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Table 2: Mean square values of grain yield and other agronomic characters of haricot bean varieties for combined analysis of variance over two years (2013 and 2014)

Source of Variation	*DF*	*Pod/ Plant*	*Seed/ Pod*	*Plant Height*	*Seed Yield*	*Total Biomass*	*1000 Seed Weight (g)*	*Harvest Index*
Variety	10	85.51^{**}	5.89^{**}	612.72^{**}	2982661**	8180903.78^{**}	85742.82^{**}	0.03^{**}
Year	1	23.04^{NS}	0.37^{NS}	214.56^{NS}	3718064**	3188242.97^{NS}	26304.08^{**}	0.33^{**}
Variety*Year	10	44.94^{**}	3.24^{NS}	154.06^{NS}	250787^{NS}	1665382.27^{NS}	19676.42^{**}	0.01^{NS}
Error	42	12.09	2.03	92.80	224240	1663408.4	663.55	0.01

*N.B. NS = Non significant, ** = Significant at the 0.01 level, DF = degree of freedom*

Table 3: Mean grain yield and agronomic characters of haricot bean varieties combined over seasons (2013 and 2014)

Variety	*Pod/Plant*	*Seed/Pod*	*Plant Height (cm)*	*Seed Yield (kg ha^{-1})*	*Total Biomass (kg ha^{-1})*	*1000Seed Weight (g)*	*Harvest Index*
Beshbesh	13.00^{BC}	6.83^{A}	57.50^{BC}	2094.7^{B}	4192.0^{BC}	162.20^{F}	0.50^{A}
Cranscope	11.67^{C}	5.00^{BCDE}	53.17^{CD}	1157.0^{DEF}	3932.7^{BCD}	312.75^{C}	0.31^{C}
Batu	9.83^{C}	4.00^{E}	33.00^{E}	678.2^{F}	2357.2^{E}	332.87^{C}	0.28^{C}
Awash Melka	18.50^{A}	6.33^{ABC}	56.67^{BCD}	1676.0^{BCD}	4147.2^{BCD}	198.40^{DE}	0.39^{ABC}
Nasir	16.67^{AB}	6.50^{AB}	67.50^{AB}	2866.8^{A}	5968.7^{A}	215.92^{D}	0.48^{A}
Dimtu	19.33^{A}	5.83^{ABCD}	70.00^{A}	2709.3^{A}	5955.7^{A}	213.92^{D}	0.46^{AB}
Gobe Rasha	10.67^{C}	6.67^{A}	46.00^{D}	1834.3^{BC}	5411.2^{AB}	539.52^{A}	0.39^{ABC}
Anger	16.67^{AB}	4.83^{CDE}	59.67^{ABC}	1366.3^{CDE}	3879.8^{CD}	163.25^{F}	0.35^{BC}
Awash-1	16.17^{AB}	5.00^{BCDE}	56.33^{BCD}	1602.2^{BCD}	4042.0^{BCD}	151.95^{F}	0.39^{ABC}
Deme	9.67^{C}	4.50^{DE}	62.33^{ABC}	1150.7^{DEF}	4315.5^{BC}	368.73^{B}	0.28^{C}
Local check	9.33^{C}	4.67^{DE}	56.00^{CD}	863.7^{EF}	2655.5^{DE}	179.77^{EF}	0.32^{C}
Mean	13.77	5.46	56.19	1636.28	4259.75	258.11	0.38
LSD (0.05)	4.05	1.66	11.22	551.74	1502.7	30.01	0.11
CV (%)	25.25	26.06	17.14	28.93	30.27	9.97	26.27

N.B = Means with the same letter are not statically significant, LSD = least significant difference, CV = coefficient of variation