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Farmers' Varietal Selection of Food Barley Genotypes in Gozamin District of East Gojjam Zone, Northwestern Ethiopia

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Abstract: In this study, the performance of four improved food barley varieties obtained from Holleta Agricultural Research Center and local variety collected from the study area were evaluated in randomized complete block design (RCBD) with three replications under farmers' participatory selection scheme during 2016 main cropping season in Gozamin district, East Gojjam Zone, Northwestern Ethiopia. The objectives of this study were to select adaptable and high yielding food barley genotype(s) using farmers' preferences and to identify farmers' preference and selection criteria of the study area. Farmers' set; grain yield, early maturity, tillering ability and spike length as their selection criteria at maturity stage of the crop. The results of analysis of variance (ANOVA) indicated significant differences among genotypes for all traits tested except number of effective tillers and thousand seed weight which were non-significant at 5% probability level. The improved variety EH-1493 (133 days) was the earliest while local variety (142 days) was the latest. The highest mean grain yield was obtained from HB-1307 (3700 kg ha^{-1}) and Cross-41/98 (3133 kg ha^{-1}) whereas the lowest from the local variety (1693 kg ha^{-1}). Similarly, HB-1307(5033 kg ha^{-1}) and Cross-41/98 (3633.33 kg ha^{-1}) had given comparatively the highest above ground biomass yield which was used as a source of feed for animals. Farmers' evaluation of direct matrix ranking showed HB-1307 and EH-1493 were the most preferred food barley varieties with a score of (29) and (28), respectively. Likewise, pair-wise ranking revealed that HB-1307 was chosen four times by farmers to be the most important variety that fulfills farmers' desires. Therefore, varieties HB-1307 and Cross-41/98 were chosen for their outstanding performance in biological parameters and also acceptable from farmers' evaluation point of view. Thus the seeds of these varieties need to be multiplied by selected model farmers in the coming year for better adoption and dissemination rate.

Key words: Direct-matrix · Food barley · Farmers' evaluation · Pair-wise ranking

INTRODUCTION

Barley (*Hordium vulgare* L.) is one of the most important cereal crops in the world, ranking fourth in production area next to wheat, rice and maize [1]. European Union, Russian Federation, Ukraine,Turkey and Canada are the top five largest barley producers in the world and Morocco, Ethiopia, Algeria and South Africa are in first largest barley producers in Africa. Barley has been produced in Ethiopia, since ancient times. It has great importance in social and food habit of the people. There are two types of barley that farmers grow in Ethiopia: food and malt barley. The majority of barley that farmers grow is food barley and it is the main ingredient for several staple dishes such as injera (leavened bread), porridge, and bread. Food barely is a cheaper cereal than maize, wheat, and teff and is often used as a substitute for lower income families. It is also used as raw material for brewing home-made alcoholic drinks.

The national area coverage of barley was estimated to be 0.99 million ha with national average productivity of 1.97 tons ha^{-1}, while the regional area coverage and average productivity was estimated to be 0.37 million ha and 1.73 tons ha^{-1}, respectively [2]. Similarly, the total area coverage for East Gojjam zone was estimated to be 0.05 million ha with productivity of 1.73 tons ha^{-1}. A number of improved food barley varieties have been released with their recommendation packages from

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different agricultural research centers with the potential productivity of about 5 tons ha^{-1} and 3 tons ha^{-1} at research station and at farmers' field, respectively. In spite of the importance of barley as a food and malting crop, and the efforts made so far to generate improved production technologies, its productivity in production fields has remained very low (about 1.9 tons ha^{-1} compared with the world average of 2.8 tons ha^{-1}). This is primarily due to the low yielding ability of farmers' cultivars, which are the dominant varieties in use, the minimal promotion of improved food barley production technologies and poor participation of farmers in variety evaluation and selection. In fact recommendation of improved varieties to a certain area needs the use of a participatory varietal selection (PVS) approach for the newly introduced improved varieties against the local varieties to select the appropriate and fit variety among the improved varieties in the study areas. PVS helps to increase the adoption of released varieties in larger areas; allow varietal selection in targeted areas at cost-effectiveness and in less time and as a consequence help seed production and scaling-up at community level. Moreover, the rationale behind to use PVS as part and parcel of modern plant breeding is due to the fact that the objectives of researchers usually yield maximization may differ from objectives of farmers like market, quality, household utilization and results from conventional research process take a long time to reach to the farmers. The approach of participatory varietal selection in Ethiopia has been tested on many crops including common beans [3], sorghum [4, 5], maize [6], teff [7] and barley [8]. However, farmers' varietal selection has not been done on the nationally released food barley genotypes in the East Gojjam zone in general and in Gozamin district in particular.

Despite the economic importance of barley crop in attaining food security and food self-sufficiency in East Gojjam zone, the role of improved varieties to increase productivity and contribute to change the livelihood of barley producing farmers is very low. This is mainly because of poor involvement of farmers during varietal evaluation that makes them to be unfamiliar with the benefits of improved varieties over the local cultivars. Thus it is imperative to evaluate the released food barley varieties in their agro-ecology using the participatory varietal selection (PVS) approach as it provides choices of varieties to the farmers for increasing production in their diversity of socioeconomic and agro-ecological conditions. Therefore, this experiment was conducted with the following objectives:

This study was conducted mainly with the objectives of selecting adaptable and high yielding food barley genotype(s) using farmer's selection scheme and identifying farmers' preferences and selection criteria of food barley genotypes in Gozamin district of East Gojjam Zone, North western Ethiopia.

MATERIALS AND METHODS

Description of the Experimental Site: This experiment was carried out in Gozamin district of East gojjam zone Amhara national regional state northwestern part of Ethiopia during the main cropping season of 2016/17. Gozamin district is located at 1002' - 10°8' N" latitude and 37°3' - 38°1'E" longitude with an altitude ranges between 1050 to 4200 m above sea level (m.a.s.l) as shown in Fig. 1. It has a hot and humid climate with an average maximum and minimum temperature of 22.4 and 10.63°C respectively, and average annual precipitation of about 1327.5 mm regarding the land features, 50% of the district is plain with gentle to flat slopes, 43% is mountainous with undulating to steep slopes and the remaining 7% constitutes valley relief. The dominant type of soil in the study areas are Nitrosol (red color).

Sampling Procedures: The sampling procedure involved, the selection of the district which was done based on purposive sampling method owning to the fact that Gozamin district is the major food barley growing area in East Gojjam Zone and its accessibility to transport. A random sampling method was employed to select three out of thirty kebeles that are found in Gozamin district and farmers were selected purposively based on their experience on growing food barley and adopting new agricultural technologies.

Treatments, Experimental Design and Field Management: A total of 5 food barley genotypes, 4 improved (HB-42, HB-1307, EH-1493 and Cross-41/98) and local variety collected from Gozamin district were evaluated by farmers for their performance and their description of genotypes indicated in Table 1. The experiment was laid out in randomized complete-block design (RCBD) with three replications each. The plot size was 5 x 3m (15 m^2) with a net plot size of 5 x 1.2m = 6m^2 for data collection. During planting, the seeds were manually drilled into five meters long ten row plot spaced 0.3 m apart. Nitrogen and phosphorus fertilizer were applied in the form of urea (46% N) and DAP (18% N and 46% P_2O_5)

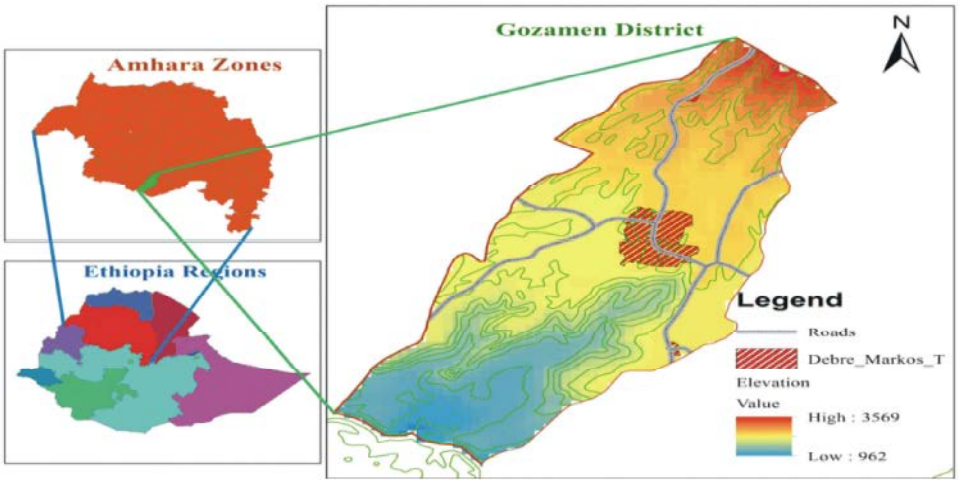

Fig. 1: Location map of the experimental area (Gozamin district)

Table 1: Description of evaluated food barley genotypes in 2016 main cropping season

			Yield (qt/ha)		
S/n	Varieties	Year of release	Research fields	Farmers' fields	Breeders/Maintainers
1	EH-1493		25-61	20-35	HARC
2	HB-1307	2006	35-50	35	HARC
3	Cross - 41/98		25-56	20-38	HARC
4	Local check	NA	-	13-18	Farmers of study area
5	HB-42	1986	23-35	20-33	HARC

Where; HARC means Holleta Agricultural Research center and qt/ha means quintals per hectare

at the rate of 75 kg ha^{-1} urea and 100 kg ha^{-1} of DAP respectively. DAP fertilizer was applied at the time of planting (as basal application), whereas urea was applied in the form of split application, half of it together with DAP and the rest as top dressing at heading based on ARARI 2014/15 recommendation packages. Hand weeding was practiced as frequently as needed.

Data Collected: Data were collected on plant and plot basis for the following important characters. Plant height, number of effective tillers per plant, number of seeds per spike, spike length and width from ten randomly selected plants of the four middle rows excluding three rows on each side of a plot and the average of them was considered for analysis on a plant bases. On the other hand, days to heading, days to physiological maturity, above ground biomass, thousand seed weight, grain yield per plot and harvest index was recorded on a plot bases.

Procedure of Farmers' Selection of Food Barley Genotypes: Farmers' evaluation and selection criteria were identified through participatory selection scheme using pair-wise and direct matrix rankings at maturity stage of the crop. A total of fourteen farmers of both sexes (male = 10, female = 4) participated in the study. Farmers were allowed to set their own selection criteria at this stage and then both male and female participants prioritized and jointly agreed on four characters (grain yield, tillering ability, spike length and early maturity). All of them were tabulated in a matrix scoring table, and each selection criterion was compared with another in a pair-wise fashion. The rank assignments were determined from the number of times each selection criterion was preferred by the group. A direct matrix table was prepared by putting the varieties listed in the row and characteristics preferred by farmers in the column. Scores were given to each variety based on the selection criteria (5 = very good, 4 = good, 3 = average, 2 = poor, and 1 = very poor). In this study five different colors of cards were used to score farmers preferred criteria using symbolic representation given as follows; very good (5) represented by deep green color card, good (4) represented by light blue card, average performance represented by yellow color card (3), poor (2) represented by light red color card and very poor represented by deep red color cards. During direct matrix ranking farmers have

given rating of importance (a relative weight) of a selection criterion ranked from 1 to 3 (3 = very important, 2 = important and 1 = less important) and rating of performance of a variety for each traits of interest (selection criteria) was given based on their level of importance on the basis of common agreement of evaluators'. The score of each variety was multiplied by the relative weight of a given character to get the final result and then added with the results of other characters to determine the total score of a given variety. Scoring and ranking were done on consensus, and differences were resolved by discussion as indicated by [9].

Data Analysis: Mean values of representative samples were used to estimate the performance of each variety for the traits measured. The data were analyzed using PROC ANOVA in SAS software version 9.1 (SAS, 2002). Mean separation was carried out using Least Significant Differences (LSD) at 5% probability level.

RESULTS AND DISCUSSION

Performance Evaluation of Food barley Varieties: The results of analysis of variance (ANOVA) presented in Table 2 indicated that there was significant differences among the tested food barley genotypes for all studied traits except number of effective tillers and thousand seed weight, which were non-significant at ($P<0.05$). The mean values of grain yield and other studied parameters of the five food barley genotypes are presented in Table 3. Genotypes had significant difference on phenological characters like number of days to heading and days to physiological maturity, which determine maturity range of food barley varieties. For days to physiological maturity, the earliest variety was EH-1493 (133 days), while, the latest maturing variety was the local cultivar with 142 days (Table 3). Generally, the improved food barley genotypes took shorter number of days to attain days to heading and physiological maturity stages than farmers local variety. The mean values of growth parameters like plant height indicated the variety Cross-41/98 recorded the tallest plant height with 122 cm and the local cultivar gave the shortest plant height of 109.67 cm. Above ground biomass is an important growth parameter for small-scale farmers that produce barley to meet the multiple interests of farmers. Farmers consider aboveground biomass as an important trait because it is used as a feed for animals and to make roofs for traditional houses. There were significant differences among food barley varieties tested for above ground biomass ($P<0.01$) as shown in Table 3. The lowest above ground biomass production was recorded for local variety (2500 kg ha^{-1}) while the highest above ground biomass weighted by HB-1307 with 5033.33 kg ha^{-1}. The ANOVA depicted acceptable level of coefficient of variation (CV) for most of the traits considered during the study (Table 2).

As indicated in Table 3, the performance of tested varieties differed significantly for yield and yield components of food barley. Thousand seed weight values ranged between 32.50 and 37.67 g with a mean of 35.93 g. The highest thousand seed weight was exhibited by HB-42; whereas the lowest weight was recorded by the local cultivar. Harvest index, which reflects the partitioning of photosynthates between grain and vegetative plant parts, is very important parameter to be considered in varietal evaluation. The mean harvest index ranged from 66.67% for EH-1493 to 85.67% for the variety Cross-41/98.

Mean grain yield among tested varieties ranged from 3700.00 kg ha^{-1} for the variety HB-1307 to 1693.00 kg ha^{-1} for the farmers local cultivar with an overall mean of 2594.00 kg ha^{-1}. The grain yields obtained from the varieties HB-1307 (3700.00 kg ha^{-1}) and Cross-41/98 (3133.33 kg ha^{-1}) were significantly ($P=0.01$) higher than all the other tested varieties. At the study area, increases in grain yield of improved varieties of food barley over the farmers' local cultivar were 118, 85, 31.48 and 30.80% for the varieties HB-1307, Cross-41/98, HB-42 and EH-1493, respectively.

Farmers' Evaluation of Food Barley Genotypes: Male and female evaluators were lumped together during evaluation as shown in Picture 1. The selection criteria suggested by farmers were grain yield, tillering ability, spike length and early maturity. Pair-wise matrix ranking of selection criteria was used to identify and prioritization order of the farmers' selection preference. Grain yield and tillering ability were proposed as very important criteria based on farmers' pair-wise ranking of selection criteria as indicated in Table 4. This is in line with the findings [10], who found the same selection criteria as the most important farmers' criteria for wheat varieties. Farmers selected finger millet variety, 'Tadesse' over the other tested varieties due to its high grain yield [11]. Besides in line with this finding [8], similarly found tillering ability as selection criterion on participatory varietal selection of barley.

Although most of the released early maturing food barley genotypes had problems related to bird damage, earliness remains as an important selection criterion for farmers of the study area in particular and in East Gojjam

Table 2: Analysis of Variance (ANOVA) for measured agronomic traits of food barley genotypes tested at Gozamin district during 2016 main cropping season

S.V	D.f	DH (days)	DPM (days)	PLH (cm)	NSPS (No.)	SL (cm)	SW (cm)	NET (No.)	TSW (g)	GY (kg ha^{-1})	AGBM (kg ha^{-1})	HI (%)
REP.	2	2.46^{ns}	5.60^{ns}	5.26^{ns}	3.27^{ns}	0.68^{ns}	0.005^{ns}	3.33^{ns}	51.84^{ns}	30860.00^{ns}	42666.67^{ns}	5.26^{ns}
TRT.	4	160.67*	36.00*	69.23*	381**	2.67**	0.024**	0.40^{ns}	13.18^{ns}	1951973.33*	2942666.67*	207.40**
ERRO	8	4.71	1.77	20.68	12.77	0.31	0.001	0.21	11.20	184143.33	265166.67	5.11
Mean	70.67	138.00	116.07	45.93	7.31	1.21	4.70	35.93	2594.00	3453.33	74.73	
C.V. (%)	3.07	1.06	3.92	7.78	7.61	2.33	9.67	9.31	16.55	14.91	3.02	

**Highly significant at 1% probability level, * significant and ns = non-significant at 5% probability level DH= Days to heading, DPM= Days to Physiological Maturity, PLH= Plant height, NSPS= Number of seeds per spike (No.), SL= Spike length (cm), SW= Spike width (cm), NET = Number of effective tillers, TSW = Thousand seed weight, GY = Grain yield (Kg/ha), AGBM = Above ground biomass (Kg/ha) and HI=Harvest index in (%).

Table 3: Mean square values of evaluated traits of food barley genotypes at Gozamin district during 2016 main cropping season

	Mean values										
Genotypes	DH (days)	DPM (days)	PLH (cm)	NSPS (No.)	SL (cm)	SW (cm)	NET (No.)	TSW (g)	GY (kg ha^{-1})	AGBM (kg ha^{-1})	HI (%)
EH-1493	63.67^{C}	133.00^{C}	113.00^{bc}	54.00^{a}	7.87^{ab}	1.15^{c}	5.13^{a}	36.83^{a}	2216.00^{b}	3333.33^{bc}	66.67^{d}
HB-1307	67.67^{C}	138.33^{b}	118.33^{ab}	51.33^{ab}	6.87^{bc}	1.34^{a}	4.70^{a}	37.23^{a}	3700.00^{a}	5033.33^{a}	73.33^{c}
Cross41/98	74.33^{b}	137.00^{b}	122.00^{a}	51.33^{ab}	7.33^{b}	1.24^{b}	4.37^{a}	35.40^{a}	3133.33^{a}	3633.33^{b}	85.67^{a}
Local	81.67^{a}	142.00^{a}	109.67^{c}	26.33^{c}	8.46^{a}	1.17^{c}	5.00^{a}	32.50^{a}	1693.00^{b}	2500.00^{c}	67.33^{d}
HB-42	66.00^{C}	139.00^{b}	117.33^{abc}	46.67^{b}	6.00^{c}	1.12^{c}	4.33^{a}	37.67^{a}	2226.67^{b}	2766.70^{bc}	80.67^{b}
Means	70.67	138.00	116.07	45.93	7.31	1.21	4.70	35.93	2594.00	3453.33	74.73
LSD (5%)	4.09	2.50	8.56	6.73	1.05	0.053	0.86	6.30	969.00	808.00	4.25

Means with the same letter are not significantly different from each other at 5% probability level.

Picture 1: Evaluation of food barley genotypes by farmers and concerned stakeholders

Table 4: Pairwise ranking of farmers' selection criteria of food barley genotypes

No.	Selection criteria	GY	EM	TA	SL	Total	Rank
1	Grain yield (GY)	X	GY	GY	GY	3	1st
2	Early maturity (EM)	-	X	TA	EM	1	3rd
3	Tillering ability (TA)	-	-	X	TA	2	2nd
4	Spike length (SL)	-	-	-	X	0	4th

Where, GY= Grain yield, EM= Early maturity, TA= Tillering ability and SL= spike length

Zone in general as the local varieties are very late maturing types. In addition, early maturity allows the crop to escape drought, to quickly provide food and cash to the household and allow farmers to use their time efficiently by harvesting their produce earlier before the peak harvesting time where labor is expensive.

Based on direct matrix ranking evaluation, farmers identified HB-1307 (total score 29) and EH-1493 (total score 28) as the best while local variety (total score 24) and HB-42 (total score 20) as the least preferred food barley varieties (Table 5). Likewise, results of farmers field evaluation using pair-wise ranking method (Table 6),

Table 5: Direct matrix ranking evaluation of food barley varieties by group of farmers'

Criteria	Grain yield	Early maturity	Tillering ability	Spike length	Total score	Rank
Relative weight	3	2	2	1	-	-
EH-1493	9 (3)	8 (4)	8 (4)	3 (3)	28	2nd
HB-1307	12 (4)	6 (3)	6 (3)	5 (5)	29	1st
Cross-41/98	12 (4)	6 (3)	4 (2)	5 (5)	27	3rd
Local cultivar	6 (2)	3 (1)	10 (5)	5 (5)	24	4th
HB-42	9 (3)	4 (2)	4 (2)	3 (3)	20	5th

N.B. Number of participants =14 (M=10 and F=4), numbers in parenthesis indicated the performance rating value of each genotype given from 1-5 (5= excellent, 4=very good, 3= good, 2= poor and 1=very poor), numbers written in the bold indicate total score of a variety as per each selection criteria, which was obtained by multiplying the relative weight of each selection criteria with that of the performance rating number in the parenthesis

Table 6: Farmers' pair-wise ranking of food barley genotypes at Gozamin district

Genotypes	EH-1493	HB-1307	Cross-4198	Local variety	HB-42	Total score	Rank
EH-1493	X	HB-1307	Cross-4198	EH-1493	EH-1493	2	3rd
HB-1307		X	HB-1307	HB-1307	HB-1307	4	1st
Cross-4198			X	Cross- 4198	Cross-4198	3	2nd
Local check				X	HB-42	0	5th
HB-42					X	1	4th

revealed that HB-1307 and Cross-41/98 as the most important varieties which was preferred four and three times, respectively. Farmers' overall evaluation of the food barley varieties based on both direct matrix and pair-wise ranking methods identified the varieties HB-1307 and Cross-41/98 as most preferred and local cultivar as the least preferred in Table 6.

CONCLUSION AND RECOMMENDATION

Differences were observed among food barley genotypes based on farmers preferred criteria. Farmers' criteria for selecting food barley genotypes were early maturity, spike length, tillering ability and grain yield. It has been revealed that farmers have faced with many problems and limitations and they are very particular in the genotypes they desire to cultivate based on various attributes. Based on farmers' evaluation of direct matrix and pairwise ranking, the highest score was recorded for HB-1307 (29) followed by EH-1493 (28). Likewise, field research on genotypes performance for biological yield analysis indicated similar results that HB-1307, Cross 41/98 and EH-1493 were high yielding genotypes, respectively. Generally most of the food barley genotypes selected by farmers' preference based on their own selection criteria and the biological response in the research station had similar results. So farmers' participation is crucial in evaluation of preferred food barley varieties for food consumption and preparing local alcoholic drinks. Researcher analysis of data and farmers evaluation provide information for designing and developing appropriate techniques to improve or select varieties that better adapted the specific environment and provide functional understanding of relevant systems to strengthen future crop and product development in a sustainable way. Therefore, varieties HB-1307 and Cross-41/98 were chosen for their outstanding performance in biological parameters and also acceptable from farmers' evaluation point of view. Thus the seeds of these selected varieties need to be multiplied by selected model farmers in the coming year for better adoption and dissemination rate.

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REFERENCES

1. FAOSTAT, 2008. World Barley production. Food and Agricultural Organization. Rome, Italy. http://faostat.fao.org/site/567/default.aspx#ancor. Accessed on November 2015.
2. CSA (Central Statistical Agency), 2015. Agricultural Sample Survey. Report on Area and Production of Major Crops. Central Statistical Authority. Statistical Bulletin 578, Volume I. Addis Ababa. May 2015, pp: 14-28.

3. Firew, M., 1997. Farmer participation in common bean genotype evaluation: The case of eastern Ethiopia. Experimental Agri., 33: 399-408.
4. Mulatu, E. and B. Ketema, 2001. Participatory varietal selection in lowland sorghum [*Sorghum bicolar*(L.)Moench] in Eastern Ethiopia: Impact on Adoption and Genetic Diversity. Experimental Agri., 37: 211-229.
5. Yalemtesfa, F. and A. Asfaw, 2016. Participatory varietal selection of intermediate altitude sorghum (*Sorghum bicolor* (L.) Moench) genotypes in Western Part of Ethiopia. African Journal of Plant Science, 11(3): 48-53.
6. Mulatu, E. and Z. Habtamu, 2002. Farmers' highland maize (*Zea mays* L.) selection criteria: Implication for maize breeding for the Hararghe highlands of eastern Ethiopia. Euphytica, 127: 11-30.
7. Belay, G., H. Tefera, G.M.D. Jarra and T. Taddese, 2006. Participatory variety selection in the Ethiopian cereal tef [*Eragrostistef*(Zucc.) Trotter]. Experimental Agri., 42: 91-101.
8. Aynewa, Y., T. Dessalegn and W. Bayu, 2010. Participatory Evaluation of malt barley (*Hordiumvulgare L.)* Genotypes for yield and other agronomic traits at North- west Ethipoia. Wudpecker J. Agri. Research, 2(8): 218-222.
9. De Boef, W.S. and M.H. Thijssen, 2006. Participatory tools working with crops, varieties and seeds. A guide for professionals applying participatory approaches in agro biodiversity management, plant breeding and seed sector development. Wageningen, Wageningen International, pp: 29-30.
10. Alebachew, H., 2012. Participatory and Performance Evaluation of Improved Bread Wheat varieties in DeguaTembien and OflaWoredas of Tigray region. An MSc Thesis Presented to Haramaya University, Ethiopia.
11. Fentie, M., 2010. Participatory Evaluation and selection of improved finger millet varieties in north western Ethiopia. International. J. Plant Sci., 3(7): 141-146.