academicJournals

Vol. 8(14), pp. 1245-1254, 18 April, 2013
DOI: 10.5897/AJAR12.1972
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Preferences and constraints of maize farmers in the development and adoption of improved varieties in the mid-altitude, sub-humid agro-ecology of Western Ethiopia

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Accepted 11 April, 2013

Understanding farmers' production constraints and preferences is important in maize breeding, especially underlying successful adoption of improved varieties and their production packages. This study was conducted to assess the present importance, and productivity constraints of maize in the mid-altitude, sub-humid agro-ecology of Western Ethiopia. Data was collected through a semi-structured questionnaire and focus group discussions, using 240 randomly selected respondent farmers, in 12 sub-districts, within three administrative zones. Maize was ranked number one as both food and cash crop by 82.9% of respondents. Most farmers (59%) use hybrids, while 24% grow landrace varieties. Unavailability of improved seed and lack of production inputs were the two major constraints reducing maize productivity, as reported by 62 and 60% of respondents, respectively. A high proportion of respondents (80%) indicated that, unpredictable grain prices are the major market constraint as 97% of the respondents sell their maize crop in the local market. Northern corn leaf blight (NCLB) was reported to be important by 46% of respondents. Breeding for improved disease resistance and grain yield, enhancing the availability of crop input and stabilizing market price during harvest time are the most important strategies to increase maize production by small-scale farmers in Western Ethiopia.

Key words: Farmers' constraints, maize, participatory research, production packages, *Zea mays*.

INTRODUCTION

Maize (*Zea mays* L.) is the third important cereal crop globally after wheat and rice (FAO, 2011). The crop occupies a pivotal role in the world economy and is traded widely. Maize demand is projected to increase by 50% worldwide and by 93% in sub-Saharan Africa between 1995 and 2020 (FAO, 2007). In the past, much of the global use of maize has been for animal feed. However, maize is increasingly used for human consumption and accounts for 70% of the food consumed in sub-Saharan Africa (FAO, 2007). The recent volatile food market and rising prices for most food crops may increase the importance of maize production. In addition, because of its productivity and wide adaptation, maize remains an important source of food with great potential

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to improve the livelihoods of most poor famers in developing countries (FAO, 2011).

In developing countries, most studies on agricultural technology development and diffusion are based on ex-post analysis of intervention programs (Bandiera and Rasul, 2006). Farmers are rarely consulted, *a* priori, about their specific circumstances, priority constraints, and their preferences with regards to production packages. Often the level of adoption is determined after costs are incurred and technologies are developed and diffused. Such top-down interventions usually result in a low level of acceptance by end-users and minimal success for variety development programs (Feder et al., 1981). Prior identification of farmers' constraints and preferences is required in order to design more appropriate, acceptable and cost effective development intervention programs (Walter and Zewdie, 2008). In addition, the likely extent of future adoption of research results has a strong influence on the efficiency of research and on the results of research priority settings (Batz et al., 2003). Complementary contributions of farmers and scientists are essential for effective agricultural research and technology development, and their adoption (Chimdo et al., 2002).

Farmers' participation in setting research priorities and technology evaluation is crucial to scientists in order to design, test and recommend appropriate new production technologies (Ashby, 1991). This can be achieved through participatory research that allows incorporation of farmers' indigenous technical knowledge, identification of farmers' criteria and priorities, and the definition of the research agenda, among others (Girma et al., 2005). Participatory rural appraisal (PRA) is a research tool to capture farmers' perceptions, constraints and preferences (De Groote and Bellon, 2000). These authors emphasized the effectiveness of PRA through seeking insights and promoting dialogue between scientists and farmers on production constraints, technology development and adoption. By integrating farmers' constraints and preferences into agricultural research, technologies can be developed that become widely adopted, resulting in more productive, stable, equitable and sustainable agricultural systems. This has led to the emergence of participatory plant breeding approaches in conventional plant breeding programs which integrates farmers' preferences and constraints (Ceccarelli et al., 2001). Participatory plant breeding approaches are reported in cassava (Witcombe and Virk, 2001), barley technology adoption in Syria, Morocco and Tunisia (Ceccerali et al., 2001), and maize in India (Joshi and Witcombe, 1996) and Ethiopia (Abebe et al., 2005).

In Ethiopia, maize is the second largest food security crop after tef [*Eragrostis tef* (Zucc.) Trotter. It is predominantly grown by small-scale farmers in the mid- and low-altitude, sub-humid agro-ecologies. It is primarily produced and consumed by the small-scale farmers that comprise about 80% of Ethiopia's population (Dawit et al., 2008). Maize has increasingly become a popular crop in the country with steady growth in production area and yield (Doss et al., 2003). The use of improved maize varieties has increased from 5% in 1997 to 20% in 2006 (CSA, 2001, 2004, 2006; Byerlee et al., 2007). The mid-altitude, sub-humid agro-ecology is the most important maize producing environment in Ethiopia (Birhane and Bantayehu, 1989; Kebede et al., 1993). This region is considered to be the major maize growing zone in the country. The region lies at an altitudes of between 1000 to 1800 m above sea level and receives a fairly reliable average annual rainfall (1000 to 1500 mm/year), rendering it a region of high potential for maize production. However, maize production has remained low, with the estimated national average yield of 2.5 t/ha due to several constraints: biotic (inadequate improved varieties, pests and diseases), abiotic (low soil fertility, land and water degradation, and drought) and socio-economic (input unavailability, lack of storage facility, poor access to markets) (CSA, 2010). Therefore, maize production components such as farmer-preferred, improved varieties, farming technologies, farm inputs, and access to markets should be developed and made available to enhance maize production, in order to achieve food security.

Bako National Maize Research Project was established under the Ethiopian Institute of Agricultural Research (EIAR) to coordinate maize research and development nationally. The project is situated in the region of mid-altitude, sub-humid maize growing agro-ecology. It is aimed at development and popularization of improved maize varieties, together with their management technologies. In the past, there was a limited participatory research approach in maize technology development and/or improvement by the project. Consequently, there is little formal documentation of farmers' production constraints and preferences which are needed to guide maize varietal development in the mid-altitude, sub-humid agro-ecology of Western Ethiopia. Therefore, the objective of the study was to assess the present importance, and production and productivity constraints, of maize in the mid-altitude, sub-humid agro-ecology of Western Ethiopia. The study would serve as the basis for formulating research and development strategies to increase maize production and productivity by resource poor famers in these and similar environments.

MATERIALS AND METHODS

Study sites and sampling

A survey study was conducted in three representative maize growing zones of Western Ethiopia; West Shoa, East Wollega and West Wollega. In each zone, two districts were selected. Two sub-districts were selected per district providing a total of 12 study sites. The study zones are situated in the mid-altitude, sub-humid agro-ecology where maize is grown as the predominant cereal crop. The zones receive the main rain from May to September in most years. Most farming activities follow the main rainy season which has a

Table 1. Area, population demography and population density of the study zones and districts (CSA, 2010).

Zone and district	Area (Km^2)	Males (000)	Females (000)	Total (000)	Density per km^2
West Shoa					
Ilu-Galaan	332.04	40.834	40.251	81.085	244.20
Bako-Tibe	1044.52	60.217	66.674	126.891	121.48
East Wollega					
Gobu Sayyo	337.53	22.013	23.874	45.887	135.95
Sibu-Sire	1132.50	61.32	54.00	115.313	101.82
West Wollega					
Najo	958	68.715	71.146	139.861	145.99
Manasibu	1668.1	69.776	74.608	144.384	86.56

uni-modal distribution. Soils are varied and generally of low fertility. This is regarded as one of the major problems for cereal production in the zones. As a result of the high intensity of rainfall in the study areas, the soils are acidic (Wakene et al., 2012).

The study sites were selected based on the importance of maize in the livelihoods of small-scale farmers, and the prevalence of major maize production constraints, including diseases, during production seasons. The survey was conducted during January, February and March, 2011. According to the recent population census (CSA, 2010), the population demography and area of the study districts are shown in Table 1. Overall, Ilu Galaan is the most densely populated (244 per km^2) and Manasibu (86 per km^2), the least.

Sampling procedures

Multi-stage random sampling techniques were applied to select the study sites that represent the diverse ecological and socio-economic environments, and varying maize production systems, in the mid-altitude, sub-humid agro-ecological zones of Western Ethiopia. The major criteria used during selection of the study sites were the relative importance of maize, and the severity of maize diseases.

Data collection

Data sources

Both primary and secondary data were utilized in the study. Primary data was collected through interview of male and female farmers, key informants and focus group discussions. The key informants included maize researchers, experienced farmers in the villages, local leaders and agricultural agents. The facilitators used pictures showing disease symptoms and cards that had drawings representing various traits and constraints to assist the responding farmers during the discussions. The secondary data was obtained from the zonal and district agricultural offices of the respective districts included in the study areas. The offices of agriculture in the respective districts were the main sources for the secondary data. Eighty (80) respondents were available per zone, per two districts (Table 2). Data was collected using a total of 86 variables. Consequently, principal component analyses (PCA) was used for data reduction and to identify the most important variables based on the magnitude of contributions to the total variation in the data set.

Administering questionnaire

A semi-structured questionnaire was administered to 240 respondent farmers from 12 sub-districts of three administrative zones. The sub-districts and respondent farmers were randomly selected in the major maize producing areas of each zone. Both male and female maize farmers were mobilized for focus group discussion through the local administrators, development agents and extension staff of the respective sub-districts. Checklists were developed and used to guide discussions with farmer groups and individual key informants. The objectives of the project and the significance of contributions from various actors were explained to both groups and communication procedures established.

The farmers were encouraged to use a language they were most familiar with. A member of the research team most versed with Afan Oromo, the local language, facilitated the group discussions. For ease of focusing the discussions and reaching a consensus, farmers were allowed to form discussion groups. Sex and age were the important criteria farmers used in categorizing themselves into discussion groups. Amongst other variables, farmers were asked to list maize varieties that they grow and provide the relative proportions of the varieties, to list and rank their criteria for variety selection in terms of their relative importance, and the main constraints to maize production. The interviews in all the study areas were held by five researchers, selected from different disciplines of the Bako Agricultural Research Centre.

Data analysis

Data from questionnaires of individual interviews was coded, captured and analyzed using the SPSS computer package (SPSS 2005). Descriptive statistics, chi-square tests, and PCA analyses were performed using the same computer package.

RESULTS

Demography, socio-economic characters and main food crops grown

Of the total interviewed farmers, 93.8% were males, while 6.2% were females. Of all the respondents 98.8% were household heads and almost all the respondents (99.6%) were farmers in occupation. Among total respondents

Table 2. Study zones, districts and sub-districts and number of sampled maize farmers in the mid-altitudes sub-humid areas of Western Ethiopia.

Zone	District	Sub-district	Female	Male	Total
West Shoa	Ilu-Galan	Siba-Biche	2	18	20
		Jato dirqi	2	18	20
	Bako-Tibe	Tulu Sangota	1	19	20
		Bacharra	2	18	20
East Wollega	Anno	Qeejo	1	19	20
		Anno Bakanisa	2	18	20
	Sibu-Sire	Biqila	1	19	20
		Chari	1	19	20
West Wollega	Manasibu	Teyiba	2	18	20
		Bengua	-	20	20
	Nejo	Goori	1	19	20
		Dilla	-	20	20
Total			15	225	240

Table 3. Major crops grown, area of production and rank in the study zones of the mid-altitude sub-humid areas of Western Ethiopia.

Zone	Crop	Production	
		Area (ha)	Rank
West Shoa	Maize	118,344	2
	Teff	181,018	1
	Pepper	36,818	5
	Wheat	57,425	4
	Sorghum	77,758	3
East Wellega	Maize	121,854	1
	Teff	74,497	2
	Wheat	9,840	5
	Sorghum	51,173	3
	Pearl millet	15,471	4
West Wellega	Teff	34,040	3
	Wheat	2,927	5
	Maize	73,960	1
	Sorghum	55,926	2
	Pearl millet	33,294	4

53.8% were educated up to primary level, 25% secondary level and 19.6% without any education. The mean household age in the study areas was 41, with the maximum and minimum ages of 73 and 20, respectively. The major five crops grown in the study zones are summarized in Table 3. Most of the respondents (82.9%) ranked maize as the number one food crop. Other important crops in the zones included teff, sorghum, pepper, wheat and pearl millet (Table 3).

Maize varieties grown

Table 4 summarizes maize varieties grown across the three zones. Farmers grow an assortment of maize types [hybrids, landraces and improved open pollinated varieties (OPVs), either on the same or different fields. Farmers grow both landraces (often referred to as local varieties) or improved varieties, to meet multiple objectives. Many of the respondents (60%) grow hybrid varieties, whilst 24% grow landraces (Table 4). Among the respondents, 39% grow the maize hybrid BH660 and 15% grow BH540. BH660, BH540, Pioneer hybrids and BH543 are the most widely grown hybrid varieties, in their order of importance in the study areas (data not shown). In some instances, the same landrace varieties are known by different names. The names of the landrace maize varieties are often descriptive, referring to certain key identifiable characteristics, especially grain color, appearance, growth habit and the perceived place of origin.

Farmers' preferences of maize varieties

Farmers said that they use many criteria in selecting maize varieties for production. Overall, the major and common selection criteria of maize varieties and corresponding number of farmers are presented in Table 5. Farmers' perceptions and rating of the different criteria varied across the study sites. The most important criteria across the studied districts were high yield, resistance to disease and insect pests, lodging resistance, ability to perform well under low soil fertility, and a combination of these. There were highly significant ($P < 0.01$) differences among the respondents in their preference to maize variety traits in all the 12 sub-districts (Table 5).

Table 4. Widely grown maize types and names with corresponding frequency and percentage of farmers in the mid-altitude sub-humid zones of Western Ethiopia.

Type	Name	Frequency	Percent
Hybrid	Different hybrids	143	59.6
Landrace	Landraces	58	24.2
Hybrid and OPV	BH-660 and OPV	2	0.8
Hybrid and Landrace	BH-660 and Landrace	37	15.4
Total		240	100

Table 5. The important farmers preferred traits of maize varieties in the mid-altitude sub-humid zones of Western Ethiopia.

Farmers preferred traits	Farmers	
	Number	Percent
Improved yield	54	22.5
Disease resistance	2	0.80
Insect resistance	6	2.50
Yield and disease resistance	41	17.10
Yield, insect and disease resistance	21	8.80
Yield, disease, insect and lodging resistance	57	23.80
Yield, disease and lodging resistance	21	8.80
Yield, insect and lodging resistance	2	0.80
Yield and lodging resistance	12	5.00
Disease and insect resistance	24	10.00
Total	240	100
Chi-square	32.65	
Significance level	0.000	

Major constraints to maize production

Table 6 summarizes the main constraints to maize production in the studied zones. Prioritization of the constraints was based on number of households affected, severity of the constraint, importance of the constraint in attainment of household objectives, frequency of occurrence of the constraint and the likelihood of a solution to be provided by the research team. The most important farmers' constraints in maize farming, as revealed by semi-structured questionnaire, were low soil fertility, high input prices (especially fertilizers and seed), leaf diseases, and early cessation of rain. Other important constraints were insect pests (termite and stalk borer), volatile grain prices, and unavailability of fertilizer (Tables 7 and 8).

Northern corn leaf blight (NCLB) and gray leaf spot (GLS) are the most important reported maize diseases. Farmers in the study area (46.7%) indicated NCLB as the major leaf disease on maize (Table 7). GLS is ranked as the second most important leaf disease in the area, as reported by 17.9% of the respondents. Price fluctuation of maize grain is also one of the major constraints in the maize market, impacting on the production of maize in the study areas.

Farmers in the study areas (80.8%) indicated that the unpredictable grain price was the major financial problem (Table 8). Furthermore, a widespread lack of storage facilities and high transportation costs affected the marketing of maize. During harvest times (November/December) the farm price of a 100 kg of maize is at Birr200 (≈12 USD), that increases to birr 500 to 600 during June/July. In the present study, the major market outlets for the sale of maize were local market as indicated by 97.1% of the respondent farmers. Only a small proportion of farmers (<3%) sold their products to other market outlets, such as unions, grain trade enterprises and farmer to farmer.

Focus group discussion

Focus group discussion was conducted to identify locally preferred maize varieties, and the traits associated with the respective varieties. Farmers listed the varieties they grew, ranked them and identified traits they preferred in

Table 6. Major maize production constraints in the mid-altitude, sub-humid zones of Western Ethiopia as revealed by five randomly selected farmers averaged over 12 sites.

Constraints	Farmers group across 12 sites					Total	Importance
	A	B	C	D	E		
Early cessation of rain	3.25	2.50	2.50	2.75	2.37	13.37	4
Diseases	3.50	3.00	3.37	3.50	3.62	16.99	3
Insect pests	2.25	2.37	3.12	2.75	2.50	12.99	5
Weeds	2.37	2.50	1.62	1.75	2.00	10.24	5
Input costs	4.87	4.62	5.00	4.87	4.87	24.25	2
Labour shortage	2.00	1.37	1.37	2.00	1.12	7.87	5
Low soil fertility	4.90	4.77	4.87	5.00	5.00	24.54	1

1 = most important, 5 = least important; A, B, C, D, E = five different farmers pooled across 12 sites.

Table 7. Major diseases and insect pests in the study area.

Name	Farmers	
	Frequency	Percent
NCLB	112	46.7
GLS	43	17.9
MSV	5	2.1
Termite	1	0.4
Stalk borer	4	1.7
NCLB,GLS, termite and stalk borer	1	0.4
NCLB,GLS and stalk borer	2	0.8
NCLB and GLS	49	20.4
NCLB, termite and stalk borer	3	1.2
NCLB , GLS and MSV	2	0.8
NCLB , GLS and termite	1	0.4
GLS and rust	1	0.4
NCLB and MSV	7	2.9
GLS and MSV	1	0.4
NCLB, GLS and *Phaosphaeria* leaf spot	5	2.1
NCLB and termite	2	0.8
NCLB, MSV and stalk borer	1	0.4
Total	240	100.0

maize, giving reasons for their choice of the selected varieties. Further, the focus group discussion identified important constraints in maize production. Farmers identified, listed and ranked the problems based on their priority of the constraint in the study areas.

A maximum of 20 and a minimum of 15 farmers group participated in group discussion across all the study areas. The gender composition of the participating farmers was considered but most respondents were male farmers. Household leaders in almost all of the study areas were male farmers. Maize was the major cereal crop in terms of area under production in all of the study areas, except in West Shoa, where it was surpassed by teff. Maize was also number one in yield per hectare and total production in the mid-altitude, sub-humid areas of Western Ethiopia (CSA, 2010, 2011). The responding farmers preferred maize because of its adaptability and also for food security. Most of the farmers in the study areas utilized improved maize seed, except in their homestead where they use own seeds of local variety called ‘Burre’.

The farmers in the study areas recognize the value of improved maize varieties because of higher yield, lodging resistance, flour quality, and market preferences. Farmers in majority of the study areas indicated that some improved maize varieties are more susceptible to diseases and insect pests than the landrace varieties, which they considered to be more adapted to the production

Table 8. Input and marketing constraints affecting maize production.

Constraint	Farmers	
	Frequency	Percent
Market		
Grain price fluctuation and low price	193	80.8
Storage facility	3	1.2
Price fluctuation and transport cost	14	6.0
Price fluctuation, transport cost and storage facility	12	5.0
Price fluctuation and storage facility	8	3.3
No sales of produce	7	2.9
Transportation cost	2	0.8
Total	240	100.0
Fertilizer		
Readily available	25	10.4
Moderately available	93	38.8
Poorly available	100	42.0
Not available	21	8.8
Do not use	1	0.4
Total	240	100.0

environments. Often the main maize growing season coincides with the severe outbreaks of leaf diseases, including NCLB, GLS and maize streak virus (MSV). Farmers indicated that there were little traditional or modern control methods applied for the control of leaf diseases on maize, especially NCLB and GLS.

Principal component analysis

PCA is most useful in data reduction and projection, and allows maintenance of smaller number of principal components than original variables. PCA is a powerful tool for pattern recognition, classification, modeling, and other aspects of data evaluation (Heberger et al., 2003). The current study used 86 variables to establish maize production constraints, using 240 respondent farmers. According to the PCA, 21 principal components (PC) were identified with Eigen values >1 (Sneath and Sokal, 1973) and contributed to 69% of the total variation (Table 10). As a result, these components and variables that were highly correlated were identified as important contributors to the variation presented in the data sets of this study (data not shown).

The most important variables well-correlated with PC1 ($r \geq 0.5$) were: which constraints limit your maize production, rank of maize among cereals produced for the last three years; maize productivity; availability of fertilizer; and widely grown maize varieties. Considering the PC2 and PC3, the important variables were: Accessibility to inputs; improved quality required from maize varieties; availability of improved seed for the production of maize; and criteria for selecting sites for maize (Table 9). Though PC1, PC2 and PC3 were the most important components and made a significant contribution to the variance (≈70%) in the data set, other components among the 21 were also relevant. Some of the important variables well-correlated with the rests of the PCs were: market for maize produce; trends of maize production; land utilization; area for maize; types of cereals grown, and preference for maize (data not shown). These were also important variables identified and retained through the PCA in the study. These variables could be used in the future studies on the preferences of farmers in similar maize growing environments.

DISCUSSION

In the present study, farmers in all the study areas grow an assemblage of different varieties in order to avoid the risk of crop failure caused by growing the same variety. Girma and Tanto (2008) reported that most farmers in Ethiopia grow a diverse assemblage of genotypes (landraces) to minimize risks of crop failure and to increase food security because the landraces are well-adapted to production environments, and carry farmers preferred traits. Further, in the Hararghe highlands of Eastern Ethiopia, Mulatu and Zelleke (2002) found that farmers' preferred landrace varieties over improved cultivars despite the higher yield potential of the latter. Both studies contended that landraces possess farmers preferred attributes, resulting from long term human selection.

Farmers considered high input costs, as compared to

Table 9. Important principal components with variables having r > 0.6.

Variable	Principal component	r > 0.6
Which constraints limit your maize production	PC1	0.825
How is the accessibility to inputs for maize production?	PCA2	0.877
what improved qualities would you like the improved maize cultivars to have	PCA3	0.676
Total area cultivated last production year	PCA4	0.868
Which cereal crops do you grow?	PCA5	0.814
What is the origin of maize in your community	PCA8	0.747
For how long have you been cultivating and consuming maize	PCA10	0.61
Where do you market your maize producer?	PCA14	0.806
What was the trend of maize production,	PCA18	0.664
Do you like maize production	PC20	0.846

Table 10. The Eigen values, percent of variance and cumulative variance explained by the 21 principal components.

PC	Initial Eigen values		
	Total	% of variance	Cumulative %
1	6.380	10.999	10.999
2	3.776	6.510	17.509
3	2.652	4.572	22.081
4	2.406	4.148	26.229
5	2.311	3.985	30.214
6	2.007	3.460	33.674
7	1.937	3.340	37.014
8	1.839	3.171	40.185
9	1.573	2.713	42.898
10	1.532	2.642	45.540
11	1.511	2.605	48.145
12	1.406	2.424	50.570
13	1.357	2.340	52.910
14	1.345	2.318	55.228
15	1.295	2.233	57.461
16	1.262	2.176	59.637
17	1.190	2.052	61.689
18	1.114	1.922	63.610
19	1.110	1.913	65.523
20	1.058	1.824	67.348
21	1.045	1.802	69.149

grain prices, as a key constraint because they believed that lower inputs costs would lead to alleviation of many other constraints. Dawit et al. (2008) found similar constraints in their studies of maize seed systems in the drought prone areas of Ethiopia. In some instances, farmers did not explicitly indicate the constraints they face. However, they said that they lack cash to buy the optimum crop input. Hailu (1992) reported the unavailability of agricultural inputs as the main bottleneck in maize production and productivity in Ethiopia. The prevalence of low quality agricultural inputs in the market is also one of the major constraints that farmers face. Maize seeds, for instance, are often adulterated or not true to type. Walter and Zewdie (2008) found that unavailability and untimely supply of seed are the major production constraints in maize growing areas of sub-Saharan Africa.

In this study, NCLB was reported as the number one disease followed by GLS. This contradicts Dagne et al. (2004) who reported GLS to be the number one leaf disease, followed by NCLB in the mid-altitude, sub-humid maize growing areas. The present result suggests that a shift in disease levels has occurred making NCLB a research priority. Declining soil fertility was also identified as a major limitation in the production of maize in these zones. Farmers indicated that a decline in soil fertility was exacerbated by mono-cropping and limited soil conservation practices.

The present study indicated that the unpredicted grain price was the major bottleneck in the maize grain market, which was further aggravated by a lack of, or poor infrastructure, including postharvest storage facilities and transport systems. In the study by Dawit et al. (2008), the volatility of the maize price was seen as one of the major challenges for maize production. Furthermore, this affected the allocation of land for maize seed production and the total quantity of maize seed produced over the last decade.

The present findings showed that maize production in the mid-altitude, sub-humid areas of Western Ethiopia is constrained by a myriad of related factors. The most important diseases, in decreasing order of importance, are NCLB, GLS and MSV. This study indicated a shift in the order of importance of major maize diseases in the study areas when compared with previous studies (Dagne et al., 2004). Recurrent future studies are required every 4 to 5 years in order to collate information on the relative importance of maize diseases and other relevant constraints in the area. Maize breeding cannot incorporate all the desired attributes instantaneously. But the key attributes should be included in a particular variety, and other candidate varieties should be bred focusing on the preferences of different groups of farmers. Equally, farmers should have access to improved seed and other inputs with reasonable price. To overcome the setback of low grain prices following maize harvests, farmers should be provided with technical and financial support to store their maize product till market prices improve.

Farmers have diverse perceptions and complex combinations of criteria to select maize varieties. From this study, farmers' preferred attributes included high yields, resistance to disease and insect pests, fair seed costs and the ability of a variety to give a reasonable yield with little application of external inputs, especially fertilizer and pesticides. To increase maize production, research should be inclusive and take into consideration the farmers' circumstances and preferences. Maize varieties and crop management packages developed should meet farmer's needs. Incorporation of farmers' preferences and production constraints in selection of maize varieties in any breeding project would increase the likelihood of adoption of the varieties. The findings from this study will form the basis for farmer-oriented maize breeding in the mid-altitude, sub-humid zone of Western Ethiopia and similar areas in the sub-Saharan Africa.

ACKNOWLEDGEMENTS

The Alliance for a Green Revolution in Africa (AGRA) is sincerely thanked for financial support to initiate the study. The Ethiopian Institute of Agricultural Research (EIAR) is acknowledged for providing leave of absence and hosting the field research to the first author. The all round support provided by the National Maize Research Project of Ethiopia is highly appreciated.

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