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Characterization of a barley-based farming system in the Arsi Highlands, Ethiopia

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In order to minimize the gap between the demand for barley, particularly malt barley, and its supply, this study was initiated to assess the existing farming systems of the selected agro ecologies in order to develop appropriate malt barley technologies and major production constraints. In line to this, two districts with a potential in barley production were purposively selected from the Arsi highlands of Ethiopia and totally 120 farmers were selected and used to conduct the study. During 2009 to 2010 production season, both food and malt barley varieties were grown by about 95% of surveyed farmers. Among the surveyed farmers, about 82% have knowledge or knowhow to improved barley varieties while 19% did not. Yielding potential and market value are the major reasons of farmers for preferring to produce some malt barley varieties over the others. Holker, miscal-21, and local food barley varieties are the relatively high-yielding as well frequently cultivated varieties in the study areas. The present and foreseen increase in number of breweries and their expansion currently and in the future indicates the demand for malt barley product in the future. Unpredictable rainfall, shortages of labor, improved seed, working capital, low quality of seed, untimely supply of inputs, and problem of good market facilities were the major constraints of barley production in the study area.

Key words: Characterization, barley, barley based farming system and Arsi highlands.

INTRODUCTION

Barley is one of the major cereal crops that are largely produced in the central and south east mid and high altitude areas of Ethiopia. It is the fifth important cereal crop after Tef, Maize, Wheat and Sorghum with annual production of about 1.2 million tons cultivated on an area of about 1.0 million hectares (CSA, 2005) and it is the most desirable crop in the highlands where there is limited alternative crop (Yosef et al., 2011). Barley is grown in about 70 million hectares in the world. Global production is 160 million tons.

Barley (*Hordeum vulgarre* L) which includes both food and malt barley species is cultivated in Ethiopia. Barley grain is mostly used as feed for animals, malt, and food for human consumption. Traditionally barley is used for making local recipes and drinks such as ‘dabo’, ‘kolo’, ‘ganfo’, ‘kinche’, 'baso,' tela', 'borde' and other types of food. Its straw is a good source of animal feed (Yosef et al., 2011) and it is also used for thatching of roofs. Malt is

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the second largest use of barley.

Malt barley, at the present time, is considered as one of the cash crops and its demand by malt factory has increased due to its increased capacity of malt barley processing and the expansion of breweries and beer consumption levels in the country (AMF, 2012). Beer and bread are some of the industrial products produced from malt and food barley, respectively. As reported by Mohammed and Getachew (2003) and presented by Ethiopian-Barley-Business (2012) malt barley is among crops demanded in good quantity that lacks supply in which its impact is directly connected with national economy, as Beer Factory import it from abroad with high hard currency. The report of Malt factory indicates that as the share of inland production of malt covers only 35 to 40% and the left 60 to 65% is imported on the behalf of beer factories which exhausting the country's foreign currency reserves. Similarly in 2011, breweries in Ethiopia imported 60% of the malt primarily from international producers (Ethiopia-Barley-Business-Case presentation, 2012).

Agricultural lead industrialization policy also demands agricultural production as an input. In spite of the demand created from agro-industry side, supply of products in quality and quantity hinders the activity of these industries and their potential growth. Since few years due to the scaling up activities by various stake holders including the Asella malt factory, barley production has been increasing in major malt barley producing areas of Arsi and West Arsi zones. However, the availability of improved seed is not satisfactory in all suitable barley producing agro ecologies.

Research on barley improvement in Ethiopia started in 1955. Since then, research system has produced substantial amount of technologies, information and knowledge. Due to the weak linkage between research and extension, however; these technologies delayed to reach to growers to bring the required impact. Coordination and cooperation among the different stakeholders in agricultural development is at its low level. Therefore, this study was initiated to assess the current problems and technology needs, identify the weaknesses and strengths of barley varieties in use as well as varieties of interest and major production constraints. The result can help the selection and dissemination of barley varieties for suitable barley producing areas through participatory approach with farmers.

Objectives of the surveys

The objectives of the farm surveys were to overview the existing farming systems of the selected agro-ecologies in order to develop appropriate malt barley technologies and to identify production constraints and opportunities for technological interventions in the study and the surrounding areas.

METHODOLOGY

Selection of the study area and sample respondents

Characterization of barley based farming system was designed to be carried out in potential barley producing areas of Arsi zone in Ethiopia. To execute the survey both purposive sampling and two stage random sampling procedures were followed, and two representative districts (Honkolowabe and Chole) were purposively selected from the potential barley producing districts of the zone. In two stage random sampling procedures; at first stage, the lists of peasant associations (PA), those potentially producing barley in their respective districts, were made by respective agricultural development officeers in consultation with the research team and two PA were randomly selected from each district. Accordingly, we selected Tajiwalkite and Lemu Kara from Honkolowabe. Similarly from Chole, Gadoyabeta and Tulu ego were selected for the study. In the second stage, totally 120 farmers were selected by equal distribution method which means 60 from each districts or 30 household heads were randomly selected from a list of farmers in each selected PAs. Finally, among the farmers selected randomly in each PA, household heads who cultivated barley on their lands and who did not cultivate were identified and used for conducting the study.

Data collection

The data used for this study were collected from both primary and secondary sources. Both informal and formal surveys were used to collect the primary data. The informal survey was conducted through group discussions, interviewing key informants, district agricultural officers, PA level development agents, group of farmers, and barley seed multiplying farmers in all districts and selected PA. The informal survey was mainly focused on the assessment and identification of barley production problems and technology needs, weaknesses and strengths of barley variety in use, variety of interest and criteria for the selection of varieties, and crops used and needed in the community.

The discussions were entirely participatory. The assessment results of the informal survey were used for forming questionnaire to collect quantitative data. The structured and semi-structured questionnaire were pre-tested and specifically designed and used to perform the formal survey. The informal survey was conducted in the months of March and April in 2010, and the formal survey was carried out in April and May, 2010.

Data analysis

The quantitative data collected through the formal survey was analyzed using SPSS computer program and various descriptive statistics and mathematical methods like mean, percentages and various analytical methods were used based on the objectives of the survey. Tables and figures were used to present summary statistics such as mean, standard errors and percentages.

Agro-ecological and climatic features of the study area

The selected districts are mainly characterized as highland areas with prolonged rainy months and various soil types. Some of agro-ecological and climatic conditions of the areas are given below according to the information gathered from districts' agricultural development offices. The altitude of Honkolowabe is in the range of 1600-3843 masl and the Chole's altitude varies from 1140—3574 masl. Based on the information obtained from districts' agricultural offices, the three major agro-ecologies namely high altitude (Dega),

Table 1. Total population of the districts' with their sex composition.

Variables	Honkolowabe		Chole	
	No.	Percent	No.	Percent
Male	35,521	49.7	44,466	50.4
Female	35,811	50.3	43,720	49.6
Total population	71,367	100	88,190	100

Source: District agricultural development offices (2011).

mid-altitude (Weinadega), and lowland (Kola) are found in the two districts. Accordingly; 30, 65 and 5% of the total areas of Honkolowabe fall in highland, mid-altitude and lowland areas respectively. Similarly, 60, 18 and 22% of the land area of Chole district fall in highland, mid-altitude and lowland, respectively. The temperature of Honkolowabe and Chole varies from 15.5 to 20°C and 15 to 25°C respectively. Average temperature of Honkolowabe is about 16°C while Chole is 20°C. The two districts are characterized by bimodal rainfall which usually starts in February and prolongs until the end of April (short rainfall period). During this period, farmers grow "belg" season crops except in the low land areas where rainfall is erratic and farmers mainly grow barley, Faba bean, field pea, maize and wheat. In the main season ("Meher"), the rainfall starts in the month of June and lasts up to October. The districts' main/ longer rainy months is from June to October and from June to September in Honkolowabe and Chole respectively. Yearly rainfall in Honkolowabe and Chole districts was 900-1400 mm and 800-1200 mm respectively. In the main season, most agricultural crops are produced by the farmers.

Soils of Honkolowabe are composed of 65% vertisol, 5% sandyloam and 30% redish brown, and Chole also has vertisol, reddish brown and sandy loam soil types with unknown proportions. The Chole district has rivers that have water throughout a year. The major rivers include Legbuna, Qoro, Giersa, Guaya, Sinkise and Gobesa. Out of these rivers some are used by a few PAs for irrigation purpose. These rivers are used for growing various vegetables, coffee, sugarcane and "chat". The total irrigated land coverage is about 1,253 ha (District Agricultural Development office, 2011).

RESULTS AND DISCUSSION

Socioeconomic characteristics

The most common socioeconomic characteristics of the households including sex, age, family size, education, occupation, land use, land holding, cropping pattern, and other socioeconomic conditions and services were studied in the area. Table 1 depicts the total population of each district and the number of household heads that have private agricultural lands and their sex composition.

Total population and their sex composition

The total population of an area can determine the agricultural activity and utilization pattern of the land. The total population of Honkolowabe was 71,367 out of which 49.7 and 50.3% were male and female, respectively. Similarly, Chole the total population of Chole was 88,190 where 50.4 and 49.6% were male and female, respectively (Table 1). From the total interviewed household heads 92.5% were male and 7.5% were female.

Age and family structure of households

It is clear that age of household head, age composition of a family and family size can determines agricultural activities and production of a family as well the community. The life of rural community mainly relies on agriculture which embraces animal rearing and crop cultivation which requires more labor.

The mean age the households considered in the study was 41.87 years (Table 2). Age composition of a family is also important factor in determining families' agri-business. Out of the families considered in the study; the average of total number of family members (TFMS) less than 15, between 15 and 25, between 25 and 55, and above 55 years was 3.74, 2.21, 1.97 and 1.21 respectively. This implies that in each family a number of children was slightly higher (3.74) than other family member groups. Family size also plays a significant role in rural agriculture dependent parents likewise male to female composition of the family. Although there was family with 18 members, the average total family size was 7.29 and there was similarity in mean of male to female composition in the study area (Table 2).

Household occupation

The major occupation of the majority of household heads (86.7%) in the study area was agricultural activity that includes both crop production and animal husbandry. There were also some household members who were involved in non-farm work such as petty trade and daily labor work in addition to agricultural activity. Among the household heads interviewed 5.8% depends only on crop production to lead their livelihoods and livelihoods of about 1.7% household heads depends only on livestock husbandry.

There is division of labor by sex and age. Women and children (above 12 years) contribute to weeding, harvesting, threshing and transporting grain. And ploughing is mainly done by men. The survey result

Table 2. Household characteristics of sample households heads.

Family structure	Minimum	Maximum	Mean	Std. deviation
Age of the respondent	24	69	41.87	11.625
Total family size	1	18	7.29	3.003
Male family size	1	9	3.83	1.908
Female family size	1	9	3.62	1.734
TFMs below 15 years	1	12	3.74	1.897
TFMs between 15 and 25 years	1	9	2.21	1.493
TFMs between 25 and 55 years	1	7	1.97	0.968
TFMs above 55	1	2	1.21	0.419

Table 3. Family labor activities.

Family members labor division	Mean	Std. deviation
Fully involved in agricultural activity	3	1.48
Partly involved in agricultural activity	2	1.72
Fully involved in studying	2	1.72
Not involved in any work	2	1.31

indicated the average labor divisions among family members that is, about 3 individuals are fully involved on farm activities when about 2 family members are partly involved. On the other hand two of the family members are not involved in any activities while two members are fully involved in studying (Table 3).

Educational status of the household heads

Education is one of the important variables which increase an individual's ability to acquire, process, and use agricultural information. Low level of education and high illiteracy rate is typical in developing countries like Ethiopia. In fact, education level of individuals assumed to increase the ability to use the obtained information in a better way.

In contrary to the conditions of developing countries more of the respondents in the study area about 33.3% can read and write whereas the illiterate respondents were only about 22.5%. Furthermore, the rest largest proportion of interviewed farmers attended primary, junior and high school educations formally (Table 4).

Farm resource utilization

Land holdings and land use pattern of the study districts

According to the information obtained from the respective agriculture development bureaus of Honkolowabe and Chole district land holdings were 34,884 and 44,979.3 ha respectively (Table 5). In both districts the land used for crop production takes more proportions. About 74.8% of land in Honkolowabe and about 64.4% of land in Chole was cropped land. Out of the cropped land more was cultivated through rainfed in both districts. However, Chole district holds more total land (Table 4) when compared with Honkolowabe's the average land holdings per household remain lower at Chole (Table 6). This could be due to the conserved/ protected land (18.6%) in Chole is more and high population holdings (Table 1).

Land use type

Rural agricultural families allocate their land for variety of purposes based on the total land they have. Accordingly, the land use patterns of farmers in the study area were cultivated land, grazing land, fallow land, homestead area and wood lands in which the average land holding size was summarized in Table 5. Farm households in both districts allocate more part of the lands for cropping that is, 46.55 and 61.72% of the household's land was cropped land in Honqolowabe and Chole respectively. The average cultivated land holding occupied by individual farmer in both locations was about 1.81 ha. The farmers of Honkolowabe have more grazing land (0.86 ha) and fallow land (0.67 ha) when compared with (0.49 ha) and (0.19 ha) that of Chole. Generally, the Honkolowabe farmers own more land and allocate more land for different purposes than farmers in Chole district (Table 6) that is, the average land holding size per household was 3.91 and 2.90 ha respectively in Honkolowabe and Chole district.

Table 4. Educational status of the household heads.

Educational status	Frequency	Percent
Illiterate	27	22.5
Read and write	40	33.3
Primary school (1-6)	21	17.5
Junior school (7-8)	23	19.2
High school (9-10)	9	7.5
Total	120	100

Table 5. Land use pattern and total land holdings of the districts.

Land use pattern	Total land holdings in ha			
	Honkolowabe		Chole	
	ha	Percent	ha	Percent
Cropped land	26,120	74.8	28,987.3	64.4
(i) Rain-fed	25,840	74	26,636.3	59.2
(ii) Irrigated	280	0.8	2,351	5.2
Forest	1,764	5	1,208	2.7
Grazing	2,600	7.5	3,506	7.8
Settlements	3,500	10	2,909	6.5
Conserved/protected	900	2.6	8,369	18.6
Total	34,884	100	44,979.30	100

Source: Respective agriculture office (2011).

Table 6. Land use type and average size per household at Honkolowabe and Chole.

Land use type	Average land size (ha)			
	Honkolowabe		Chole	
Cropped land	1.82	46.55%	1.79	61.72%
Grazing land	0.86	22.00%	0.49	17.00%
Fallow land	0.67	17.14%	0.19	6.60%
Homestead	0.29	7.41%	0.20	7.90%
Wood lot or forest land	0.27	6.90%	0.23	7.93%
Total	3.91	100	2.90	100

Land leased in or out pattern in 2010

In the study areas, farmers practice both land leased in and land leased out for performing the agricultural activities. From 120 households involved in the study 29.17, 20.83 and 21.17% were practicing land leased in for barley production, for other crop production and for grazing respectively. On the other hand, 5 and 0.83% of the farmers were engaged in land leased out for agriculture and for grazing respectively (Table 7). The survey result also showed that more farmers in Chole practiced land leased in for barley production (74.3%) and for other crops (64%) than farmers in Honkolowabe district (Table 7). In connection to land leased in or out, considering the lands' rental value is crucial. Land rental value can vary based on a variety of factors like agro ecology, soil condition, and land cultivation history and so on. In land leased in and out system of the study area the average rental value of agricultural land and grazing land was 2438.85 and 1596.05 Ethiopian birr/ha respectively during the survey period.

Livestock production

Livestock are one of the important sources of household's income for many rural communities. Livestock have multiple uses aside from income

Table 7. Land leased in or out pattern in 2010.

Land leased in or out	Total No. of farmers		Honkolowabe		Chole		Min. (ha.)	Max. (Ha.)	Mean (ha.)
	No.	percent	No.	Percent	No.	percent			
Leased in for barley crop production	35	29.17	9	25.7	26	74.3	0.25	1.75	0.69
Leased in for other crops production	25	20.83	9	36.0	16	64	0.25	2.50	0.70
Leased in for grazing	26	21.17	14	53.8	12	46.2	0.25	3.00	0.91
Leased out for agriculture	6	5.00	1	16.7	5	83.3	0.25	2.75	0.83
Leased out for grazing	1	0.83	0	0	1	100	1.00	1.00	1.00

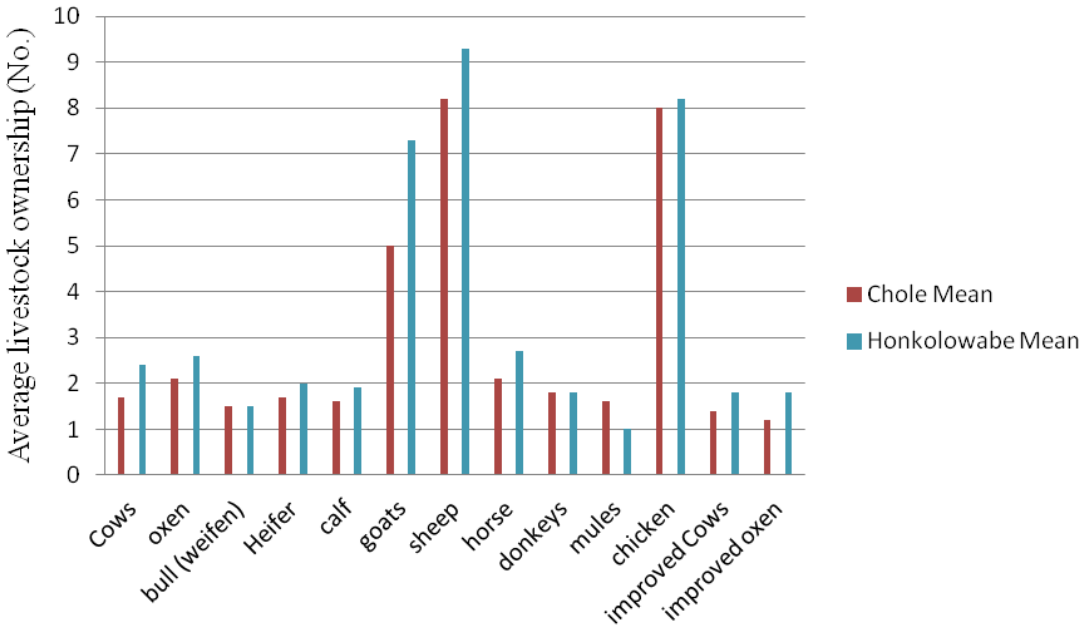

Figure 1. Average number of owned livestock per household in the survey area.

generation, including cash storage for those beyond the reach of the banking system, draught and pack services, milk and meat for household consumption, and manure for fuel and fertilizer (Sintayehu et al., 2010). Accordingly, Oxen have been used as drought power for land preparation, for transporting and threshing crops. Cows give milk to the family's consumption and the sale of milk products serve the family as the major sources of income. Donkeys are used for transporting crops from the field to home area and transporting the sell crops to marketable areas, while horses and mules are used as means of transportation. Average livestock that were owned by sample farmers are shown in Figure 1.

The overall mean of cows, oxen, bull, heifer and calf owned per the household of Honkolowabe district farmers were higher when compared to that of Chole's district (Figure 1). Generally, the result indicates at Honkolowabe the livestock holding per household were higher. Goat and sheep numbers were also relatively higher at this location. According to this survey the ownership of improved oxen and cows in Chole was higher than in Honkolowabe as shown in the figure. The main livestock diseases reported in the case study areas were: internal parasites, blackleg and anthrax. Shortage of grazing lands, unavailability of livestock medicine and long distance to implement artificial insemination are the most cattle production constraints of the study areas.

Crop production

It is clear that crop production pattern of an area depends mainly on agro ecology factors namely climate, soil types, crops type, community crop production habit and also marketing factors. Combining all these elements together Arsi zone is characterized by a cereal dominated farming system in which bread wheat and barley are the major crops (CIMMYT, 2000). Even though wheat and barley

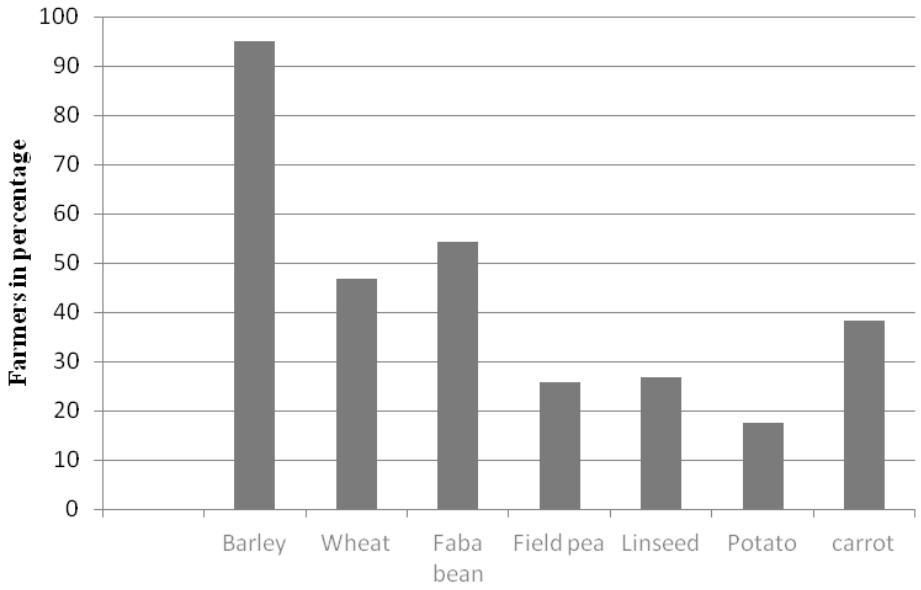

Figure 2. Major Crops under production in the study area.

are more popular in Arsi, crops like faba bean, field pea, linseed, potato, are mainly grown in the study areas. Some vegetables such as potato and carrot are also under cultivation by more farmers in the study area (Figure 2). Some crops like maize, tef, sorghum, rapeseed, onion, garlic and cabbage are also in cultivation in smaller amounts by some farmers. The study result showed that some variation between the districts; however, all the crops shown in Figure 1 are grown at both locations except carrot which is limited only to Honkolowabe district.

Malt barley is the crop grown mostly in the survey area. Yields of the main crops grown in the survey area in the year 2009 were indicted in Figure 3 based on the analysis of survey data. The best mean yield 1.779 t/ha was obtained from variety Holker (malt barley). The second best mean yield (1.608 t/ha) was from local food barley varieties. In spite of the importance of barley as a food and malting crop, its productivity in production fields has remained relatively low (about 1.3 t/ha compared with the world average of 2.4 t /ha) (Bayeh and Berhane, 2011) and they also indicated different biotic and abiotic stresses which are leading to low barley productivity. But, in recent years a concerted effort has been made by researchers, development agents and farmers to increase the outputs and incomes of small-scale farmers by improving the productivity of barley through participatory research and development efforts. As a result the average yield obtained from holker, miscal-21 and food barley varieties increased to 3.2, 3.5, and 4.3 t/ha according to the informations collected from the districts' agriculture offices. Mean yields from wheat and faba bean crops were equal. Almost about the same yield (2.080 and 2.020 t/ha) was also obtained from carrot and potato accordingly. There was also about equal yields of field pea and linseed (0.668 and 0.602 t/ha) respectively. According to the survey results obtained malt barley, faba bean, wheat and food barley were grown by many respondents.

Barley production

Barley production is common in the study areas for variety of purposes like marketing, home consumption in the form of injera, local drinks (tela, areqe), qolo, genfo, kinche, and bread. Barley is also produced for its straw for animal feed and it is used for thatching of roofs. Most of the interviewed farmers had grown local food barley varieties and about 57% of them were growing malt barley variety before five years of the survey time. The farmers accessed to improved barley varieties by AMF, agricultural offices, and research centers. Variety Holker was the most popular to the farmers' of both locations. In 2009/2010 production season, both food and malt barley varieties were grown by about 95% of the total respondent farmers. In similar season, Holker and Miscal-21 (malt barley varieties) were grown by about 62.5 and 12% of respondent farmers respectively. Even though the farmers' land allocation trend for barley was increased, there was farmers (14% of the interviewed) not cultivating barley at survey time.

Knowledge and introduction of improved barley variety

Knowledge is important for farmers to use the improved

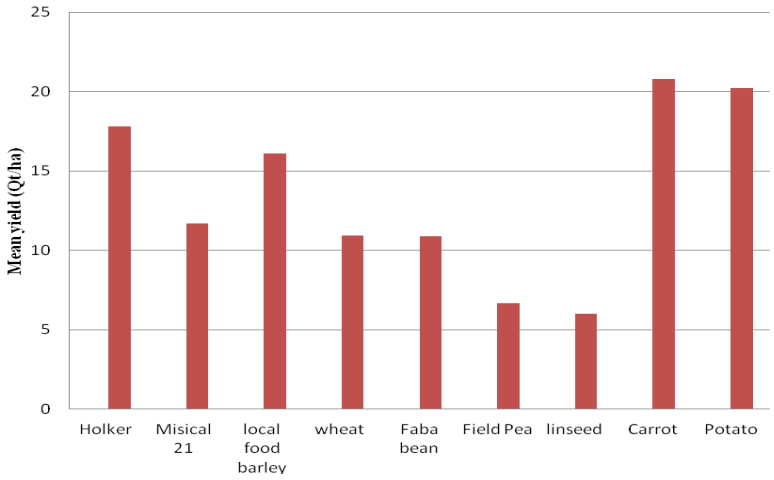

Figure 3. Mean yield (q/ha) of crops commonly grown in the study area.

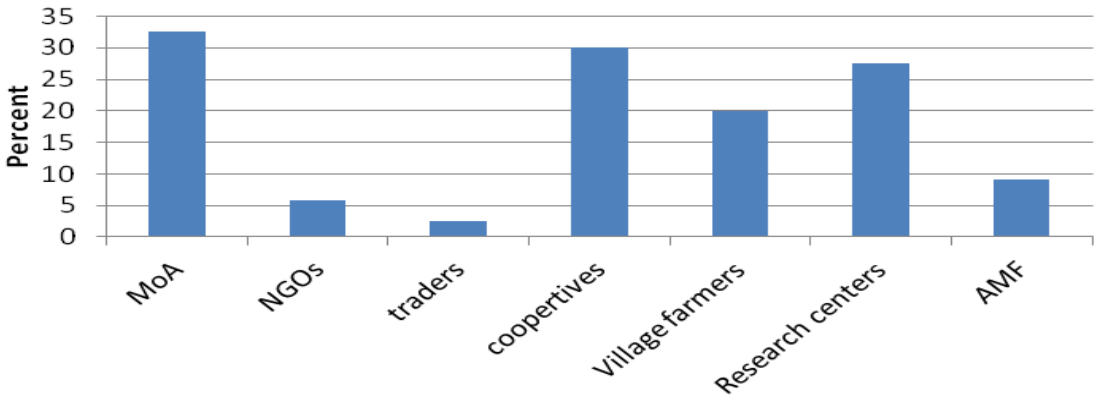

Figure 4. Stakeholders contribution in introducing improved barley varieties.

varieties introduced and knowledge level determines the utilization of the improved technology (Brij, 2006). Farmers of an area obtain information or knowledge from other farmers, bureau of agriculture, NGOs, research centers and the like.

Among the interviewed farmers about 82% have knowledge or knowhow of improved barley varieties while 19% did not. As indicated in Figure 4, bureau of agriculture (MoA) (32.5%), cooperatives (30%), Agricultural research centers (27.5%) and village farmers (20%) were played a significant role in the introduction and provision of improved barley varieties in order to enhance barley production. At the survey time (2009/2010) farmer cooperatives / unions, government (BoA), village farmers, and research centers were used as source of improved barley seeds while Assela malt factory, NGOs, and private seed company (traders) contributed less. The FAO - Crop Diversification and marketing Development Project (FAO –CDMDP), Assela (2010) reported that seed production of the most grown crops (Wheat, Barley, Pulses, and Oilseeds) in Arsi zone have been increased in recent years. According to the report, the newly established Oromiya Seed Enterprise (OSE), Oromiya Bureau of agriculture and Rural Development, FAO, Assela malt factory and other NGOs were facilitating the seed supply where the EIAR and ESE were the producer and supplier of the basic seed. Barley seed produced and the number of farmers engaged in production in 2006 to 2008 was indicated in Table 8.

Malt barley varieties

As to the information obtained from the farmers, the yielding potential and market value were the major reasons for producing some malt barley varieties or preferring its production over the others. The survey result indicated Holker and Misical-21 (malt varieties), HB 1307, Shege, Dimtu, HB-42 and local food barleys were

Table 8. Amount of seed produced by the farmers in 2006-2008.

Years	No of farmers	Production (tons)
2006	46	33
2007	461	375
2008	777	342
2009	411	47

Source: FAO – CDMDP (2010).

grown around Honkolowabe districts in 2009/10. At Honkolowabe malt barley was the most important cereal crop grown by all of the respondent farmers. Crops like linseed, Faba bean, field pea and potato were also grown. In the survey area next to malt barley carrot was the most preferred horticultural cash crop which was grown by about 77% of the respondent farmers.

Farmers in Chole district also grew three malt varieties namely Beka, Holker and Misical -21 and Food barley varieties include: HB-1307, Tesfaye, Nechgebse, Nazo, Zebale, Mwange, Warkiye and local food barley. At Chole food barley was widely grown more than malt barley due to late introduction of malt barley to the area. Other crops (like linseed, pulse crops (Faba bean and field pea), wheat, and potato) were dominantly grown in Chole district.

Generally three malt barley varieties Holker, Misical-21 and Beka were in production. Holker malt barley variety was more popular around Honkolowabe when compared to Chole. As to the discussion made with farmers group, Holker was more preferred for the yield potential and market price value. Farmers are more interested in production of Holker and Misical 21 for the sake of their yield potential, but AMF refused to use Misical- 21 due to lack of limited qualities required for the preparation of malt. Even though the straw of barley was preferable for cattle feed, the semi – dwarf of barley type which gives less straw was highly preferred than the long type which was susceptible to lodging and wind damage. In both locations malt barley produced, was mainly used as cash crop when food barley was used for family consumption.

Pest, disease, weed control and fertilization

In the past years most farmers were not using yield improving inputs through improving the crops' performance and growth. But, in recent years the input utilization level is increasing due to the efforts exerted through the extension activities to increase of level of awareness to inputs even if it is not at adequate level. In order to improve productivity of barley using inputs at right time, right type, and at right rate are important points to be taken into account (Getachew et al., 2011). According to the farmers' explanation, even though they were utilizing inputs, there were problems in application time, in type of inputs and in rate of inputs used.

In 2009/2010 production year, among the farmers involved in the study only 7% used pesticide on barley field to control aphids. Absence of serious pest problem, high price of chemicals and lack of chemicals were the reasons for the reduction of pesticide usage. Leaf rusts and leaf blights were the major barley diseases in the study area while smut and scold were also appeared as barley diseases as indicated by respondent farmers. As a factor of cereal based mono-cropping system grass weeds like *Avena fatua*, *Lolium temulentum,* and *Setaria pumila* were the so important weeds in the study areas. Due to the morphological similarity identification and controlling through hand weeding was difficult except after flowering. In the discussion made with the farmers, they explained grass and other weeds were highly contributing to the lower productivity of barley. In order to control broad leaf weeds 80% of farmers were used herbicides to control weeds in barley while the rest farmers used hand weeding. Similarly, to supply crops with sufficient nutrients important for plant growth and development adding fertilizers to the soil is crucial. From the total farmers interviewed 80% were used fertilizers for barley production. The type of fertilizers used was only DAP and manure as supplementary. Urea which is rich in nitrogen was not totally used. As the result obtained from interviewed farmers, the average rate of DAP fertilizer under usage was 73kg/ha which was much far below from the recommended rate. The survey indicated that there were farmers who used 200 kg/ha of DAP and there were also farmers that used 15 kg/ha DAP for barley production. The amount of fertilizer used by the farmers depends on different factors. As replied by farmers to determine fertilizer rate; some (22.5%) rely on recommended rate, some (41%) rely on crop rotation practiced, some (22.5%) rely on the amount of manure applied, and few (13%) depend on fertilizer price.

Household income and income sources

It is clear that the rural household livelihoods mainly depend on agriculture which includes livestock production and crop production. The life of farmers in the study area relies mainly on crop production which is cereal based farming in which livestock husbandry plays a significant

Table 9. Farmers' income sources and the farmers' percentage on district bases.

Income sources	Honkolowabe (n=60)		Chole (n=60)		Combined (N=120)	
	No.	Percent	No.	Percent	Total No.	Percent
Food Barley	27	45.0	23	38.3	50	41.7
Malt Barley	53	88.3	24	40.0	77	64.2
Other cereal crops	25	41.7	12	20.0	37	30.8
Pulse crops	14	23.3	38	63.3	52	43.3
Oil crops	13	21.7	11	18.3	24	20.0
Vegetable and fruits	42	70.0	13	21.7	55	45.8
Spices production	3	5.0	-	-	3	2.5
Tree wood and wood products	4	6.7	11	18.3	15	12.5
Livestock and Livestock product sales	27	45.0	37	61.7	64	53.3
Non-farm works	7	11.7	10	16.7	17	14.2
Remittance and gifts	-	-	3	5.0	3	2.5

Table 10. Annual income from different commodities.

Annual income	Combined (N=120)		Minimum (in ETB)	Maximum (in ETB)	Mean (in ETB)
	Total No.	Percent			
Food Barley	50	41.7	100.00	12000.00	2643.60
Malt Barley	77	64.2	200.00	26550.00	7156.70
Other cereal crops	37	30.8	160.00	11400.00	3019.46
Pulse crops	52	43.3	200.00	13600.00	2612.92
Oil crops	24	20.0	190.00	15000.00	2377.46
Vegetable and fruits	55	45.8	100.00	63000.00	4403.00
Spices production	3	2.5	3000.00	3000.00	3000.00
Tree wood and wood products	15	12.5	210.00	10000.00	2654.00
Livestock and Livestock product sales	64	53.3	250.00	28800.00	4145.94
Non-farm works	17	14.2	210.00	45000.00	4669.41
Remittance and gifts	3	2.5	2600.00	8000.00	4533.33

ETB= Ethiopian Birr, 1$=18ETB at the survey period.

contribution. The study result indicated that the farm households in the study area generate their income mainly from different cereal crops, pulse and oil crops, vegetable and fruits. Livestock and their products are among the important sources of income for many households. Among 120 interviewed farmers for more than 64% of them malt barley was source of income. Malt barley was income source for more than 88% farmers interviewed in Honkolowabe and for 77% farmers in Chole (Table 9). Next to malt barley, livestock and livestock product sales, vegetable and fruits, pulse crops, food barley, other cereal crops, oil crops and tree wood and wood products were used as income sources for 53.3, 45.8%, 43.3, 41.7, 30.8 and 12.5% farmers respectively (Table 9). Non-farm works was also sources of income for some (14.2%) farmers among the interviewed farmers while income from remittance and gifts was insignificant.

The amount of income earned from different Commodities varied with the suitability of an area for production and might be the farmers' dedication on management to the commodity production. Similarly, the farmers in the study sites generated income from crops production and livestock keeping and also few farmers from non-farm works.

In the study area, more farmers generated more income from malt barley production i.e. the mean income earned from malt barley sales by more than 64% respondent farmers was 7,156.70 ETB which was the highest income in comparison with the mean income obtained from the sales of other commodities. The study showed that farmers could get minimum income of 200 ETB and on contrary farmers could earn income up to 26,550 ETB from malt barley crop sales (Table 10). Out of the farmers interviewed about 53.3 and 45.8% of them got mean income of 4145.94 and 4403.00 ETB per year from livestock and livestock product sales, and vegetable and fruits sales respectively.

Barley production opportunities and constraints

Nowadays many factories are engaged in beer production and a large number of beer factories are under construction and expansion, and this shows the presence of higher demand for malt barley products now and in the future. Due to inadequacy of malt barley products with in the country many beer factories are importing malt barley from abroad. So as to enhance its malt production Assela malt factory is also under expansion to maximize the malt supply to the beer factories. As to the information gathered from some experts, Arsi and Bale highlands are suitable and ample for malt barley production to fulfill high malt barley demands with in the country. Different research activities are also undergoing to provide farmers with productive and quality malt barley varieties, and extension and introduction of new improved malt barley to farmers is undergoing by different stakeholders. Combining all these facts together, the opportunity for barley production improvement in the future is expected to be high to fill the maximum demand gap.

Unpredictable rainfall, pests, diseases like scald and net blotch, lack of pesticide, shortages of labor (during weeding, harvesting and threshing), shortage of improved seed, shortage of working capital, low quality of seed, untimely supply of inputs, problem of good market facilities were the major constraints raised by the respondent farmers. Water logging problem in general unpredictable high rainfall in particular and frost problem, climate change from season to season were among the reasons resulting to low grain yield and low quality seed produce of the survey area. Fertilizer and other chemicals were sold to farmers mostly on a cash basis through Ministry of Agriculture and Service Cooperatives. Although farmers were aware of the positive effects of fertilizers on crops, due to financial shortage the resource poor farmers were not used the inputs totally or used under the recommendation rates. This had hindered the effect of inputs on their crop yields.

Insects such as shoot fly, aphids and cutworms caused considerable damage on barley crop. Pesticides against the pest problem were not easily available to farmers in the area. Net blotch, scald, leaf rust and head smut were the main barley diseases reported by the respondent farmers. Farmers mainly complained that they could not get good market facilities especially to malt barley and carrot produces. The outsider traders and brokers were the beneficiary of their product on behalf of the producers. Occasionally there were no malt barley product collectors in Chole district, and farmers were forced to sell with low price to local small traders which were occasionally used to sell to Asella Malt Factory.

Conclusion

Arsi zone is characterized by both crop production and livestock husbandry over which crop production dominates. Crops like wheat, barley, faba bean, field pea, linseed, potato and carrot are the major crops produced in the study locations and crops like tef, maize, sorghum are grown on small plots by some farmers. Crop production in Arsi is highly dominated by wheat cultivation in general whereas barley is commonly cultivated in highlands of the zone. Barley grain is produced for sale, home consumption and for its straw for animal feed. In the past five years household's land allocation for barley production was increased due to the wide works on improved varieties introduction and provision by different stakeholders (agricultural development office, research centers, Assela malt factory, agricultural cooperatives, etc). MoA, research centers, cooperatives/ unions, village farmers were played significant roles in the supply of improved barley seeds where research centers are engaged in improved variety or technology generation and MoA together with cooperatives/ unions works on the technologies extension and dissemination.

Holker, miscal-21, and local food barley varieties were the relatively high yielding varieties and the highly cultivated varieties in the study areas. In Honkolowabe, malt barley was the most commonly grown cereal crop while food barley was more common in Chole. Due to the variation of awareness creation activity in the areas, there was variation of crop cultivation pattern. For instance, farmers in Chole district were aware of the improved malt barley varieties than farmers of Honkolowabe. For enhancing productivity of barley using only the productive and quality improved varieties cannot lead us to the intended target unless we use full production packages at proper time and amount with proper type. In the study areas, the level of pest disease control was low because of shortage and unavailability of pesticides. Furthermore, DAP was only chemical fertilizer which was utilized by the smallholder producers and urea was not used totally.

The increase in number of breweries and their expansion currently and in the future indicates the demand for malt barley product in the future. Research on barley improvement has produced substantial amount of technologies, information and knowledge, and also on producing. More efforts are also underway for the extension of improved technologies to the farmers. These all together shows the opportunities for barley production improvement in the future.

Unpredictable rainfall, barley diseases, lack of pesticide, shortages of labor (during weeding, harvesting and threshing), shortage of improved seed, shortage of working capital, unavailability of quality seed, untimely supply of inputs, problem of good market facilities were the major constraints of barley production in the study area. Significant yield reduction was also appeared sometimes due to the occurrence of unpredictable rain during harvesting time. Hence, taking relevant actions by considering those indicated constraints, can improve barley production and productivity in the study areas.

Conflict of Interest

The authors have not declared any conflict of interest.

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