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The status and constraints of food barley production in the North Gondar highlands, North Western Ethiopia

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Abstract

Background: The study was conducted in 2016 main cropping season in the North Gondar highlands of North Western Ethiopia. The objectives were to assess the status and to identify constraints of food barley production in the area. Three districts, namely Dabat, Debark and Wogera, were deliberately selected for this study, since they are the major barley producing districts of the north Gondar highlands.

Results: Primary data with 180 farmers, focus group and key informant discussions were carried out to collect data. The collected data were subjected to descriptive statistics and analyzed with SPSS software. The result showed that 95.6% of the farmers grow local food barley showing the great association of this crop with food security of the households. Nearly half of the respondent farmers (51%) grow only in a quarter of their land. Only 18.3% of the farmers have access to improved varieties of food barley. According to farmers, the major actor involved in supporting their barley production is district agriculture office. The majority of the farmers (82%) indicate that area sown to barley is declining. The major reasons put by focus group discussants and key informants for the declining of barley cultivation are as follows: shifting to market oriented and cash crops; unavailability of improved varieties of barley; lack of researchers working in the improvement of barley; declining the fertility of the soil from time to time; declining the productivity of landraces from time to time.

Conclusion: Therefore, as long as farmers are cultivating barley and the area is potential to the crop, various actors should be involved to boost production and productivity of the crop through trainings and demonstration plots. The landraces the farmers kept for generations should be conserved before they lost.

Keywords: Food barley, Production, Status, Constraints, North Gondar

Background

Barley (*Hordeum vulgare* L.) is one of the cereal crops, domesticated about 10,000 years ago in the Fertile Crescent [1]. Throughout the history, barley has undergone continuous manipulation in an effort to optimize its use for human consumption and an animal feed. Worldwide, barley is mainly produced for feeding and malting. Ethiopia is the second largest barley producer in Africa [2].

Ethiopia accounts nearly 25% of the total production in Africa [2]. Barley is the predominant cereal in the high altitudes (> 2000 m.a.s.l.) [3]. Ethiopia is also recognized as a center of diversity for barley having global significance because of its improved traits, including disease tolerance [4, 5]. The national area coverage, production and productivity of barley were estimated to be 959,273.4 ha, 2,024,921.7 tons and 2.11 tons/ha, respectively. Similarly, the total area coverage, production and productivity for North Gondar were estimated 46,155.9 ha, 98,014.8 tons and 2.14 tons/ha, respectively [6]. The average productivity in the North Gondar was slightly higher than the national average indicating the area is potential for food barley production.

Barley including both food and malt barley species is cultivated in Ethiopia. Ethiopia produces mostly food

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barley, with its share estimated to be 90% while that of malt barley having a share of 10% [7]. Barley grain in Ethiopia is mostly used as feed for animals, malt and food for human consumption. Traditionally barley is used for making local recipes and drinks and other types of food. Its straw is a good source of animal feed [8], and it is also used for thatching of roots.

North Gondar highlands have a huge potential of barley production. However, the trend of food barley production in the area has been declining for the past years. There are several factors for the same. The low productivity of landraces of food barley along with the current attention of the government could be the main reason, among many, for shifting of food barley production to other high market-value crops (e.g., wheat and malt barley) [personal observation]. The actual status of food barley production and associated production constraints have not systematically studied in the area. This study, therefore, is conducted with the objectives to assess the current status of food barley production and to identify the major production constraints in the study areas.

Methods

Selection of the study area and sample respondents

This study was designed to be carried out in potential barley producing areas of north Gondar highlands in Ethiopia. Both purposive sampling and random sampling procedures were used to select the respondents using three stages. In the first stage, three districts, viz. Debark, Dabat and Wogera, were purposively selected from the potential barley producing districts of the zone in terms of large area coverage for barley. The selection of these districts was made in consultation agriculture experts from North Gondar zone department of agriculture and field observation. In the second stage, two Peasant Associations (PA) were purposively selected from each of the selected districts in consultation with district agricultural experts with the major criteria of large area coverage and more consumption preference of barley than other crops. Accordingly, Adisgie miligebsa and Gomia PAs from Debark district, Woken and Talak mesik PAs from Dabat district and Daber lideta and Kossoye PAs from Wogera district were selected. In the third stage, from each PA, 30 respondents were selected using random sampling technique, thereby making a sample of 180 respondents.

Data collection and analysis

Data were collected using both qualitative and quantitative methods. Primary and secondary data sources were used to collect the information.

Data were collected from participants using structured questionnaire, focus group discussions (FGDs) and key informants. To gather the information from the respondents, face-to-face interviews were employed using a structured questionnaire. It is a common approach in rural areas with poor infrastructure, little access to electronic media and low literate levels of respondents. Prior to data collection, respondents were briefed the objective of the study and confidentiality/anonymity of the information. Interviews were conducted in a convenient time and area for both farmers and the interviewers. The pre-study was conducted to identify anything that are confusing, ambiguous, difficult to understand and irrelevant for the context. The survey was conducted from February to March, 2016. Six enumerators who had local knowledge and language were recruited and trained. The trained enumerators, under the supervision of the researcher, interviewed those sampled farmers.

At the household level, information was collected on sex, age, farming experience, level of education, household size and marital status of the respondent. Data on area coverage of major crops, barley cultivation in the field, application of fertilizer, access to improved varieties of food barley, organizations involved in barley production, farmers' perception on the barley crop, genetic conservation, variety selection and replacement and role of women were also collected. The collected data were analyzed using descriptive statistics such as mean and percentage. SPSS version 16 [9] was employed for data analysis.

Results and discussion

Demographic characteristics

Household size and the demographic characteristics of the respondents for various variables are presented in Table 1. 149 (83%) of the respondents were males, and 31 (17%) were females. Age of respondents ranged from 27 to 86 years old with the mean of 45.6 years. Around three-fourth of the respondents' age (73%) fell between 27 and 50 years implying that they are in active productive age. The age of the household head can determine the agricultural activity of a family [10]. With regard to educational status, about 22% farmers were illiterate and about 17% of the respondents were able to read and write. This showed that about 39% of farmers were not well educated at least in primary schools. The majority (62%) of the respondents had at least started formal education. This finding is in contradiction to the conditions of developing countries in which most of the population is illiterate [11]. Education is one of the important variables which increase an individual's ability to acquire, process and use agricultural information [12]. Household size of the households plays significant roles in rural agriculture dependent parents. Household size of the respondent farmers ranged from 3 to 16 with an average household

Table 1 Demographic characteristics of the respondents *Source*: Field survey (2016)

Variable	Frequency	Percentage
Sex of respondent		
Male	149	83
Female	31	17
Age of respondent		
27–50	131	73
Above 50	49	27
Educational level		
Illiterate	39	22
Read and write	30	17
Primary (Grade 1–8)	107	59
Secondary (Grade 9–12)	4	2
Marital status		
Married	171	95
Single	3	1.5
Widowed	5	3
Divorced	1	0.5
Household size		
3–6	72	40
7–10	98	54
Above 10	10	6
Farming experience		
5–10	18	10
11–30	115	64
31–50	42	23
Above 50	5	3

size of 7.2. It was reported that 60% of the respondents had more than six families per household. It indicates that the fertility rate was not less than 6 children per mother which is above the national average [13]. Household size plays significant roles in rural agriculture [14]. Farming experience of the sampled households was from 5 to 61 years, with average of 25.5 years. Older farmer had more farming experience than that of younger once.

Barley Production Status 95.6% of the households grow local food barley (Table 2). This showed the great association of this crop in the food security of the farming community. 51.1% of them grow only in quarter of hectare indicating farmers grow barley just for their daily consumption rather than for market supply.

With regard to barley production using improved varieties, 97.2% of the respondent did not grow improved food barley at all (Table 2). This is mainly because of inaccessibility of improved food barley varieties to these farmers. This finding is in agreement with [15] who stated that less than 1% (0.6%) of barley growers use modern seed varieties. Household survey data by Spielman et al. [16] also supported our finding. The major

Table 2 Area coverage of food barley *Source*: Field survey (2016)

Area coverage (Hectare)	Local food barley		Improved food barley	
	Frequency	Percentage	Frequency	Percentage
0	8	4.4	175	97.2
0.01–0.25	92	51.1	0	0
0.26–0.50	40	22.2	2	1.1
0.51–0.75	10	5.6	0	0
0.76–1.00	9	5.0	1	0.6
> 1.00	21	11.7	2	1.1

crops growing in the study area are food barley, improved malt barley, wheat, potato, triticale, garden pea and faba bean (Fig. 1). The figure showed that 95.6%, 2.8%, 61.7%, 88.3%, 68.9%, 31.7%, 16.7% and 77.2% of the respondents cultivated local food barley, improved food barley, malting barley, wheat, potato, triticale, garden pea and faba bean, respectively.

Food barley cultivation

The majority of the farmers (76.1%) stated that they rotate barley with other crops. Some farmers (17.2%) respond that they rotate barley and at the same time fallow it to make the soil rest (Table 3). According to the information collected from FGD, the main crops farmers rotate with barley are leguminous crops, namely faba bean, garden pea and linseed in order to increase the fertility of the soil. They also rotate with cereal and oil crops.

Application of fertilizers

Fertilizer plays a pivotal role to increase productivity of plants including barley. The majority (85%) of respondents use fertilizers for their barley field, while some (15%) respondents do not apply fertilizers in their field at all. This encouraging statistics in the usage of fertilizers by farmers contradicts a research finding which shows that from 2003 to 2013 on average, two-third of the barley growers did not apply any fertilizer to their plots in Ethiopia [15]. From those applying fertilizer in their barley field, 45.8% of them apply artificial fertilizers and only 9.8% use bio-fertilizers including compost, but nearly 44.4% of them apply both artificial and natural fertilizers (Table 4).

Access to improved food barley varieties

Results show only that 18.3% of the respondent farmers had access to improved food barley (Table 5. The majority of the respondents (81.7%) had no access to cultivate improved food barley varieties. Table 2 shows

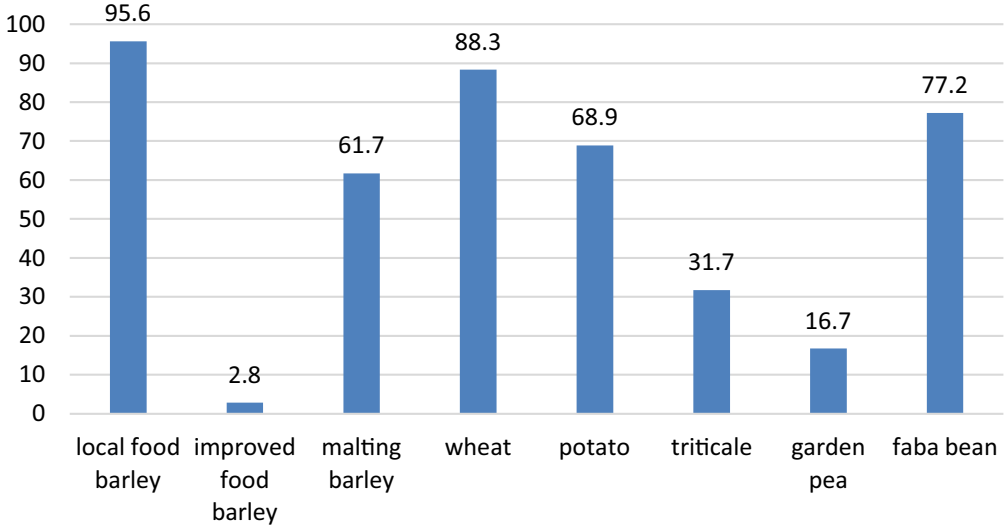

Fig. 1 Cultivation of major crops grown in 2016

Table 3 Barley cultivation practices *Source*: Field survey, 2016

Barley cultivation practice	Frequency	Percentage
Year after year	4	2.2
Fallow	8	4.4
Rotation	137	76.1
Fallow and rotation	31	17.2
Total	180	

Table 4 Application of fertilizers *Source*: Field survey (2016)

Fertilizers application practice	Frequency	Percentage
Yes	153	85
No	27	15
Total	180	
If yes, type of fertilizer?		
Artificial	70	45.8
Natural	15	9.8
Both types	68	44.4
Total	153	

that 97.2% of the farmers are not growing improved varieties of barley mainly because of the fact that suitable condition is not created by responsible bodies to supply improved varieties of barley in their piece of land.

Role of organizations in improving barley production

Stakeholders play a great role in boosting productivity of barley. The major actor involved in increasing productivity of barley is district agriculture office which was mentioned by 62.2% of the respondents. About quarter (25.6%) of the respondents stated that they do not have support in any organization in barley production (Table 6). This finding is in agreement with Wuletaw et al. [17] who stated that district agricultural office is one of the key institutions contributed for various activities in malt barley seed production in a study conducted in similar areas of this study.

Farmers perception of barley varieties

The perception of farmers with regard to barley varieties in relation to area coverage, diversity, factors affecting their decision in varietal choice and adjustment of sowing time was studied and reported accordingly.

Area allocation for barley cultivation

The trend of area allocation for barley production has been decreasing over time as indicated by majority (81.7%), 10.6 and 7.8%, respectively (Table 7). This showed the fact that barley has received far less attention compared to the other major cereals and as a result farmers are shifting their barley cultivation into other cash and productive crops.

Diversity of barley landraces

The majority of farmers indicated that the diversity of barley landraces is declining (85.0%) (Table 8). This is

Table 5 Access to improved food barley of respondent farmers *Source*: Field survey, 2016

Access to improved food barley varieties	Frequency (N)	Percentage (%)
Yes	33	18.3
No	147	81.7
Total	180	

Table 6 Organizations involved in barley production

Supporting organization	Frequency (N)	Percentage (%)
Agriculture office	112	62.2
Research center	3	1.7
Agriculture office, Research center	10	5.6
Agriculture office, Research center and Other organizations	6	3.3
Other organizations	3	1.7
No support from any organization	46	25.6
Total	180	

Table 7 Area coverage of barley *Source*: Field survey (2016)

Trend of area allocation for barley over years/time	Frequency (N)	Percentage (%)
Increasing	19	10.6
Decreasing	147	81.7
No major change	14	7.8
Total	180	

Table 8 Farmers response on barley diversity trend *Source*: Field Survey, 2016

Barley diversity trend	Frequency	Percentage
Increasing	15	8.3
Decreasing	153	85.0
No change	12	6.7
Total	180	

an indication that the North Gondar highlands barley diversity is declining and there should be a conservation mechanism either in situ or on farm before we lost the remaining land races. Inability of the farmers to grow improved varieties of barley is an indication that improved varieties of barley are not a threat for the loss of landraces. This is in agreement with the findings of Eticha et al. [18] who stated that it is not because of the introduction of improved varieties of barley that substantially contributed for the ongoing loss of landraces in…. districts rather other factors. Tsegaye and Berg [19], on the other hand, support our finding that in East Shewa the expansion of other crops like tef and wheat contributed significantly to the genetic erosion of tetraploid wheat landraces.

During FGDs, participants mentioned the basic reasons for decreasing barley landrace diversity in the areas. These include, among others, are inability of the rain to come on the usual months of May and June causing the varieties sown in these months to move out of the production system; decrement in the land size; less market demand and less price; supply of improved technologies by the government including malting barley, triticale and wheat; decrement in the fertility of the soil since most landraces prefer fertile soil. The majority of farmers stated that the diversity of barley is declining from time to time, still some of them are interested to maintain diversity of barley landraces. The major reasons are as follows: Barley landraces are hunger relievers since some of the landraces mature earlier than other crops; tolerance to natural disasters; used for various foods and local drinks There are no improved varieties of barley that can replace them, since they mature and arrive in different seasons of the year; their medicinal value; the seeds are available in the surrounding without additional cost and energy.

Table 9 Factors affecting decision on variety choice *Source*: Field survey (2016)

Varietal choice decision	Frequency (N)	Percentage (%)
Household preference	6	3.3
Environmental conditions	113	62.8
Combination of both	53	29.4
Any other reason	2	1.1
Existing natural resource and any other reason	2	1.1
Household preference and existing natural resource	4	2.2
Total	180	

Factors affecting decision on variety choice

Of the factors affecting the decision to choose a variety to plant in a given field, the majority (62.8%) of them put natural resource as the most followed by combination of household preference and natural resources (29.4%) (Table 9).

The response of respondents for factors that determine their food barley varietal choice is presented in Table 10. 47.1% and 36.1% of the respondents mentioned that rainfall and soil type, respectively, are the most important

Table 10 Natural factors that determine varietal choice *Source*: Field survey (2016)

Which natural resource affects varieties to choose?	Frequency	Percentage
Rainfall	81	47.1
Type of soil	62	36.1
Any other reason	3	1.7
Rainfall and type of soil	21	12.1
Rainfall, type of soil and any other reason	2	1.3
Type of soil and any other reason	3	1.7
Total	172	

Table 11 Adjusting sowing time with soil moisture *Source*: Field survey (2016)

Adjustment of sowing time with moisture	Frequency	Percentage
Yes	171	95.5
No	9	5.0
Total	180	
If yes, when do you sow?		
Early	22	12.9
Late	8	4.7
Immediately when wet	141	82.4
Total	171	

factors. According to the respondent farmers, the most crucial natural resources affecting which landrace to plant in a given season are rainfall and type of soil with the values of 47.1 and 36.1%, respectively (Table 10). Findings from similar study indicated that variation in soil type which is one of the natural resources for the crop is one of the main reasons for to choose the best variety to grow [20].

Sowing time adjustment

Farmers were asked whether they adjust sowing time with the availability of moisture or not. The majority of them stated that they adjust sowing time with available moisture (95%), while some said otherwise (5%) (Table 11). From those who adjust sowing time with soil moisture, the majority (82.4%) of them stated that they sow their land immediately when the soil is wet. Some said they sow early (12.9%) and others said they sow late (4.7%) (Table 11). The farmers adjust sowing time so that crops have matured by the time the soil moisture reserves are depleted [21]. Those farmers that stated that they sow their barley immediately when the land is wet put the following reasons: in order for the seed to germinate immediately; to make the stem strong; to make the crop reasonable yield; to protect from different diseases and birds attack otherwise if sown in dry soil it will not grow until the soil is wet and on the mean time it will be vulnerable to the above diseases and birds; to have uniform germination and vigor and give high yield.

Conclusions and recommendation

The North Gondar highland farming communities grow food barley more than any other crop showing the great association of this crop in their food security. However, the production and productivity of this crop are declining from time to time as compared to the potential of the area to the crop. Lack of improved varieties of food barley, less involvement of stakeholders and weak integration among them, shifting to market oriented and cash crops mainly due to government attention, land fragmentation, declining the fertility of the soil, climate variability, extended time needed to separate the seed from the husk are the major factors identified in this study. The diversity of landraces is also reduced. Although the abovementioned ones are the reasons for declining production and productivity of food barley, the farmers know and aware of their crop since they know it from time immemorial like where and when to sow each landrace of the crop they have, shifting the crop with leguminous crops, applying both artificial and natural fertilizers. The landraces the farmers kept for generations and are adaptable to the different conditions have to be conserved before they lost. Stakeholders including the government should be involved in boosting production and productivity of the crop, and the government officials should give value for the potential of the area into consideration as much as they give value for cash crops. By taking the importance of this crop to the farming community as well as the potential of the area, it is recommended that high-yielding improved varieties of barley and all other improved technologies should be introduced and intensive capacity building should be done by agricultural extension experts, development agents and researchers.

Abbreviations

PA: Peasant Association; FGDs: farmer group discussions.

Authors' contributions

DT initiated the idea, wrote the proposal, collected the data, performed the analysis and wrote the paper. BD collected the data, crafted the design and also participated in writing and editing the paper. Both authors read and approved the final manuscript.

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Competing interests
The authors declare that they have no competing interests.

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Please contact corresponding author for data requests.

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