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# Assessment of Garlic Production Constraints and Trait Preferences in Garlic Cultivar Development in Two Woredas, Sidama Region, Ethiopia

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

Garlic (*Allium sativium L*.) is the major food and cash crop in the highland regions of Ethiopia. However, farmers are not integrated into the garlic breeding process. The objectives of this assessment were to identify farmers' key garlic production constraints and establish preferred traits in garlic cultivar development in the two woredas of Sidama Region (Ethiopia). A participatory rural appraisal (PRA) study was conducted through a structured survey involving 36 households in Malga and Gorche woredas. A structured survey used a questionnaire which was administered to farmers to collect information on key production constraints, varieties of garlic seed used for production, seed source etc., according to the assessment result of this study, the cultivar used for garlic production is the local variety in the two woredas. Hence, the most important garlic production constraints are lack of high yielding cultivars, garlic disease and insects. To conclude active farmer participation in early breeding stages is critical for a successful garlic breeding program. Based on the assessment it is possible to recommend that high yielder garlic variety,

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disease tolerance, insect resistant and cultivars having high dry matter content are the most important parameters preferred by farmers, which helps them to produce maximum products and serve as a source of income to many rural farmers.

*Keywords: Assessment; constraints; farmers; food supplement; garlic; source of income.*

## 1. INTRODUCTION

"Garlic (*Allium sativium L.*) belongs to the Alliaceae family and is the second most widely used Allium next to onion [1]. In Ethiopia, garlic is one of the important bulb crops produced for home consumption as spice or condiment in the preparation of soup, pickle and other preservatives as well as a source of income to many rural farmers in many parts of the country [2]". "Despite its importance, great potential for production and high market demand, the current garlic production and productivity is limited and remain seasonal. Low soil fertility is one of the factors limiting the productivity of different crops in Ethiopia mainly accounted for removal of surface soil by erosion, nutrients removal by crops from the soil, complete removal of plant residue from farm-land and lack of crop rotation system on the farm land resulting in lower crop yields" [3,4].

"To mitigate these problems, Ethiopian farmers have a tradition to maintain or improve the fertility of the soil using fallowing, farmyard manure, intercropping and crop rotation systems" [5]. Application of manure enhances soil fertility and increases the productivity of garlic by improving soil properties and nutrient status. Similarly, [6] reported that "application of organic materials like farm yard manure, compost or green manure in combination with inorganic fertilizer improved soil physical properties and the author indicated that the uptake of nitrogen, phosphorus, potassium, zinc, manganese, copper and iron were increased significantly by crops when 50% of organic fertilizers in combination with 50% inorganic fertilizers were applied".

"Several scientists have emphasized the need for active farmer participation in plant breeding is critical for successful adoption of improved varieties and their production packages" [7,8]. However, the link between research and farmers is still very weak or absent in most developing countries [9]. According to Sidama Region Agricultural Office, "there is no improved garlic variety to be used by the farmers currently and it is the local garlic cultivar Tuma that the farmers use for production. Since it is a newly established region, the agricultural office is trying to provide improved seeds to the farmers".

Therefore, the assessment of farmers' knowledge and preferences in cultivar development was undertaken through farmer participatory approaches. Therefore, the objectives of this survey were to identify and analyze farmer's key constraints in garlic production, and establish farmers' preferred traits to be included in cultivar development and variety selection process at the study sites of Sidama Region, Ethiopia.

## 2. MATERIALS AND METHODS

### 2.1 Description of the Study Areas

The assessment of this study focused on highland areas of Sidama Region, Ethiopia and covered two garlic growing woredas namely Malga and Gorche. These areas are the most fertile and productive, and their climatic conditions are well suited for garlic production in the Region.

Malga is located at 06° 54' 31" N latitude and 38° 42' 30" E longitudes covering a total area of 206.74 square kilometers with 129,694 inhabitants [10]. Most Kebeles (smallest Ethiopian administrative unit in Ethiopia) are classified as 'rural' [10]. The rainfall distribution is bimodal with a long (June to September) and short (March to May) rainy season. The altitude ranges in elevation from 1500 to 3000 m.a.s.l and receives 1200–1600 mm rainfall annually; the average annual temperature ranges from 12.6 to 20°C. The dominant soil type in the woreda is Alisol, characterized by loam to clay-loam textural classes [11].

Gorche is located at 6° 59' 36" N, 38° 19' 30" E a total area of 10,000 $km^2$, of which 97.71% is land and 2.29% is covered by water with 11,398 people and is one of the largest places in Ethiopia. The rainfall distribution is unimodal from June to September. The altitude of Gorche is 1870 m.a.s.l and the dominant soil type in the woreda is Alisol, characterized by loam to clay-loam textural classes.

## 2.2 Data Collection

A questionnaire was developed and administered to farmers to collect information on farm size, land allocated to garlic, source of garlic seeds, constraints for garlic production, garlic varieties used, type of fertilizer used and number of times that garlic is produced in the study areas. Different administrative levels were considered which includes woreda and kebele leaders. A random sampling involved two woredas, three kebeles per woreda and six respondents per kebele. This resulted in a total of two woredas, 6 kebeles, and 36 respondents. Data were gathered using a structured survey questionnaire to get characteristics of the farms and production systems and different factors that reduces garlic production in the two woredas.

## 2.3 Sampling Procedure

A purposive sampling procedure was used to identify the highland regions chosen for their great importance in garlic production [12]. Random sampling was employed to select farmers in each kebele from the two woredas with the help of the kebele leaders and extension workers. During data collection, participatory rural appraisal allowed farmers to express their opinions through group discussions. A checklist was prepared in advance to guide the discussion.

The permission letter was brought from Sidama Region Agricultural Office; the Office also gave us a letter to give it to the study woredas and to the respective study kebeles.

## 2.4 Data Analysis

Data were analyzed using Excel. Descriptive statistical measures like, percentage, frequency, and mean were used to summarize and categorize the assessment data. Tables and bar graphs were used to represent the data.

# 3. RESULTS

## 3.1 Experience and Gender Composition of the Interviewed Farmers in the Study Areas

According to the assessment results of this study from the two woredas, all household heads had greater than fifteen years of experience on garlic production (Table 1). Results on gender involvement in decision-making on garlic production indicated that both males and females were involved in the main garlic production activities. But the number of male participants were greater than female participants in the two woredas (Table 1).

## 3.2 Household Heads Educational Status in the Study Areas

The below figure showed that the educational level of the household head of the interviewed individuals were (50%) illiterate, (27.8%) 1-6 grade and (22.2%) 8-10 grade in Malga woreda and (66.6%) illiterate, (16.7%) 1-6 grade and (16.7%) 8-10 grade in Gorche and the percentage of literate in the two woreda was (0%) (Fig. 1).

## 3.3 Source of Seed

Farmers in the study areas acquired garlic seed from their own field (33.3%) and from the open market (66.7%) in Malga woreda. And in the case of Gorche woreda (38.9%) was from their own field and (61.1%) from the open market. Research institutions and private companies play no role (0 %) as seed providers from the two woredas (Fig. 2).

## 3.4 Major Garlic Production Constraints and Garlic Varieties Grown

The most important identified garlic production constraints across the study areas were as follows: insects (38.9%), low yield (27.8%), lack of fertilizer (16.7%) and garlic disease (16.6%) in Malga woreda. And, lack of fertilizer (33.3%), insects (27.8%), garlic disease (22.2%) and low yield (16.7%) were constraints in Gorche woreda (Table 2).

Garlic varieties grown in the study areas were presented in (Table 2). Even though different improved garlic varieties were released in Ethiopia, it was the local garlic variety (100%) grown in the two woredas (Table 2).

## 3.5 Land Size for Garlic Production in the Study Areas

The land to be allocated for garlic production in the study areas was presented in (Table 3). Most farmers allocated farm size of (5.95%) hectare for the production of garlic in Malga and (6.58%) in Gorche woredas respectively (Table 3).

### 3.6 Type of Fertilizer Used and Number of Times Garlic Grown in the Study Areas

Concerning to the application of fertilizer farmers used compost (100%) for the growth of garlic from the two woredas (Table 4).

The number of times that garlic was grown in the two woredas was presented in (Table 4). And the participants in Malga woreda informed that (44.4%) is 1 time and (55.6%) is 2 times a year. And it was (27.8%) and (72.2%) who responded 1 time and 2 times respectively in the case of Gorche woreda (Table 4).

**Table 1. Experience and gender composition of the interviewed farmers in the study areas**

| | | Woreda | | | |
|---|---|---|---|---|---|
| | | Malga | | Gorche | |
| | | No of farmers | % | No of farmers | % |
| **Experiences (years)** | <5 | 0 | 0 | 0 | 0 |
| | 5-10 | 0 | 0 | 0 | 0 |
| | 10-15 | 0 | 0 | 0 | 0 |
| | > 15 | 18 | 100 | 18 | 100 |
| **Gender** | Male | 14 | 77.78 | 16 | 88.89 |
| | Female | 4 | 22.22 | 2 | 11.11 |

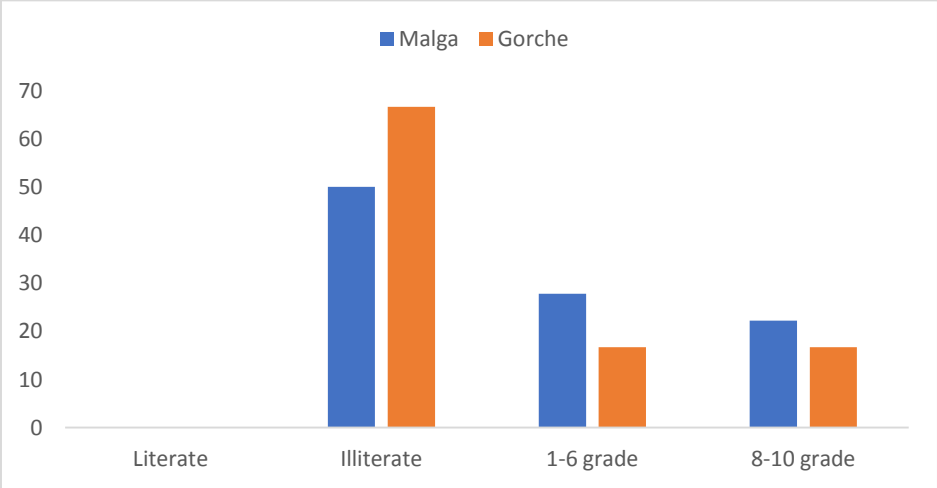


**Fig. 1. Household heads educational status in the study areas**

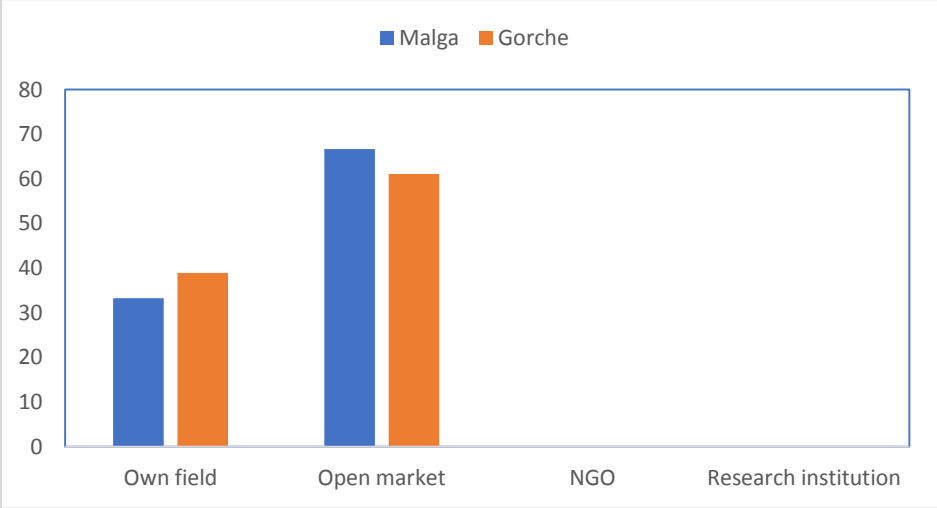


**Fig. 2. Source of garlic seed among 36 farmers in the study areas**

**Table 2. Garlic production constraints and varieties used in the study areas**

| | | Woreda | | | |
|---|---|---|---|---|---|
| | | Malga | | Gorche | |
| | | No of farmers | % | No of farmers | % |
| **Constraints** | Garlic diseases | 3 | 16.6 | 4 | 22.2 |
| | Insects | 7 | 38.9 | 5 | 27.8 |
| | Lack of fertilizer | 3 | 16.7 | 6 | 33.3 |
| | Soil degradation | 0 | 0 | 0 | 0 |
| | Low yield | 5 | 27.8 | 3 | 16.7 |
| **Varieties** | Local | 18 | 100 | 18 | 100 |
| | Qoricho | 0 | 0 | 0 | 0 |
| | Tsedey | 0 | 0 | 0 | 0 |
| | Bishofitu Nech | 0 | 0 | 0 | 0 |

**Table 3. Mean household farm size and cultivated land for garlic in the study areas**

| Woreda | Mean total land holding (ha) | Mean garlic production area (ha) | (%) |
|---|---|---|---|
| Malga(n=18) | 0.84 | 0.05 | 5.95 |
| Gorche(n=18) | 0.76 | 0.05 | 6.58 |

**Table 4. Type of fertilizer used and number of times garlic grown in the study areas**

| | | Malga | | Gorche | |
|---|---|---|---|---|---|
| | | No of farmers | % | No of farmers | % |
| **Type of fertilizer** | Urea | 0 | 0 | 0 | 0 |
| | DAP | 0 | 0 | 0 | 0 |
| | Compost | 18 | 100 | 18 | 100 |
| **Number of times** | 1 time | 8 | 44.4 | 6 | 33.3 |
| | 2 times | 10 | 55.6 | 12 | 66.7 |

### 3.7 Age of the Interviewed Farmers in the Study Areas

Age of the interviewed farmers was clearly presented in (Fig. 3). Farmers whose ages were 34-48(33.3%), >48(66.7%) and for age ranges <18 and 19-33 were (0%) in the case of Malga woreda. Whereas, it was (0%) for age ranges <18 and 19-33 and it was (27.8%) for 34-48 and (72.2%) for age ranges >48 in the case of Gorche woreda (Fig. 3).

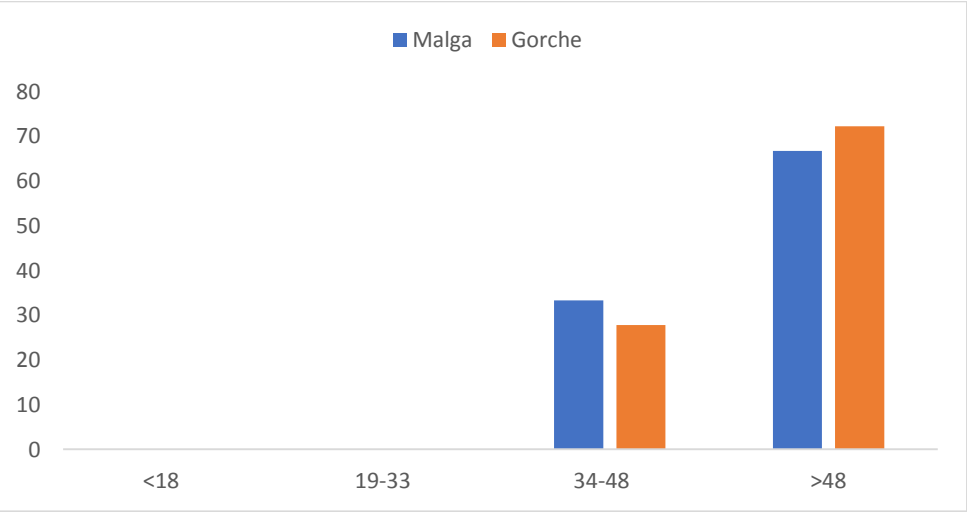


**Fig. 3. Age of the interviewed farmers in the study areas**

## 4. DISCUSSION

According to the assessment results, all household heads of the participants in the two woredas had greater than fifteen years of experience in garlic production (Table 1). And this indicated that farmers in the study woredas had more experience in garlic production although they didn't have an access of improved garlic varieties. These results are generally in the contrary with the results presented earlier where most of the household heads in Adet Zuria kebele were young and thus might not have much experience in garlic production [13].

Age of the household farmers in the two woredas were greater than 34 years old (Fig. 3). This showed that as the rural households' heads get older, they tend to decide to participate not only in the production, but also in transportation and marketing components of garlic in the study areas. [8] indicated that age is an important factor in market participation as revealed in pineapple market in Kenya.

With regard to gender of the household head from the study areas, the number of males were greater than females (Table 1). This showed that the decision on garlic production was determined by males. Which is in the contrary to the studies [14] that indicated the probability of participation in transportation-distribution of yam is positively related to gender of the respondents. Likewise, one study reported that female-headed households were more likely to adopt land and water technologies compared to male-headed households [15].

Household heads educational status in the study areas indicated that the majority of the interviewed farmers were illiterate, from which few of them were grades,1-6 and 8-10 respectively (Fig. 1). Many researchers have studied sociodemographic characteristics for their effect on agricultural production [16,17]. In a study carried out in Venezuela, age and education had a significant positive influence on the adoption of soil conservation measures and therefore on the production of certain crops [18]. Also, the study by [19] reported a positive influence of education on the adoption of conservation agriculture technology in tropical territories.

Mean garlic production area to be allocated in the two woreda was 0.05 ha (Table 3). This implies that garlic is cultivated by small scale subsistent farmers. The same farming pattern was reported in Jimma area, Oromia region, Ethiopia [20].

About 100% of the interviewed sample farmers in the two woredas used compost, the organic fertilizer for garlic production and they applied during sowing without following any standards (Table 4). Application of fertilizers is an important cultural practice in vegetable production as it helps to satisfy the nutrient needs of crops required for the production of high yield and farmers from Adet Zuria kebele used DAP and urea fertilizers to produce garlic [13].

"The use of improved garlic varieties is a very important input to produce high quantity and quality of garlic yield. Although different improved garlic varieties such as Qoricho, Bishoftu Netch and Tseday 92 were released from different research institutes in Ethiopia" [21]; farmers from Malga and Gorche woredas used only local garlic varieties sourced from their own savings and/or from the local market and it is because the area is found in the newly established region and no research practices were conducted yet (Table 2). Planting materials sourced from such informal seed systems have limitations in terms of quality as the interviewed farmers mentioned which is in agreement with the observations of [22]. According to the key informants, unavailability of planting materials of improved garlic variety is a very limiting factor for the development of garlic production in the study area.

Diseases and insect pests are a serious concern in the production of garlic in Ethiopia including the study area. The current study therefore discovered that unavailability of high yielding certified seed varieties, acute shortage of fertilizers and pesticides and prevalence of leaf rust in the on-season are the main tribulations of garlic production where their occurrence differs with the study woredas and farmers used cultural practices to control the diseases and insect pests of garlic (Table 2). The results are generally in agreement with the findings of various researchers who found that white rot and rust are the common diseases of garlic in Ethiopia [23,24, 25,13].

In order to identify suitable adaptation practices to a certain territory, it is necessary to previously establish the groups of actors involved, defined by similar characteristics from the point of view of land use, the production system [26], ethnicity [15], culture [27], the territory where they do

agriculture and the productive chains to which they belong [28,29,30]. This stage facilitates the analysis of adaptation, since in general they will have similar threats, impacts and feasibility attributes compared to the proposed actions [31,32].

## 5. CONCLUSION

This study represents an advance of great methodological utility because it provides an approach to study issues in garlic production systems, with results that increase existing knowledge with theoretical and statistical foundations. Likewise, this methodology can be applied in other institutions, communities or organizations.

This research will form an important part in establishing the baseline on the location of the areas of importance for garlic production in Sidama region, so that, farmers in the study areas will get the opportunity to produce maximum products.

Nevertheless, the production and productivity of garlic in the study area is facing different constraints which requires research and extension services. Therefore, information about the current garlic production practices is paramount important to design intervention strategies.

## 6. RECOMMENDATIONS

The findings of this assessment indicated that both Malga and Gorche woreda farmers had greater than fifteen years of experience in the production of garlic. However, there were constraints which require various intervention strategies which include among others:

Upgrading the skills, knowledge and attitudes of the smallholder farmers in the agronomic management and providing improved garlic varieties which are resistant to disease and insects, fertilizers, pesticides, insecticides.

## CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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## APPENDIX

**Questionnaires for assessment of production of garlic**

**Part I. Demographic information:**

1. Name of farmer/Code: _____

2. Sex of household head a. Female b. Male

3. Age of household in years a). <18 b). 19-33 c). 34-48 d). >48

4. Educational status of household head a). literate b). Illiterate c). 1-6 grade d). 8-10 grades

5. District _____Kebele _____

**Part II. Farm practices:**

1. What is your total land holding?

a). <0.50 ha b). 0.50-1.0 ha c). 1.0-1.50 ha d). >1.50 ha

2. What size of your land is dedicated to garlic production?

a). <0.25ha b). 0.25-0.50ha c).0.50-0.75ha d).1.0ha e).>1.0ha

3. How long is your experience in garlic production?

a. <5 years b. 5-10 years c.10-15 years d. > 15 years

4. Where do you get your planting materials from?

a. from traders b. agricultural bureau c. research institutions

d. private companies e. farmers keep their own seeds from their harvests

5. Which variety of garlic do you grow?

a. Bishoftu Nech b. Tsedey c. Qoricho d. Local

6. How many times in a year do you produce garlic?

a. once b. twice c. trice

7. Please provide on the types of fertilizers used

**Table 1. Type of fertilizer used in the study area**

| Type | Yes | No |
|---|---|---|
| Urea | | |
| DAP | | |
| Compost | | |
| Other | | |

**Part III: Pest (Disease, Insect and Weed) Control:**

1. What is the most important garlic pest in this area?

a. diseases b. insects c. weeds d. others

2. What other control method (s) do you use against disease?

a. chemical b. cultural c. both



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