Maize production constraints at household levels: The case of Hawassa Zuria district in Sidama Region, Ethiopia

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Received 11 January, 2022; Accepted 7 April, 2022

Maize is the most important cereal crop in Ethiopia in terms of plantation area, the volume of production, and its economic importance regarding food security. Despite the relative yield increment at the national level, maize production in the study area has been hindered by a couple of factors. This study was conducted to assess and evaluate maize production constraints in the Hawassa Zuria district. Primary data was collected from 60 randomly selected maize producers. Accordingly, socioeconomic factors such as sex (β = -2.02), educational level (β = 0.18), total livestock unit (TLU) (β = 0.27), and major income source (β for agriculture = 2.75 and β for private works = 3.05) could significantly influence maize production and productivity at 1% probability level. The institutional factors such as access to agricultural inputs, extension services, credit, irrigation, and membership in rural cooperatives; and agronomic factors such as fertilizer use, planting density, weeding frequency, tillage mechanisms, and pest and disease infestation were identified as the major challenges likely influencing maize production in the study area. Based on the study outcomes, policy recommendation is made such as improving the educational level, enhancing input access and empowering farmers to adopt and apply a full package of agronomic practices that help to improve soil fertility and thus crop productivity. Therefore, addressing these constraints would have a vital role in improving food production.

Key words: Agronomic factors, determinants, maize, multiple linear regression, production and productivity, policy recommendation.

INTRODUCTION

The global food demand is expected to rise steeply due to the escalating population growth, shifting of dietary

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preferences, and raising the demand for renewable energy (Yengoh, 2012). Ensuring food security by producing enough food with good quality and making it accessible and affordable for consumers around the world is the most important policy objective (Saghir and Hoogeveen, 2016). The recent estimation indicated that the global food demand will increase by 100% up to 110% from 2005 to 2050 (Tilman et al., 2011). The green revolution that transformed Asian agriculture did not bring a profound outcome in Africa and food shortage and poverty remains major issue. Ethiopia is the second-most populous country in Africa with a population size of above 110 million. The country has a considerable variation of climate due to the wide range of altitudes. Like other SSA countries, the issue of food insecurity is one of the hot policy areas in Ethiopia. Agriculture is the dominant sector that contributes about 46.3% of the total GDP and 80% of employment (Solomon, 2020). The crop production system is highly dominated by smallholders who cultivate about 90% of cropland and produce above 90% of agricultural output (Urgessa, 2014).

Among food crops in high demand are the cereal crops of which maize accounts for the majority in terms of cultivation and use as food, feed for animals, and source of energy (bio-fuel) (Fan et al., 2020; Shiferaw et al., 2011). It is a major strategic crop in terms of area coverage, the volume of production, and its economic importance in Ethiopia (CSA, 2019; Abate et al., 2015). Although the Ethiopian government allocated about 10% of its total expenditure to the agricultural sector (which is the benchmark of a New Partnership for Africa’s Development (NEPAD) for sub-Saharan Africa) (Abraha, 2015), the productivity of cereal crops is below the global average due to a multitude of biotic and abiotic factors (Dessie, 2018). For example, the national average cereal yield is low (about 2.45 t ha\(^{-1}\)) (Dessie, 2018) as compared to the global average yield of 3.9 t ha\(^{-1}\) (Tadele, 2017). Also, there was a huge gap between the actual and potential yield of maize (Liben et al., 2020); and the water-limited yield potential is about 13.9 t ha\(^{-1}\) (GYGA, 2020).

The low productivity of maize in farmers’ fields is mainly attributed to soil fertility depletion. Subsistence-oriented production systems, institutional weakness, and soil fertility deterioration as a result of inadequate use of external inputs are among the mentioned factors that are potentially influencing crop production and productivity (Urgessa, 2014). The study conducted in South Ethiopia revealed that inherent soil fertility, limited access to improved seeds, pests and diseases, erratic rainfall, soil erosion, deforestation, limited access to credit services, weak market linkages, and poor field management practices among the major factors affecting crop production (Yokamo et al., 2018).

The fertilizer use in the country is inadequate to sustain crop production. For example, the N and P consumption in maize production increased from 16 kg ha\(^{-1}\) in 2004 to about 34 kg ha\(^{-1}\) by 2013 (Abate et al., 2015). This amount is below the “Abuja’s Declaration on Fertilizer use for the African Green Revolution” of 2006 in which member states of the African Union adopt to increase fertilizer use to 50 kg ha\(^{-1}\) by 2015. Moreover, nutrient mining due to inadequate external input supply and straw removal, monocropping, bio-physical and institutional factors such as limited access to relevant production inputs, infrastructural underdevelopment, and poor farm mechanization, are also mentioned for their significant contribution to low crop productivity (Anteneh and Asrat, 2020; Tamene et al., 2015). As of late, organic fertilizer has been getting sound attention due to its ability to improve soil quality and thereby crop productivity. Despite its importance, it is not widely adopted and promoted in the country since the households are using it for other competing needs (Abera, 2017).

Planting density is among the most important yield determining factor. Agronomic panel survey (APS), which is conducted in the Oromia and Amhara regions revealed that about 87.5% of farmers maintained their maize planting density below the national recommendation rate (which is 44,444-53,333 plants/ha depending on the variety) at harvest and this contributed to lower grain production (Tesfaye et al., 2019). This is confirmed through the revealed positive relationship between plant density with grain yield and the number of harvested cobs.

Several studies that have been conducted in Ethiopia focused on the adoption of agricultural technology, value chain analysis, and highlighted some determinant factors affecting crop production and marketing (Abebe and Halala, 2020; Degefu et al., 2017; Mazengia, 2016; Chilot and Dawit, 2016). However, only limited information is available in this region, particularly in the study area regarding the maize production trends at household levels and this study was conducted to assess and evaluate the major bottlenecks affecting maize production and productivity in the wider scope. Therefore, this study was conducted with the objectives of evaluating the major factors affecting maize production (socio-economic, institutional, and agronomic factors) at the smallholder farmer’s level and reviewing policy implications.

**METHODOLOGY**

**Description of the study area**

The study was conducted in the Hawassa Zuria district of Sidama region, Ethiopia (Figure 1). Hawassa Zuria district borders Lake Hawassa in the north, Oromia region in the west, Boricha district in the south, and Tula town in the east. It is located at latitude and longitude of 07° 01’ 54” N and 38° 15’ 39” E, respectively, and the altitude of 1700-1850 m.a.s.l. The agro-climatic condition of the district is warm sub-humid lowlands (85%) and sub-humid (15%), with the mean annual rainfall and temperature of 1015 mm and 23.6°C, respectively. The livelihood of the people is mainly based on mixed subsistence farming and crop production involved in the intensively managed small farms. Enset (Ensete ventricosum),
maize, teff, haricot bean, sweet potato, and sugarcane are among the dominant crops grown in the study area.

**Sampling procedure and sample size**

A two-stage sampling technique was employed in the present study. The study district (Hawassa Zuria district) and two villages (Guye Bole and Amol Faja) were selected using the purposive sampling technique due mainly to their maize production potential. A total of 60 household heads involved in maize production were randomly selected from the two villages.

**Data source and collection methods**

The current study used both primary and secondary data. The primary data was collected through pre-tested and semi-structured questionnaires that comprise information related to socio-economic characteristics, institutional and agronomic variables. The questionnaires were designed in a way that enables the collection of relevant information capable of answering the research objectives. The primary data was collected in July 2021 through experienced enumerators who know the local language and culture. The secondary data were collected from different published sources and reports. Several articles were reviewed and relevant information was extracted. Data from the Central Statistical Agency of Ethiopia (CSA) as well as FAOSTAT database were used in the present study.

**Statistical analysis**

Descriptive statistics such as mean, percentage, frequency, minimum and maximum were used to analyze the household-level characteristics and other relevant institutional and agronomic factors. Different data analysis tools such as Microsoft Excel, SPSS V.22, and STATA V.12 were used for statistical analysis; while Sigma Plot V. 12.5 was used to draw figures.

**Model specification**

Multiple linear regression (MLR) model was employed to identify the linear relationship between independent and dependent variables for socio-economic factors affecting maize production. This model was selected because all the sampled respondents are maize producers and also due to its simplicity and practical applicability (Wondim et al., 2020). The general form of a multiple linear regression model is given under Equation 1:

\[ Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \epsilon_i \]  

where \( Y \) = maize production (t ha\(^{-1}\)), \( \beta_0 \) is the intercept, \( \beta_1, \beta_2 \ldots, \beta_k \) are a vector of parameters to be estimated, \( X_1, X_2,\ldots, X_k \) are a vector of explanatory variables and \( \epsilon \) is a disturbance term.

The post estimation diagnostic tests (linearity, normality, and multicollinearity) were conducted to check the validity and robustness of the estimated model.

**Linearity:** The normal probability plot (\( p-p \) plot) was drawn to check the relationship between maize production and the independent (socio-economic) variables. Figure 2 (left) shows that all the observations are laid near the fitted straight line implying a nearly linear relationship between maize crop production and independent variables.

**Normality:** It was checked through a graphical method using a histogram of residual. Figure 2 (right) reveals that the normality assumption is approximately fitted because the histogram of the residuals of the maize production has a bell shape and is unimodal.

**Multicollinearity:** It was detected by a Variance Inflation Factor (VIF) approach. A VIF having a value less than 10 is usually considered as no multicollinearity while a VIF having a value more than 10 is considered as highly collinear. Table 1 shows that the...
variables used for identifying socio-economic factors affecting maize production in the study area have a VIF value of less than 10. The mean VIF value is 3.47 and while the mean tolerance value calculated was 0.472, which means that there is no evidence of multicollinearity in the variables of the estimated model.

RESULTS AND DISCUSSION

Household characteristics of the respondents

The household characteristics of the continuous and categorical variables are presented in Tables 2 and 3. The average age of the sample households is 41.65±15.32 years (ranging from 25 to 88 years). The average educational level of the sample respondents is 5.86 years. The average family size is 5.58±1.9 members. Whereas the dependency ratio ranges from 0 to 5 with an average of 1.05±1.01. The average farm size, farm size allocated for maize, and farming experiences in the study area were 0.77±0.55 ha, 0.68±0.72 ha, and 25.4±13.84 years, respectively (Table 2). The descriptive result on categorical variables revealed that 88.3% of the total sample respondents are male-headed households, while 11.7% are women-headed households. On average, about 91.7% of the sample respondents depend on agriculture. Among the total sample respondents, 96.7% are livestock owners, whereas 53.3% of the respondents have an ox that is
Table 2. Results obtained from descriptive statistics on continuous/quantitative variables.

| Variable                                | Observation | Min | Max  | Mean  | St dev. |
|-----------------------------------------|-------------|-----|------|-------|---------|
| Age                                     | 60          | 25  | 88   | 41.65 | 15.32   |
| Education level (in years)              | 60          | 0   | 15   | 5.86  | 4.57    |
| Family size                             | 60          | 2   | 10   | 5.58  | 1.9     |
| Dependency ratio                        | 60          | 0   | 5    | 1.05  | 1.01    |
| Total farm size (Ha)                    | 60          | 0.15| 2.5  | 0.77  | 0.55    |
| Farm size allocated for maize (Ha)      | 60          | 0.11| 5    | 0.68  | 0.72    |
| Farming experience (years)              | 60          | 2   | 65   | 25.4  | 13.84   |

Source: Survey Result (2021).

Table 3. Results obtained from descriptive statistics on categorical variables.

| Variable          | Category     | Observation | %   |
|-------------------|--------------|-------------|-----|
| Sex               | Male         | 53          | 88.3|
|                   | Female       | 7           | 11.7|
| Income sources    | Agriculture  | 55          | 91.7|
|                   | Salary       | 2           | 3.3 |
|                   | Private works| 3           | 5   |
| Pieces of cultivated land | 1 | 38 | 63.3 |
|                   | 2            | 20          | 33.3|
|                   | 3            | 2           | 3.3 |
| Hired labor       | Yes          | 28          | 46.7|
|                   | No           | 32          | 53.3|
| Livestock ownership| Yes        | 58          | 96.7|
|                   | No           | 2           | 3.3 |
| Oxen ownership    | Yes          | 32          | 53.3|
|                   | No           | 28          | 46.7|

Source: Survey Result (2021).

Maize is the most important strategic crop in the food security of Ethiopia. It accounts first in total production and productivity and second to teff (Eragrostis tef) in area coverage. The data showed that the area coverage and total production of maize exceeded 2.2 million hectares and 9.6 million tons, respectively, while the productivity is about 4.2 t ha\(^{-1}\) by 2019 (Figure 3) (FAOSTAT, 2020). Also, the reported regional (Sidama region) maize productivity is about 4.38 t ha\(^{-1}\) (CSA, 2020). The increase of maize productivity from the 1990s is due to the wide adoption of improved seeds, increased investment in extension systems and seeds, and improved access to markets, to mention a few (Abate et al., 2015). Despite such a yield increase, there was a huge yield gap between actual and potential yields. The result of the current study showed that the yield of maize during the 2019/2020 growing season ranged from 0.5 to 6.5 t ha\(^{-1}\) among the sample respondents and the average yield was 2.05 t ha\(^{-1}\), which is about 104.8 and 113.6% lower than the national and regional average yields, respectively (Figure 4). Moreover, only 8.3% of sample respondents achieved a higher grain yield above the national average. This result revealed the lower yield performance in the study area and thus alarming for exploring the solution to improve its productivity.

Status of maize production

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Figure 3. Maize yield (kg ha\(^{-1}\)), total production (×10^4 tons), and area coverage (×10^4 ha) in Ethiopia from 1993-2019. Source: FAOSTAT database.

Figure 4. Maize grain yield (t ha\(^{-1}\)) of the 2019/2020 growing season in the study area. This yield data is obtained through structured questionnaires by interviewing respondents how much they produced in last season.
Table 4. Estimates of regression analysis.

| Variable                          | Coefficients | Std. error | t-ratio | p-value |
|-----------------------------------|--------------|------------|---------|---------|
| Constant                          | -0.93        | 1.52       | -0.61   | 0.54    |
| Sex (Male=1)                      | -2.02        | 0.56       | -3.58   | 0.001***|
| Age                               | 0.006        | 0.025      | 0.25    | 0.806   |
| Education level (years of schooling) | 0.18        | 0.056      | 3.25    | 0.002***|
| Family Size                       | -0.06        | 0.109      | -0.57   | 0.572   |
| Dependency Ratio                  | -0.16        | 0.14       | -1.13   | 0.26    |
| Total farm size                   | -0.91        | 0.596      | -1.54   | 0.13    |
| Farm size allocated for maize     | 0.604        | 0.66       | 0.92    | 0.36    |
| Farming experience                | 0.02         | 0.027      | 0.74    | 0.461   |
| Total livestock unit (TLU)        | 0.27         | 0.074      | 3.61    | 0.001***|

**Major income source**

- Agriculture: 2.78, 0.97, 2.85, 0.006***
- Private work: 3.05, 1.11, 2.73, 0.009***

Number of observations: 60

F (11, 48): 4.58
R-squared: 0.5122
Prob > F: 0.0001

***Indicates a significance level at 1% probability.
Source: Survey Result (2021).

Major determinant factors affecting maize production in the study area

**Socio-economic factors**

Among the regressed ten variables, four variables could significantly (at 1% of probability level) influence maize production (Table 4). The coefficient of sex (β= -2.02) indicates that when the household head is male, the maize production is decreased by 2.02 t ha⁻¹, ceteris paribus. This finding is in agreement with Asfaw et al. (2012). On the contrary, Gishu et al. (2018) reported that male has relatively better access to the information and thereby adopt the maize variety more than their female counterparts, while Bekele and Guadie (2020) reported a non-significant effects of sex on coffee production.

The coefficient of educational level (β= 0.18) reveals that a unit increase in the education level of a household increases the maize production by 0.18 t ha⁻¹, ceteris paribus. This study is in line with Mazengia (2016). Education is one of the most important variables which likely influence crop production. The study revealed that educated households have a better understanding of accessing useful agricultural technology, formulation, and execution of farm plans and have relatively better access to market information than non-educated households (Gishu et al., 2018; Mazengia, 2016). Moreover, Atinafu et al. (2022) reported that a one-year increase in education attainment significantly (at a 10% significant level) increases the probability of the adoption and intensity of improved wheat production technology by 0.07 and 1.029%, respectively.

The coefficient of total livestock unit (TLU) (β=0.27) reveals that a unit increase of TLU increases the maize production by 0.27 t ha⁻¹, ceteris paribus. The presence of TLU is an important factor for households to easily exchange the livestock into cash and buy different agricultural inputs, produce more manure, and also it serves as compensation at the time of risks such as crop failure. Previous studies reported that households with TLU have more probability to adopt modern agricultural technologies than their counterparts (Gishu et al., 2018; Berihun et al., 2014). The coefficient of the major income source (β for agriculture= 2.75 and β for private works= 3.05) reveals that the households who rely on agriculture and private works produce 2.75 and 3.05 t ha⁻¹ more yield than the households who majorly depend on salary, respectively. This is because the households who mainly depend on agriculture can thoroughly manage their field to get a high yield. Also, a household with a private job can be able to buy improved seeds such as high-yielding variety (HYV) and fertilizers, manage their fields, and hire external labor than full-time salaried HHs. This result is in agreement with Berihun et al. (2014).

**Institutional factors**

The survey results revealed that all the sample respondents in the study area uses improved maize
varieties. Also, about 96.7% of the sample respondents applied chemical fertilizer in the previous growing season (Figure 5). This figure does not depict the intensity of fertilizer use rather than its utilization/adoption by respondents. Access to irrigation is a major factor likely influencing agricultural production. It is an unsurpassed strategy in the region where there are erratic rain and frequent drought. In the present study, about 66.7% of the sample respondents do not have access to irrigation and only 33.7% use traditional irrigation systems. The limited access to irrigation is related to financial constraints to build irrigation canals, expensiveness of motor pumps, lack of awareness, the disintegration of land, and so on. The study revealed that farmers with irrigable land and who use irrigation water have a 9.8 and 23.6% higher probability of adopting chemical fertilizer and HYV as compared to their counterparts (Berihun et al., 2014). Access to extension service is an important variable to disseminate agricultural information to farmers, which helps them to get awakened about the existence and benefits of improved agricultural technologies. It was reported that a producer who has close contact with extension agents produces a higher maize yield (Wondim et al., 2020). Although the government is hugely investing in public extension services, about 41.7% of the sample respondents are not users of extension services in the study area (Figure 5).

Credit is an important variable that facilitates producers to purchase the agricultural inputs to influence the long-term investments in their farms. It significantly impacts the household’s decision of the use of chemical fertilizer and improved varieties (Berihun et al., 2014). In the present study, about 86.7% of sample respondents have no access to credit services. This profoundly influences maize production due to the limitation of cash to buy agricultural inputs. The study demonstrated that credit access significantly influences the probability of adoption and intensity of improved wheat production technology by 0.47 and 6.95%, respectively, ceteris paribus (Atinafu et al., 2022). Rural cooperatives play a vital role in enhancing farmers’ access to different services such as extension and market information. Regarding membership in a rural cooperative, about 85% of the sampled respondents are not a member of any farmers’ organization. Farmers who participate in social activity have better access to agricultural information than their counterparts. A Tobit model result revealed that being a member of any social organization enhances the
probability of adoption and intensity of improved wheat production technology by 0.156 and 2.273%, respectively (Atinafu et al., 2022).

**Agronomic factors**

**Use of organic fertilizer:** The blanket recommendation of nitrogen and phosphorous fertilizer at the national level is among the major challenges affecting soil and crop productivity. The use of organic fertilizer in farmland becomes the most important practice to enhance soil quality and thereby crop productivity. In the present study, about 85% of the total sampled respondents use organic manure in their fields (Figure 6). Regarding straw use, about 88.3% of the sample respondents do not use/return straw into fields (Figure 6); rather they use it for other competing values such as animal feed, fuel for cooking, and so on. Additionally, the survey results showed that farmers who use organic manure and return straw into the fields have obtained a higher yield (45.3 and 16.5%, respectively) than their counterparts as indicated in Table 6. Yengoh (2012) reported that the use of animal droppings and compost improves the soil structure, enhances soil aeration, and increases grain yields.

The application of organic fertilizer is crucial to augment the low nutrient supply status, particularly in low-input and low-output areas including the Hawassa Zuria district. It enhances soil fertility to form a conducive environment for sustainable production (Andong et al., 2019; Liu et al., 2014). Table 5 reveals the positive influence of organic fertilizers on maize yield in different regions of Ethiopia. However, it is very substantial to

| Input type     | Application rate (t ha\(^{-1}\)) | Average grain yield (kg ha\(^{-1}\)) | Yield increases over the control (%) | References                           |
|----------------|----------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|
| Compost        | 5-10                             | 3722.5                              | 21                                  | Laekemarian and Gidago (2013)        |
|                | 5                                | 6132                                | 54.5                                | Negassa et al. (2001)                |
| Farmyard manure (FYM) | 12                               | 6204                                | 20.1                                | Gemechu (2020)                      |
|                | 3-5                              | 6192                                | 14.7                                | Berhanu (2019)                      |
|                | 4-12                             | 6088                                | 61.4                                | Negassa et al. (2005)                |
| Wheat straw (WS) | 3-5                             | 7386.5                              | 36.86                               | Jelde and Shimelis (2019)            |
| WS+FYM         | 6-10                             | 9894                                | 83.3                                |                                     |

Source: Different published sources
Table 6. Average maize yield under a different category of agronomic variables in the study area.

| Variable          | Category | Maize yield (t ha\(^{-1}\)) |
|-------------------|----------|-----------------------------|
| Manure            | User     | 2.15                        |
|                   | Non-user | 1.48                        |
| Straw return      | User     | 2.3                         |
|                   | Non-user | 2                           |
| Planting density  | Low      | 2.57                        |
|                   | Medium   | 1.33                        |
|                   | High     | 1.32                        |
| Weed frequency    | Twice    | 1.43                        |
|                   | Thrice   | 2.37                        |

Source: Survey Result (2021).

Figure 7. Frequency distribution of planting density (A) and weeding frequency (B) among sample respondents.

Plant density: Plant density is among the major yield determining factors that affect crop production and productivity. It affects crop yield by influencing yield components. The majority of maize growers in the study area use the low planting density, that is, below the national recommendation rate. The survey results show that 58.33, 16.7 and 25% of the sampled respondents use planting density of <44,444 (low), 44,444-60,000 (medium) and >60,000 (high) plants/ha, respectively, for planting (Figure 7A). Some respondents perceive that planting densely results in weak crop growth and thereby lower yields. Maize is planted during the rainy season and which increases the probability of lodging at a higher density. In Ethiopia, the optimum plant spacing and density recommended for maize are 75 cm x 30 cm.
Table 7. Frequency distribution of tillage/producing methods among sample households in the study area.

| Tillage methods | Observation | Percentage |
|-----------------|-------------|------------|
| Hand hoe        | 17          | 28.3       |
| Oxen            | 42          | 70.0       |
| Tractor         | 1           | 1.7        |
| Total           | 60          | 100        |

Source: Survey Result (2021).

Table 8. Frequency distribution of sample respondents on the pest and disease incidence and pesticide use.

| Parameter                      | Category | Observation | Percentage |
|--------------------------------|----------|-------------|------------|
| Pest and disease incidence    | Yes      | 46          | 76.3       |
|                                | No       | 14          | 23.3       |
|                                | Total    | 60          | 100        |
| Pesticide application         | Yes      | 11          | 18.3       |
|                                | No       | 49          | 81.6       |
|                                | Total    | 60          | 100        |

Source: Survey Result (2021).

(which is 44,444 plants/ha) (Temesgen, 2019), but it may reach up to 53,333 plants/ha depending on the variety. However, this spacing recommendation has been used for a long time without taking into consideration the various morphological differences that exist among maize varieties as well as edaphic and climatic variations (Tasew, 2021; Temesgen, 2019).

The results showed that planting at lower density gives about 93.2 and 94.7% higher yield than planting at medium and higher density, respectively (Table 6). The reason might be increasing the plant density with inadequate/limited soil nutrients results in yield reduction. As the plant density increases, the available resources to the individual plants decrease. Contrary to this finding, Tesfaye et al. (2019) found a positive and linear relationship between maize grain yield and plant density. However, it is advisable to determine the optimum plant density depending on the environmental factors (soil status and moisture supply) and agronomic management practices of the locality to get maximum yields (Temesgen, 2019; Lakew and Berhanu, 2019).

Weeding frequency: Weeds are a permanent constraint to crop productivity in agriculture. The survey result revealed that 66.7% of the sampled respondents weed their maize field three times while the remaining 33.3% weeds only two times in a growing season (Figure 7B). Weeding three times results in a higher yield advantage (65.7%) over weeding twice (Table 6). The decline of yield with poor weed management is due to the increased inter-competition for soil nutrients, moisture, and sunlight, which resultantly reduces resources use efficiency and affects crop productivity. This finding is in agreement with (Tamene et al., 2015). Therefore, improved field management and on-time weeding are important to enhance crop productivity.

Tillage mechanisms: Among the total sampled respondents, about 70% plough their land by oxen (using their own and hired oxen), while the remaining 28.3% prepare through hand hoe using labour force (including hired labour), and only 1.7% use a tractor (Table 7). The results demonstrated that the use of modern farm mechanization practices is extremely low in the study area. However, the low farm mechanization in Ethiopia, and particularly in the study area, is due to cost, land fragmentation, issues related to cost-benefit (utility), to mention a few. As suggested by Guush et al. (2016), having policies that actively assure widespread availability of appropriate mechanized services to producers at affordable prices, likely impacts Ethiopia’s agricultural transformation.

Pests and diseases: Several biotic and abiotic factors contribute to the low maize productivity in the study area. In this study, about 76.3% of sampled respondents’ fields were infested by some pests and diseases in the last growing season (Table 8). Regarding agro-pesticide use, only 18.3% of sample respondents have applied it (Table 8). The reason is that households may not afford the agrochemicals due to high costs. Recently, the most devastating pest called fall armyworm (FAW)
(Spodoptera frugiperda) became an economically important pest among maize producers in Ethiopia, including the study district. It contributed to low crop production more than any pests from its introduction in 2017 in the country (Assefa, 2018; Keno et al., 2018). The increasing distribution and influence of crop pests and diseases exacerbate future food insecurity and stability of food supplies. Therefore, the development of appropriate strategies such as disease-resistant varieties, adapting and optimizing efficient farming methods, sustainable and integrated pest management, and other crop protection strategies are needed to ensure future food production and security (Keno et al., 2018; Yengoh, 2012).

CONCLUSION AND POLICY RECOMMENDATION

Maize is a strategic crop for food security in Ethiopia and there is a significant margin for fully capturing the increasing domestic market. In this study, the major determinants affecting maize crop production and productivity were evaluated in the Hawassa Zuria district of Sidama region, Ethiopia. Accordingly, socioeconomic, institutional and agronomic factors were found to be the most important factors likely affecting maize production in the study area. Moreover, a wider knowledge gap among farmers was identified regarding the application of suggested agronomic practices. Based on the study findings, the following policy recommendation has made: (i) improving the educational level of households that facilitates better acceptance of agricultural technologies and access to marketing information, (ii) improving accessibility of agricultural inputs such as fertilizer, improved seeds, and credit services to farmers and building irrigation schemes to increase crop productivity and (iii) empowering farmers to adopt and apply a full package of agronomic practices that help to improve soil fertility and thereby crop productivity. However, additional study of this kind across the whole region is important to provide the basic information related to factors affecting crop production and to explore different strategies to reduce the yield gap at household levels.

CONFLICT OF INTERESTS

The authors declare that they have no known competing financial interests.

ACKNOWLEDGEMENTS

The authors greatly acknowledge China Agricultural University (CAU) and Sino-Africa STB project for the invaluable support to conduct the study. They also acknowledge the extension agents for their invaluable support during data collection.

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