On-Farm Diversity of Faba Bean (*Vicia faba* L.) Farmers' Varieties in Eastern Hararghe Zone, Ethiopia

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Abstract

Ethiopia is considered as the secondary centre of faba bean diversity. However, the extent of its diversity at present time is not well known in the eastern Hararghe Zone. Therefore, survey study was conducted from December 2018 to March 2019 to identify patterns of on-farm diversity of faba bean farmers' varieties and their use; and to assess production attributes, constraints, and role of gender in the production and management of faba bean farmers' varieties in eastern Hararghe Zone. Two stratified agro-ecological zones (Tepid moist mid-highland, M3 and Tepid sub-humid mid-highland, SH3) were selected from the zone. Three Kebeles from each agroecologies were randomly selected. From each Kebele, 12 general informants and two key informants based on their gender and wealth status were selected, making a total of 72 general and 12 key informants, a total of 84 informants. Structured and semi-structured questionnaires were used for the general and key informants, respectively. The data were analyzed using descriptive and inferential statistics using R (version 3.5.2) software. Eight farmers' varieties of faba bean were identified. Highest varietal diversity (H = 1.35) was recorded at Gara Abdula kebele of M3 while the lowest diversity value (H = 0.81) was at Obi Kutir 1 kebele of SH3. Variety Safisa was reported for its highest market price (32.8 ETB kg^{-1}) and variety Dabale was the highest yielder (1900 kg ha^{-1}). Most farmers (94%) use traditional seeds and 72% of farmers grow faba bean on < 0.125 ha land area. Baqela Faranji was the widely (33%) cultivated variety. Diseases (100%), weeds (89%) and land shortage (85%) were the main faba bean production constraints. Roles of male adult and female adult family members take the upper hand in all faba bean production and post-harvest management activities. In conclusion, expansion of chat crop and shortage of land are the major reasons for low faba bean diversity.

1. Introduction

Faba bean (*Vicia faba* L.) is one of the earliest domesticated food legumes in the world (Singh et al., 2013). It is the fourth important pulse crop in cultivated area and production in the world after dry bean (*Phaseolus* sp), dry peas (*Pisum sativum ssp. arvense*) and chickpeas (*Cicer arietinum* L.) (Kumari and van Leur, 2011). It is believed that Central Asia is the origin for faba bean, whereas secondary centres of diversity are postulated in Ethiopia and Afghanistan (Hajjar and Hodgkin, 2007).

Faba bean is among the most important pulse crop in Ethiopia having elevations of 1800 - 3000 meters above sea level and receiving average annual rainfall of 700 - 1100 mm. It was the first crop among the pulses grown in the country both in terms of area coverage and volume of annual production (CSA, 2020). The production obtained from faba beans was 3.10% of the grain production (CSA, 2015). Faba bean grows in several eco-geographical regions of the country including Arsi and Bale highlands, Central highlands of Ethiopia (South-West, West and North Showa), Tigray, North and South Wollo, North and South Gondar, East and West part of Gojam, Wollega, Guji highlands, Hadiya, Sidama and Gamogofa (Asnakech, 2014). It has an ability to grow over a wide range of climatic situations and broad adaptability to a range of soil conditions (Yahia et al., 2012). It has high nutritional value and it is used almost daily in human diet of many Ethiopians (Teklay *et al.*, 2015).

In the recent developed intensive cropping systems, crop diversity is reduced to one or very few species that are genetically homogeneous. Sustainable management of crop genetic resources assure crops diversity, both in trust collections or gene banks (*ex-situ*) and on farms (*in-situ*) (Smale, 2006; Mintewab, 2008). For farmers, crop diversity is important to combat production risks found in the changing environments. Understanding farmers' preferences for crop attributes and their incentives to grow diverse varieties are critical to the success of on-farm conservation (di Falco et al, 2010). Many farmers still depend on a few varieties and mostly prefer to grow their own varieties due to its better selling price locally, environmental adaptability (resistance to drought, poor soil and frost occurrences), cooking quality, better suit with their production system, and yield stability of the variety despite occurrences of disease and pest problems (Tafere *et al.*, 2012).

Effective on-farm management and conservation of genetic resources takes place where the genetic resources are valued and used to meet the needs of local communities. The probability that farmers choose to cultivate a certain crop variety, on the other hand, is dependent on the key attributes the farmers associate with the variety. Faba bean research in Ethiopia focused mostly on developing varieties released from research centres (Asnakech, 2014) and has given less emphasis on studying its diversity and improving quality traits of preferred farmers' varieties. Therefore, it is imperative to investigate the diversity of faba bean farmers' varieties grown in the study area for further research work. Hence, the objectives of this study were to identify patterns of on-farm diversity of faba bean farmers' varieties grown, their uses, and management practices in eastern Hararghe Zone; and to assess production attributes, production constraints, and the role of gender in the production and management of faba bean farmers varieties in eastern Hararghe Zone, Ethiopia.

2. Materials And Methods

2.1. Description of the study area

The study was conducted in eastern Ethiopia of Oromiya regional state, east Hararghe Zone, in Deder, Kersa, Meta, and Jarso districts. East Hararghe Zone is characterized by plateaus, rugged mountains, deep gorges and flat plains. It is located at latitude: 7°30´ - 9°45´N; longitude: 41°10´ - 42°50´ E; altitude: 500 - 3040 meters above sea level. It receives a rainfall of 400 - 2000 mm and an average minimum and maximum temperature of 10 - 25°C (Degefa and Tesfaye, 2008). The major crops grown in eastern Hararghe Zone include sorghum and maize are cultivated as sole and also intercropped with other crops like chat, common bean, faba bean, field pea, sweet potato, potato, etc. Vegetable crops like cabbage, onion, tomato, and fruit crops like mango, banana, and papaya are some of crops grown in the zone (CSA, 2014).

2.2. Informant selection, sampling sizes and procedures

Two stratified agro-ecological zones (Tepid moist mid-highland, M3 and Tepid sub-humid mid-highland, SH3) were selected from the zone based on an agro-ecological classification developed by the Ethiopian Institute for Agricultural Research (EIAR, 2011). Potential faba bean producing districts were purposively

selected from each agro-ecological zone to represent the two production systems and three sub-districts (*kebeles*) were randomly selected from each agroecology. The survey included 12 randomly selected farmers from each *Kebele* by considering the wealth status and gender of the farmers (6 low-income and 6 middle to high-income households among which 3 women from high-income households, 3 men from high-income households, 3 women from low-income households and 3 men from low-income households), making a total of 72 general and 12 key informants, a total of 84 informants. Structured and semi-structured questionnaires were used for the general and key informants, respectively. The purpose of the study was explained to the informants and prior informed oral consent was obtained before the study was conducted.

2.3. Major data collected

Quantitative and qualitative ethnobotanical primary data were collected on faba bean farmers' varieties from the informants. The structured surveys applied with general informants were documented using Open Data Kit (ODK), an application on the smart phone. The semi-structured interview questions employed and interviewed the key informants and transcribed into a Microsoft Excel spreadsheet. A sample of seeds for each variety that were named by the farmers in that *Kebele* was collected. During the study, market values of faba bean farmers' varieties in the local markets were done and recorded the prices of faba bean varieties in Ethiopian Birr per kg.

2.4. Methods of data analysis

Ethnobotanical data were analyzed through descriptive and inferential statistical analysis using R software of version 3.5.2. Microsoft Excel was used for its graphic visualization. A two-factor analysis of variance (ANOVA) was conducted to determine whether there were significant differences in the area planted to agro-ecological zone followed by a post hoc Tukey test to identify pair-wise significance. The diversity of faba bean varieties across the study kebeles and agro-ecological zones were subjected to Shannon Diversity Index (SDI) analysis as:

$$H' = -\sum_{i=1}^{s} pi \ln(pi)$$

Where: *pi* is the proportion of the total number of varieties in the ith class and n is the number of households producing faba bean.

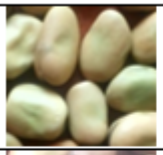
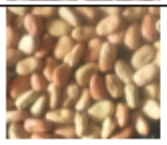
3. Results And Discussion

3.1. Faba bean farmers' variety identification

Thirty six respondents (18 male and 18 female) of faba bean growing farmers from each agroecology (M3 and SH3) participated in the interview having different age ranges. The age of respondents ranged from 18 to over 60, and the greatest number of informants were between the ages of 31 to 45 years. Farmers have developed traditional naming systems for faba bean varieties they grow in both SH3 and

M3 production areas. Based on the names and descriptions given by farmers, eight faba bean farmers' varieties were identified (Table 2.1). These farmers' varieties varied in seed size, colour, maturity, yield potential, and other agronomic traits. The names given by the farmers are also related to those characters. For example, of the eight local names given by the farmers the names *Baqela Faranji* and *Baqela Habasha* were referred to their seed colour as they were cream and brown, respectively. *Batte* refers to multiple traits describing the seed shape and size as flat and very big, respectively. *Dabale* name was related with its high yielding capacity. *Dhera* refers to the crops morphology related to its growth habit as it grows tall. *Hadho* is the name given to the faba bean farmers' variety that was cultivated for long period of time and transferred from generation to generation and experienced a long cultivation history in the farming society. Very small size is the characteristic feature of the name *Bukuri* that one key informant described as this farmers' variety has as similar taste as that of field pea. The name *Safisa* refers to relatively early maturing faba bean farmers' variety and two key informants said that it matures in 90 days.

Table 2.1. Name of faba bean farmers' variety, images, and collection site in 2017 and 2018, east Hararghe Zone, Ethiopia

No	Local name	Amharic name	Translation of local name	Image of seeds	Collection from		
					Kebele	District	AEZ
1	*Baqela Faranji*	*Yeferenji Baqela*	White peoples' faba bean		Burka Jalela	Meta	SH3
2	*Baqela Habasha*	*Yehabesha Baqela*	Black peoples' faba bean		Obi Kutir 1	Deder	SH3
3	*Batte*	*Teftafa*	Flat faba bean		Rameta	Qersa	SH3
4	*Dabale*	*Techemere*	Additional (in yield)		Burka Jalela	Meta	SH3
5	*Bukuri*	*Tininish*	Small		Obi Kutir 1	Deder	SH3
6	*Hadho*	*Enat*	Mother of seed (many years stayed)		Afgug	Jarso	M3
7	*Dhera*	*Rejim*	Tall		Gara Abdulla	Jarso	M3
8	*Safisa*	*Fetan*	Speedy (early maturing)		Gara Abdulla	Jarso	M3

NB: AEZ = Agro-ecological zone, SH3 = tepid sub-humid mid highlands, M3 = tepid moist mid highlands

Table 2.2
Name of faba bean farmers' variety, identification criteria, and uses in 2017 and 2018, east Hararghe Zone, Ethiopia

No	Local name	Identifying character	Advantages reported	Seed size	Culinary uses	Non-culinary uses
1	*Baqela Faranji*	Seed colour (cream)	Higher yield, pest resistant	Big	Shiro, Ashuqi, vegetable	Fodder, fuel
2	*Baqela Habasha*	Seed colour (light brown)	Very good taste	Medium	Shiro, Ashuqi, vegetable	Fodder, fuel
3	*Batte*	Shape (flat)	Big size and good for eating alone	Very big	Shiro, Ashuqi, vegetable	Fodder, fuel
4	*Dabale*	Medium size seed	Higher yield, pest resistant	Small	Shiro, Ashuqi, vegetable	Fodder, fuel
5	*Bukuri*	Small seed and plant height	Very good taste like field pea	Very small	Shiro, Ashuqi, vegetable	Fodder, fuel
6	*Hadho*	Seed is big and grow tall height	Good for *fuli*, *ashuqi*, *nifiro*	Big	Shiro, Ashuqi, vegetable	Fodder, fuel, soil fertility
7	*Dhera*	The plant height is very tall	Soil fertility, animal feeding	Big (Cream)	Shiro, Ashuqi, vegetable	Fodder, fuel, soil fertility
8	*Safisa*	Seed colour (cream)	Soil fertility, early maturing	Medium	Shiro, Ashuqi, vegetable	Fodder, fuel, soil fertility

3.2. Faba bean farmers' varieties distribution and diversity

3.2.1. Distribution of faba bean farmers' varieties in both agroecologies

Distribution of farmers' varieties across agroecology and in the whole eastern Hararghe Zone was studied for its type of farmers' varieties grown and the proportion of farmers cultivating the faba bean farmers' varieties. The types of faba bean farmers' varieties grown by the farmers of the two agroecologies were different (Figure 2.2). The result of the study indicates that the farmers in M3 agroecology grow more number of faba bean farmers' varieties than the farmers in SH3 agroecology. Five varieties in SH3 and six varieties in M3 agroecologies were grown by the farmers. *Baqela Faranji*, *Baqela Habasha* and *Batte* were

cultivated in both agroecologies of the study area. *Dabale* and *Bukuri* were the two varieties only grown in SH3 whereas *Hadho*, *Safisa* and *Dhera* were grown in M3 agroecology only.

In SH3 agroecology, about 53% of the farmers grow *Baqela Faranji* followed by *Baqela Habasha*. However, a few farmers (3%) grow *Bukuri* variety. Majority of the farmers (44%) grow faba bean variety *Hadho* in M3 agroecology and the lowest numbers of farmers grow *Baqela Habasha* and *Batte* (8%). The varieties that were popularly grown by the farmers could be those giving preferred traits in addition to reasonable yield under stress conditions and provide the necessary values for the smallholder households. Asnakech (2014) reported that farmers have some specially preferred traits which may not be considered by breeders stating that 13.4% of the respondents preferred the local landraces for their good biomass, and 19.4% for their resistance to disease and very few respondents (2.4%) preferred the landraces due to the unavailability of improved faba bean varieties.

The proportions of farmers cultivating the documented faba bean farmers' variety types in both agroecologies were analysed (Figure 2.3). The survey results indicate that farmers in east Hararghe zone grew a total of eight faba bean farmers' varieties. Among these farmers' varieties, *Baqela faranji* was the widely cultivated faba bean farmers' variety (33%), followed by *Hadho* (22%) by the interviewed farmers in the study area. *Bukuri* was the variety cultivated by a few farmers (1%) participated in the interview.

3.2.2. Faba bean farmers' varieties richness and diversity

The faba bean crop grown in the study area was compared against other legume crops for its interspecific diversity (Figure 2.4). Accordingly, all faba bean growing farmers in both agroecologies also grow majorly fenugreek (75%) in M3 and field pea (66.67%) in SH3 agroecologies. A few farmers (2.78%) grow chick pea in SH3 and 5.56% of the farmers in M3 agroecology grow common bean. Key informants mentioned that fenugreek seed is among the essential seed to prepare the sauce called *Hulbeta* which is commonly consumed in Hararghe area with *injera*.

The result of the study indicates that the faba bean farmers' varieties richness and diversity for each *kebele* was different (Table 2.3). The number of varieties (varietal richness) per household is the same (1) in all *kebeles*. The total number of faba bean farmers' varieties (gamma diversity) was higher (5) in *Gara Abdula* and *Afgug*, followed by *Efa Jalela* (4) in which all *kebeles* were located in M3 agroecology. However, the varietal richness has slightly lower in SH3 agroecology in which three varieties were recorded in each *kebele*. The reason for the diversity decline in SH3 agroecology was the substitution of faba bean crop production fields to *chat* crop areas forced the loss of diversity of faba bean in the area. According to Taye and Aune (2003) reported *chat* production in Habro district, is rapidly replacing cereal and coffee production fields.

The Shannon-Wiener Diversity Index analysis, the highest value of varietal diversity (H = 1.35) was recorded in Gara Abdula *kebele* of M3 agroecology. The lowest SDI (H = 0.81) was recorded from Obi Kutir 1 *kebele* of SH3 agroecology. Generally, the index values are higher in tepid moist mid highland (M3)

and slightly lower in tepid sub-humid highland (SH3) areas. Such low Shannon diversity values in *kebeles* found under SH3 indicate that most of the area planted to faba bean is dominated by only three number of faba bean varieties having similar varieties. Beside to replacing the faba bean to *chat* farming land which causes crops declines diversity, the farmers also continue to grow the faba bean variety which best suit to their agroecology putting other varieties aside. Similar report was presented by Mulugeta (2017) where the lowest SDI (0.9) of field pea was recorded for SH3 agroecology compared H3 and M3 agroecologies.

Table 2.3
Varietal richness and diversity of faba bean farmers' varieties at *kebele* levels in east Hararghe Zone during 2017 and 2018 cropping season (n = 72, or 12 per *kebele*)

Agroecology	*Kebele*	Total variety listed	Varieties per household	Diversity index			SDI
				Alpha diversity	Gamma diversity	Beta diversity	(H)
Tepid sub-humid highlands (SH3)	Rameta	12	1	1	3	3	1.03
	Burka Jalela	12	1	1	3	3	0.99
	Obi Kutir 1	12	1	1	3	3	0.81
Tepid moist mid highlands (M3)	Gara Abdula	12	1	1	5	5	1.35
	Efa Jalela	12	1	1	4	4	1.30
	Afgug	12	1	1	5	5	1.12

3.3. Use values of faba bean farmers' varieties

The respondent farmers in eastern Hararghe zone use faba bean for different purposes (Figure 2.5). The crop is used for food (100%) and as fodder (100%) for their livestock feeding purposes in both selected agroecologies. About 83% of the farmers in M3 and few farmers (3%) in SH3 agroecological zones used faba bean for market purposes. Similarly, 78% of the farmers in M3 and 53% of the farmers in SH3 agroecological zones used the crop as a fuel and 6% of the respondent from SH3 agroecology used faba bean varieties for bee forage. The high protein content of faba bean makes it to be preferred for consumption by the farming communities.

Human consumption (food) value

The respondents revealed the importance of faba bean farmers' varieties (Figure 2.6a) and ranked variety *Bukuri* (100%) as the extremely important variety for consumption. The key respondents explained that *Bukuri* variety was preferred for its taste and used to prepare the best quality *wot* like field pea. All of them (100%) also ranked *Dabale* and *Dhera* varieties as a very important variety. Key informants indicated that different types of foods are prepared from faba bean such as sauces (*Kiki* and *Shiro wot*), *Shumo* (boiled beans), *Ashuqi* (roasted and boiled), *Fuli* (split and boiled sauce mainly consumed with bread), and *Asheti* (raw green) are the major food types that farmers prepared from seed of faba bean. The result from key informants indicated that *Baqela Habasha* and *Bukuri* are mostly preferred to prepare *Kiki* and *Shiro wot* due to its good taste due to its inherent genetic difference compared to other faba bean farmers' varieties. The genetic characteristics of faba bean varieties has sufficient variability in carbohydrate, fiber, and protein contents and quality that can determine the taste and cooking qualities for consumption (Gasim et al., 2015). However, all varieties are equally preferred for *Shumo*, *Ashuqi* and *Asheti*. Asnakech *et al*. (2016) reported that faba bean local landraces were preferred by most of the farmers (64.8%) for their good food quality and better price on the market.

Fodder value

The respondent farmers mentioned the fodder value of faba bean residue obtained after harvest for livestock consumption (Figure 2.6b). About 67% of the respondents reported that *Dabale* variety was very important for its fodder value followed by *Batte* (50%) and *Safisa* (40%). The key informant farmers relate the fodder quality of the varieties with their high biomass production and ease of palatability to the livestock.

Soil fertility management value

The response of farmers for preferred values of faba bean varieties towards soil fertility management was presented in figure 2.6c. All of the respondents preferred variety *Batte* followed by *Baqela Faranji* (83%) as they have a very positive effect on soil fertility management in their farm. About 100% respondents responded as the variety *Baqela Habasha* and *Bukuri* have only positive effect in soil fertility management role. Faba bean is normally a legume crop capable to fix free nitrogen that increase soil fertility as the expense of the varieties ability to symbiosis with the rhizobia for nodulation. According to the report of Anteneh and Abere (2017), the effectiveness of faba bean nodule in nitrogen fixation depends on the variety of the crop and its ability to symbiosis with the rhizobia found in soil.

Importance for income

The result of the study showed (Figure 2.6d) variety *Batte* (33%) the extremely important faba bean farmers' variety fetching high income. All the respondents (100%) equally responded *Dabale*, *Bukuri* and *Safisa* were the very important varieties for their income value. However, a few respondents (8%) and (6%) reported *Baqela Habasha* and *Hadho*, respectively, as not so important for their market value. The reasons for the variability of faba bean varieties in market value were the consumers' preference towards

the varieties for its seed size, taste, ease of cooking, tolerant to natural calamities, straw, palatability, and seed storability (Asnakech *et al*., 2016).

Table 2.4
The combined result of two years average yield and price of faba bean farmers' varieties in eastern Hararghe Zone (2017 and 2018 cropping season)

No	Faba bean varieties	Average yield (kg ha-1)	Average price (ETB kg-1)
1	Dabale	1900	17.33
2	Baqela Faranji	1442.5	19.63
3	Baqela Habasha	1264.5	21.92
4	Batte	1071	29.5
5	Hadho	951.5	31.81
6	Dhera	949	31
7	Safisa	890.5	32.8
8	Bukuri	933.5	18

The relationship between the average seed yield and average market value in Ethiopian Birr (ETB) of faba bean farmers' varieties produced in East Hararghe Zone is shown in Table 2.4. The price of one kg of *Safisa* (32.8 ETB kg^{-1}) variety seed was highest as compared to the other farmers' varieties seeds obtained from the zone. However, *Dabale* (17.33 ETB kg^{-1}) and *Bukuri* (18 ETB gk^{-1}) were the cheapest varieties in the study areas. The low price values in some areas were related with the distance of the producers from consumers in need as the big markets were too far from the potential farming communities producing ample amount of yield.

3.4. Important Attributes of faba bean farmers' varieties

Important characteristic features of the eight faba bean farmers' varieties collected from the study area were ranked by the farmers for selected properties (Figure 2.7). The ranking result revealed that all varieties do not produce high yield at times of drought (Figure 2.7a). However, the variety *Bukuri* produced medium yield; however, *Safisa* and *Baqela Habasha* gave very low yield during drought time than other varieties. Faba bean is a cool season crop that requires sufficient moisture to grow and yield high. It has relatively shallow roots, thus the crop may suffer from drought stress in soils that dry quickly (Asnakech *et al*., 2016). Farmers ranked Bukuri farmers' variety as the variety relatively sometimes affected by frost followed by *Batte* (Figure 2.7b). However, *Safisa* rarely affected and relatively resistance to frost. The ranking result made by farmers' for resistance to common diseases showed that *Batte*, *Bukuri* and *Dabale*

varieties were sometimes affected by common diseases in the study area (Figure 2.7c). Two key informants explained as *Safisa* and *Hadho* varieties were the more tolerant varieties to common diseases. This may be due to genetic variation between varieties. Comparison based on taste for human consumption showed that *Bukuri* and *Baqela Habasha* are the varieties that have very good taste (Figure 2.7d). Three key informants also explained that *Bukuri* and *Baqela Habasha* taste is similar to that of field pea taste and more preferred to prepare *wot* (Ethiopian sauce). Both varieties also resemble in possessing small seed size and the inherent genetic difference in seed nutrient content of the varieties made them to be very good in taste. According to the report of Gasim et al. (2015), the genetic characteristics of faba bean varieties determine the nutrient constituents in the seed and the taste qualities of the varieties.

3.5. Production and related aspects of faba bean farmers' varieties

3.5.1. Seed source of the varieties

The respondents grow traditionally obtained faba bean which the farmers handled for long period of time and newly released varieties from research centre and universities on their farm (Figure 2.8a). The survey results indicated that majority of the respondent farmers grow traditional (94%) faba bean farmers' varieties and only 6% of the respondent farmers grow new faba bean varieties.

Respondent farmers reported that they obtain the seeds of faba bean varieties from different sources such as family, market, neighbours and formal through universities and research centres (Figure 2.8b). About 47% of the farmers obtained the seed of the traditional varieties from their family members like their fathers, uncles, brothers for the first time and 35% of the respondents obtained from market and 13% obtained seeds from their neighbours. Only few (3%) respondents reported as they got new improved variety from the market for the first time and 3% of the respondents mentioned that they got new variety from formal way. This was due to the reason that the farmers' access to get improved faba bean varieties from formal institutions was very limited. Similar result was reported by Asnakech (2014) that the main source of faba bean seed was farmer to farmer seed exchange as indicated by 42.9% of the respondents, while 27.2% obtained the seed from their parents, 11.6% purchased from the market, and 7.5% of the farmers from Ministry of Agriculture (MoA).

3.5.2. Growing experience and site of plantation

The farmers participated in the interview have been growing different faba bean varieties for a varied years in the study area (Figure 2.9). The result showed that the respondents grown *Baqela Faranji* (46%), *Baqela Habasha* (38%), *Bukuri* (100%), *Hadho* (20%), and *Safisa* (56%) faba bean farmers' varieties for greater than ten years in the study area.

Farmers of the study area participated in this interview reported that planting location and the soil fertility status on which they plant faba bean varieties (Figure 2.10a). According to the respondents, all farmers in *Efa Jalela kebele* (100%) and most farmers in *Burka Jalela kebele* (92%) plant faba bean in their main crop fields. About 33% of the respondents planted faba bean in their home gardens in *Obi kutir 1* and a small fraction of the interviewed farmers in *Gara Abdula* (6%) plant faba bean in their field margins.

Farmers in *Afgug kebele* (83%) and *Efa Jalela* and *Rameta* (both 75%) plant faba bean on low fertile soil (Figure 2.10b). On the other hands, in *Obi Kutir 1* and *Burka Jalela* (58%) the respondents reported that they plant faba bean varieties on soil having medium fertility status. None of the farmers interviewed in the study area reported planting of faba bean in high fertile soil. The reason that the farmers use low soil fertility is that faba bean has a capacity to fulfil its nitrate need through fixing free nitrogen from air. Grain legumes grown in poorly fertile fields contributed more net N to the soil and a better potential for net N benefit by growing grain legumes in poorly fertile fields as observed by Kermah et al. (2018).

3.5.3. Area of the farms covered by faba bean

The farmers in eastern Hararghe Zone grow faba bean in different size of land (Figure 2.11). The result of the study showed that the average farm size of faba bean for the low income farmers was 0.091 ha and for the mid to high income farmers was 0.163 ha. The largest area the farmer possessed for faba bean production was 0.375 ha in the study area. The relatively wider areas of faba bean land were possessed by mid to high income farmers. The majority of the respondents (72%) possess less than 0.125 ha of land for growing faba bean. Negligible number of farmers (1%) have greater than 0.375 ha of land ready for faba bean sowing in one cropping season. Some key informants reported that the growing area of faba bean since recent years was getting low due to land shortage and large area of farm covered by *chat* plant. This was caused by high population density in the zone and farmers possessed an average farm size of 0.65 ha per household (Lemma and Wondimagegn, 2014).

Influence of agroecology and kebele **on faba bean growing area**

The area planted to faba bean by the respondent farmers varied between agroecologies and *kebeles* (Table 2.5). The farmers' faba bean growing area was not significantly ($p > 0.05$) different between agroecologies in 2018 cropping season. However, the result of Tukey test indicated that the growing area was significantly ($p < 0.05$) varied between the agroecologies during 2017 cropping season and higher value (0.13 ha) of growing area was recorded in SH3 agroecology. This indicates that there are good growing conditions like enough land, climate and availability of production inputs in SH3 of the 2018 cropping season. In contrast to this result, Menbere (2017) reported non-significant difference in cropped area of common bean due to agroecologies.

The growing area was also significantly ($p < 0.001$) varied among *kebeles* in both 2017 and 2018 cropping seasons (Table 2.5). The highest faba bean area of production was recorded at Obi Kutir 1 *kebele* both in 2017 (0.26 ha) and 2018 (0.266 ha). Key informants in Obi Kutir 1 explained as there is relatively enough farm size in the *kebele* and the growers allocated higher area of land to grow faba bean.

Betelhem *et al*. (2020) also reported significant differences in production areas in which on average, households in East Gojjam Zone planted more land to common bean (0.57 ha), followed by South Wollo (0.43 ha), Kefa (0.20 ha), and Bench Maji and Sheka (0.14 ha).

Table 2.5
Mean cropped area (ha) of faba bean per household as affected by *kebele* and agro-ecology in east Hararghe Zone in 2017 and 2018

Kebele	**Cropped area (ha)**	
	2017 (yr)	**2018 (yr)**
Burka Jalela	0.073b	0.078b
Obi Ku 1	0. 260a	0.266a
Rameta	0.066b	0.078b
Afgug	0.092b	0.108b
Epa Jalela	0.083b	0.114b
Gara Abdula	0.094b	0.13b
P - value	1.61e-15***	2.4e-08***
Agroecology		
Tepid, moist mid highlands (M3)	0.09b	0.12
Tepid, sub-humid highlands (SH3)	0.13a	0.14
P - value	0.0238*	0.288ns

NB: The cropped area includes the sole crop area and area under intercropping. Means followed by the same letters are not significantly different according to Post Hoc Tukey's test (α = 5%), *ha* = hectare, *Kebele* = sub-district.

Influence of wealth status on area of faba bean production

The impact of wealth status on faba bean cropped area of farmers in eastern Hararghe Zone was analysed using t-test (Table 2.6). The result showed that area of faba bean the farmers possessed was not significantly ($p > 0.05$) affected by the wealth status of the farmers in 2017 cropping season. However, wealth group has a significant ($p < 0.001$) impact on farm size of faba bean in 2018 cropping season. The cropped area in 2018 by the mid to high income group was higher (0.17 ha) than the low income group (0.09 ha) which may be due to the large land area possessed by the mid to high income

group and they proportionally allocate more land area to faba bean compared to low income group farmers. Similar result was reported by Betelhem *et al*. (2020) in that the mid-to-high income (0.39 ha) group planted significantly more common bean than low income (0.29 ha) group in 2015/16 cropping season in Bench Maji, Sheka, Kafa, east Gojjam and south Wollo.

Table 2.6
Mean value of faba bean farmers' varieties cropped area (ha) as affected by wealth group of farmers in east Hararghe Zone in 2017 and 2018 (n=72)

Wealth	Area of faba bean planted	
	2017 cropping season	2018 cropping season
Low income	0.38a	0.37b
Mid to high income	0.51a	0.67a
Means followed by the same letters are not significantly different according to t-test at 5% level of significance.		

3.5.4. Cropping practices

In the study area of both M3 and SH3 agroecologies, faba bean was planted as an intercrop or in rotation with other crop species by all respondent farmers (Figure 2.12a). Accordingly, most of the farmers (50%) in SH3 agroecology plant faba bean in intercropping with maize, and with *chat* and potato (33% each). In the M3 agroecology, faba bean is frequently intercropped with *chat* (47%), and less frequently with barley (11%). Three key informants explained that intercropping is usually practiced as crop intensification package in response to the shortage of land per household as a result of rise in population, to maximize profit and to minimize risk, moisture saving and to maintain soil fertility in the area. Similarly, Jima and Birhanu (2017) reported that all of the respondents participated in the interview practicing intercropping of different crops in west Hararghe Zone.

Farmers in the SH3 agroecology rotate faba bean frequently with maize (47%) and barley (42%) and less frequently with potato (6%) as shown in Figure 2.12b. In M3 agroecology also the respondents reported that they rotated faba bean mainly with wheat (43%) followed by maize (40%), garlic (36%), onions (29%), and less frequently with cabbage (10%) (Figure 2.12b). Five key informants explained that they plant faba bean in rotation in every year, every second or third year on the same field to increase yield of cereal crops involved in rotation. This is in agreement with the reports of Angus et al. (2015) that the yield of wheat after two successive legume break crops was 0.1 - 0.3 t ha^{-1} greater than after a single legume break crop.

3.5.5. Time of sowing

According to the response of faba bean growers participated in the interview, planting of faba bean varieties differs in time (Figure 2.13). Accordingly, the respondent farmers reported that the preferred time

of sowing of faba bean farmers' varieties can be extended from early June for *Baqela Faranji* (4% of the respondents) up to mid July for *Safisa* variety (40% of the respondents) in the study area. Key informants mentioned that the time of planting of the varieties is highly dependent on type of varieties and the onset of rainfall. Similar reason was suggested by Mulugeta (2017) for the planting time of field pea in Arsi and Kefa Zones.

3.5.6. Time of harvesting

The main harvesting time of faba bean farmers' varieties were identified by the interviewed farmers (Figure 2.14). Majority of the faba bean grower respondents (46%) reported that *Baqela Faranji* variety is harvested at the beginning of December, for *Baqela Habasha* (54%) in late December, for *Dabale* (67%) in early December, for *Bukuri* (100%) in mid November, for *Dhera* (100%) in mid December and *Safisa* (40%) in mid November. Key informants said that the harvesting time depends on the planting time that is influenced by the onset of rainfall in the cropping season.

3.6. Yield of faba bean farmers' varieties

The yield of faba bean farmers varieties produced in East Hararghe Zone was analyzed based on farmers yield obtained report. The faba bean farmers' varieties in the study area were different from each other in their average yield (Figure 2.15).

As it can be seen from the result of the two consecutive years (2018 and 2019 cropping years), the highest average yield was recorded for *Dabale* (1900 kg ha^{-1}) and the lowest average yield was recorded for *Safisa* (890.67 kg ha^{-1}). The low yield of these varieties might be due to the inherent genetic variation and shortage of moisture during 2018 growing seasons. In line with this result, Tafere *et al*. (2012) reported grain yield of ten faba bean varieties ranged from 450 kg ha^{-1} to 2490 kg ha^{-1} in which Selale (2500 kg ha^{-1}) was the highest yielding and Gebelcho (450 kg ha^{-1}) were the lowest yielding varieties. Four key informant farmers suggested that those faba bean farmers' varieties can perform better if accompanied by recommended cultural practices.

3.7. Production constraints of faba bean farmers' varieties

The potential production constraints of faba bean in the study area were mentioned by the informant farmers (Figure 2.16). According to the results, the major faba bean production constraint in the study area was the diseases (100%), followed by the weeds (89%). Four key informants reported that rust (*Uromyces fabae*) and chocolate spot (*Botrytis fabea*) were the dominant disease affecting faba bean production in the area. They mentioned that *cuqi* (*Galinsoga parviflora* L.), *coqorsa* (*Cynodon dactylon* L.), parasitic weed (*Orobanche* sp) and *migira sare* (*Digitaria* sp) among important weeds grown in faba bean farm. Shortage of land (85%) and insect pests (68%) are also very important constraints hindering production of faba bean in the study area. Similarly, Asnakech *et al.* (2016) reported that most of the respondents (87.9%) of Finfine Special, Arsi and North Showa Zones reported faba bean chocolate spot disease as a major problem for faba bean production. Teklay *et al.* (2013) also reported that parasitic weeds like *Orobanche crenate* affect the yield of faba bean in Ethiopia.

3.8. Management practices of faba bean farmers' varieties

The respondents from both agroecologies practiced no chemical method of insect pest and common diseases control measures. Some of the reasons mentioned for not using any pest control measures by key informants were that they cannot afford to buy the chemicals and some of the farmers lack awareness towards the impact of pests and diseases on the yield of faba bean.

Weed control

The majority (78%) of the respondents used hand weeding for controlling weeds grown in faba bean farm. Some of the farmers used hoeing (14%) and few respondents (8%) used slashing as weed controlling options in the study area. Some key informants reported that some farmers used non selective herbicides before sowing of faba bean to control weeds.

Soil fertility management

The soil fertility management practices of the informants were analysed (Figure 2. 17). The result of the study revealed that most of farmers applied compost as the source of soil fertility management system in all *kebeles* except for *Gara Abdula* where 50% of farmers did not applied any soil fertility management practices. All respondents in *Burka Jalela* applied compost (100%) and besides to compost 25% of them also applied manure as the soil fertility management methods on their faba bean farms. Key informants reported that no farmer used inorganic fertilizers such as DAP, Urea and NPS in their faba bean farms. They believe that those inorganic fertilizers increase vegetative growth of faba bean crops and lead to lodging. However, inorganic fertilizer application as the starter is essential to be applied for faba bean production as reported by MoARD (2008) that 46 kg ha^{-1} P_2O_5 and 18 kg ha^{-1} N_2 is the amount of recommended inorganic fertilizer for faba bean variety Gachena.

3.9. Role of gender in production and management of faba bean

Regarding the gender roles, the respondents reported that the participation of female elders in faba bean production and management was nil in *Meta* district, 17% in *Qersa*, 25% in *Deder*, and 14% in *Jarso* districts (Figure 2.18). The participation of male adults in all districts was the highest (100%) and the female adults were also highest at *Qersa* and *Deder*, but 97% at *Jarso* and 92% at *Meta kebele.* Less participation of male elders also reported in *Meta* (8%) district. Key informants mentioned that elders and children less participated in faba bean production as it needs more energy and endurance.

Participation of all gender in the family of the respondents in faba bean production and management activities were analysed as shown below in Table 2.7. This study showed that family members of the farmers of both sex having different age category participate in different activities related to faba bean production and management. Two key informants mentioned that men are primarily responsible for ploughing and women are primarily responsible for food preparation. The key informants also reported

that weeding is the dominant activity requiring large human power at critical time and can easily done by every age and gender groups. Mashingaidze et al. (2009) mentioned that smallholder farmers in the tropics faces serious weed challenge than any part of the world and spend 75% of their time battling with weeds in their fields. Ploughing, hoeing, cleaning, cooking, marketing activities were not or with less degree practiced by male children and female children in the Zone. These activities require high energy that the children cannot perform. In general, the key respondents underlined that there is no clearly visible sole responsibility of any age and gender group in majority of faba bean production and management activities. However, the most pronounced difference in gender roles of adult farmers was observed for ploughing (97% done by male adults compared to 3% done by female adults) and hoeing (97% done by male adults compared to 25% done by female adults) due to the heavy duty of the activities. Seed selection, storing and marketing, which bears important implications for the conservation of varietal diversity, was reported to be the responsibilities of both genders of adults and elders, excluding both ages of children in east Hararghe Zone.

Table 2.7
Proportions of the general respondents and role of gender in production and management of faba bean in east Hararghe Zone (n = 72)

Activity	Gender	Frequency	%	Activity	Gender	Frequency	%
Hoeing	Female children	1	1	Ploughing	Female adults	2	3
	Female adults	18	25		Male children	8	11
	Male children	18	25		Male adults	70	97
	Male adults	70	97		Male elders	17	24
	Male elders	17	24	Cleaning	Female adults	71	99
Levelling	Female children	3	4		Female elders	7	10
	Female adults	56	78		Male children	1	1
	Female elders	4	6		Male adults	72	100
	Male children	18	25		Male elders	18	25
	Male adults	72	100	Seed selection	Female adults	70	97
	Male elders	20	28		Female elders	7	10
Sowing	Female adults	66	92		Male adults	72	100
	Female elders	5	7		Male elders	9	13
	Male children	11	15	Storing	Female adults	71	99
	Male adults	72	100		Female elders	7	10
	Male elders	20	28		Male adults	72	100
Weeding	Female children	12	17		Male elders	13	18
	Female adults	72	100	Marketing	Female adults	71	99

Activity	Gender	Frequency	%	Activity	Gender	Frequency	%
	Female elders	8	11		Female elders	5	7
	Male children	27	38		Male adults	72	100
	Male adults	72	100		Male elders	6	8
	Male elders	17	24	Cooking	Female children	1	1
Harvesting	Female adults	71	99		Female adults	71	99
	Female elders	7	10		Female elders	9	13
	Male children	5	7		Male children	1	1
	Male adults	72	100		Male adults	71	99
	Male elders	20	28		Male elders	9	13
Threshing	Female adults	60	83	Fodder collection	Female children	1	1
	Female elders	5	7		Female adults	26	36
	Male children	16	22		Male children	21	29
	Male adults	72	100		Male adults	71	99
	Male elders	18	25		Male elders	15	21

4. Conclusion

Through field survey in eastern Hararghe Zone, farmers' knowledge related to faba bean on-farm diversity, production, use, and constraint management were collected and analyzed. Totally, eight faba bean farmers' varieties were identified. The diversity of faba bean farmers' varieties is higher in tepid, moist mid highlands (M3) agroecology as compared to tepid, sub-humid mid highlands (SH3) agroecology. Respondents use the faba bean farmers' varieties for food (consumption), fodder, income, soil fertility management and as honeybee forage. The use value of faba bean varies depending on the faba bean variety type and agroecology. Farmers mostly grow faba bean in intercropping and rotation system that plays positive role in agroecological intensification and soil fertility maintenance. The wealth of farmers affected the area of land allocated for faba bean production where mid to high income farmers grown on

a larger average land area. All gender and age groups of the famers' family participated in most of the faba bean production and postharvest activities. In general, the on-farm diversity of faba bean farmers' varieties is low at the study area. Thus, germplasm conservation, awareness rising of local farmers to properly manage the seeds, and further research to improve the yielding capacity of faba bean farmers' varieties is needed in order to maintain the diversity of faba bean.

Declarations

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Conflict of interests

The authors declare that there is no conflict of interest.

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Figures

Figure 1

Location map of the survey study areas.

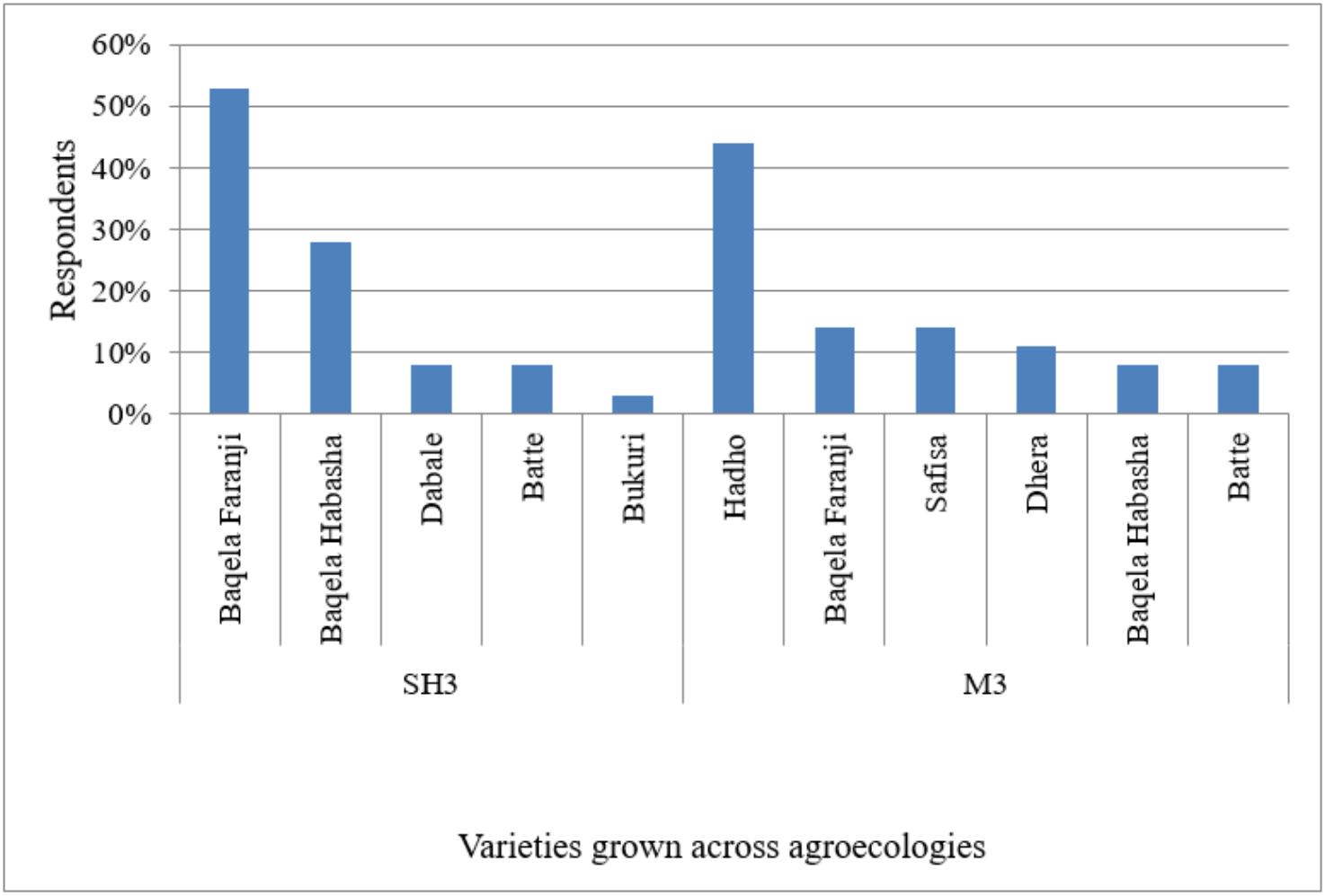

Figure 2

Distribution of faba bean farmers' varieties across agroecologies of eastern Hararghe Zone(n = 72)

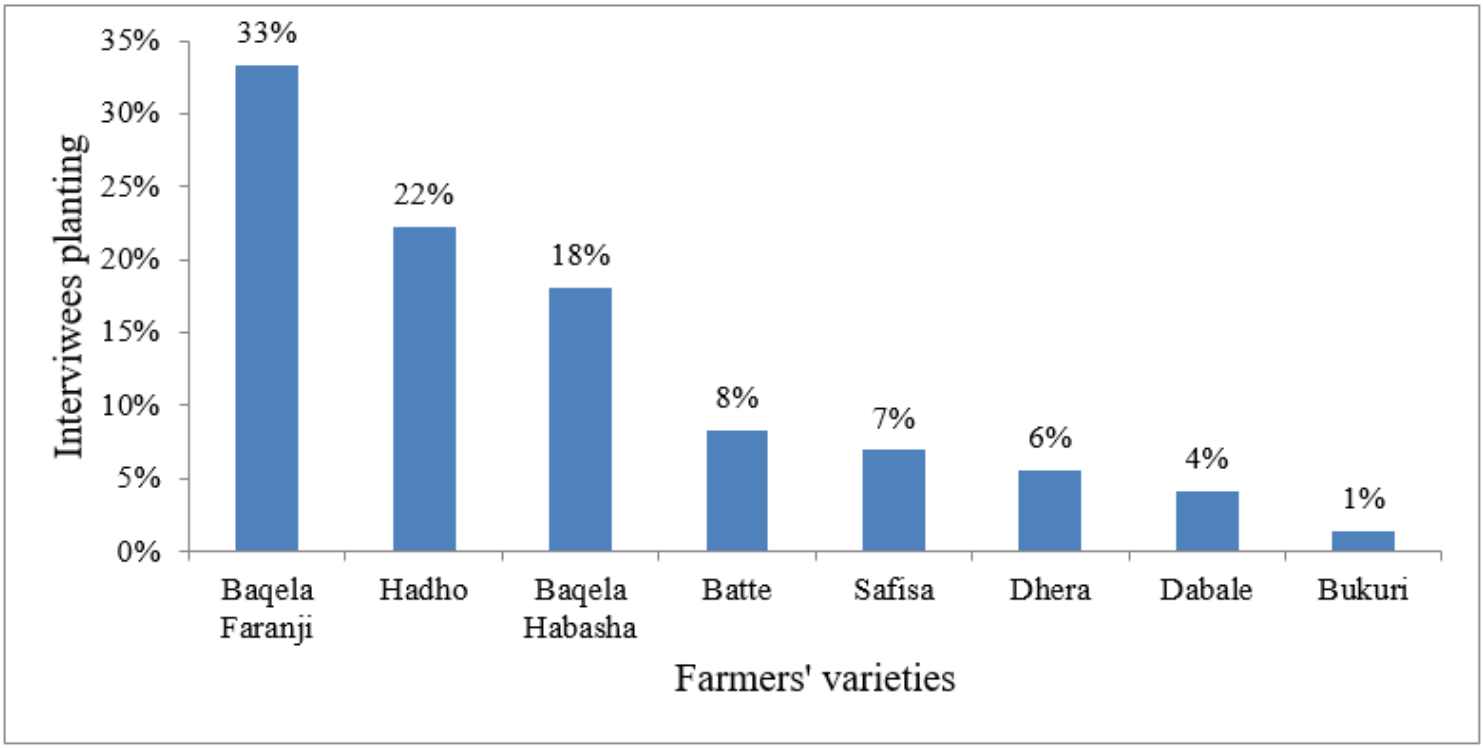

Figure 3

Proportions of general respondents growing faba bean farmers' varieties in eastern Hararghe zone

Figure 4

Faba bean interspecific diversity with other legumes in the study area (n = 36 for each agroecology)

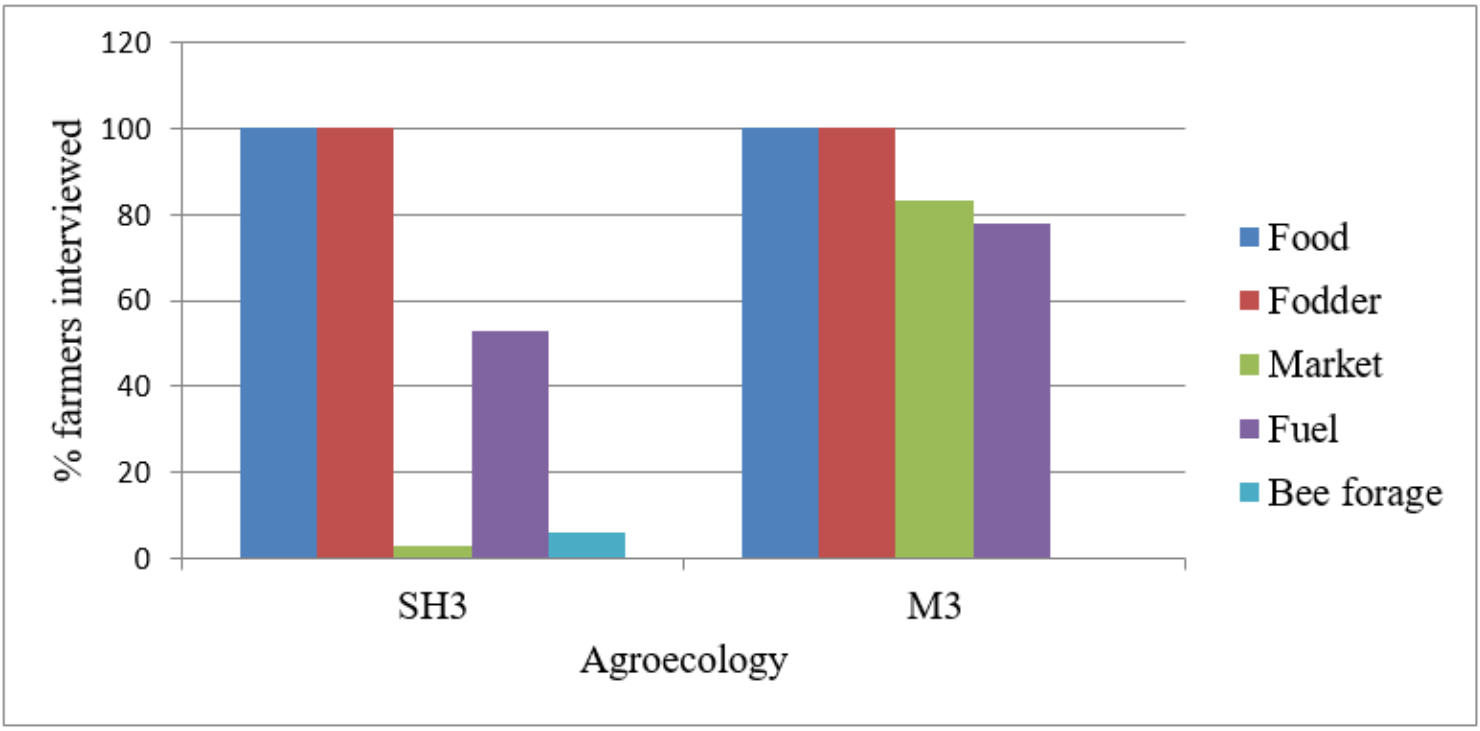

Figure 5

Use values of faba bean in M3 and SH3 agroecologies of east Hararghe Zone, Ethiopia (n = 72)

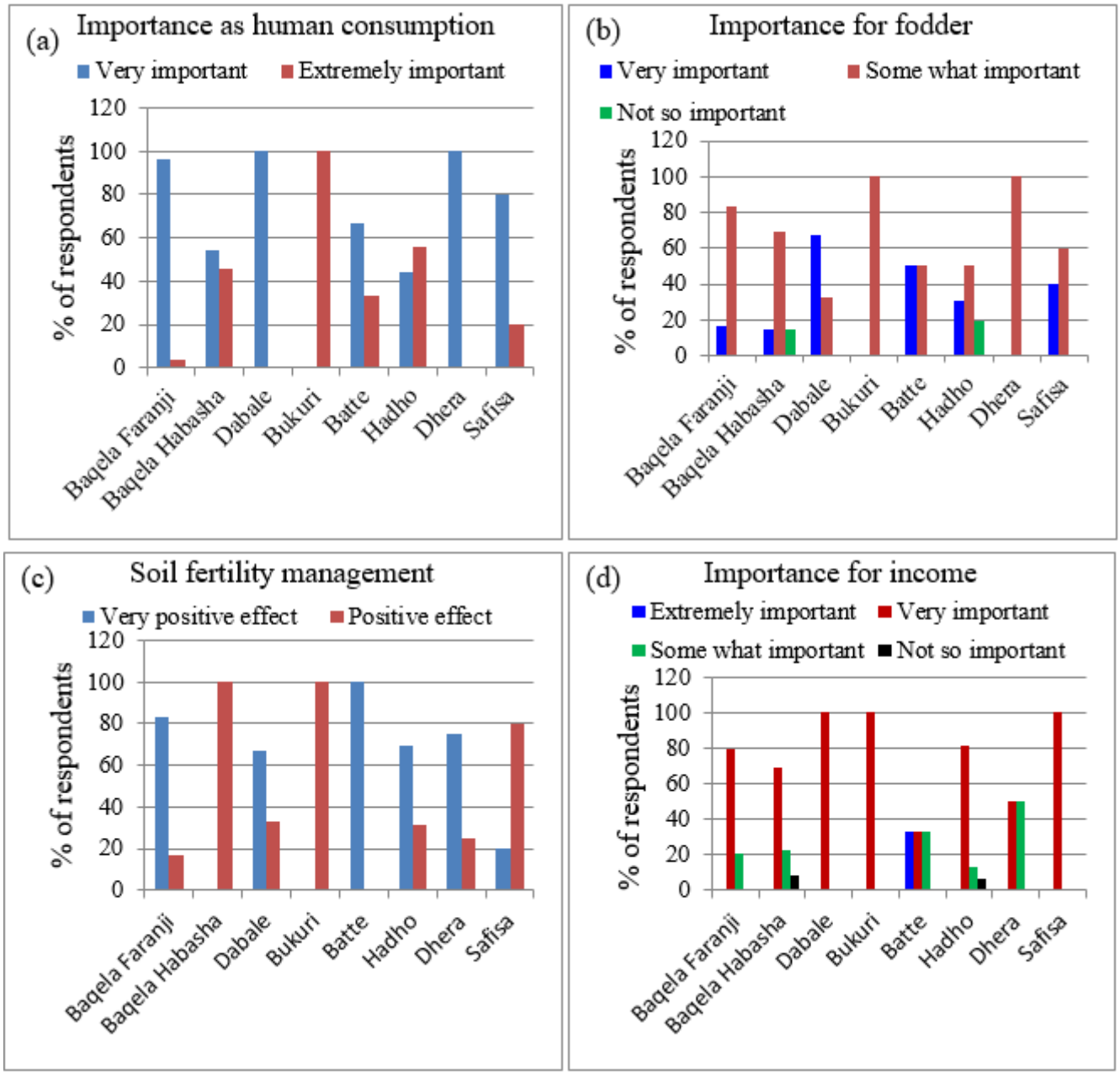

Figure 6

Faba bean values: (a) for human consumption, (b) for fodder, (c) for soil fertility management, (d) for income (n = 72)

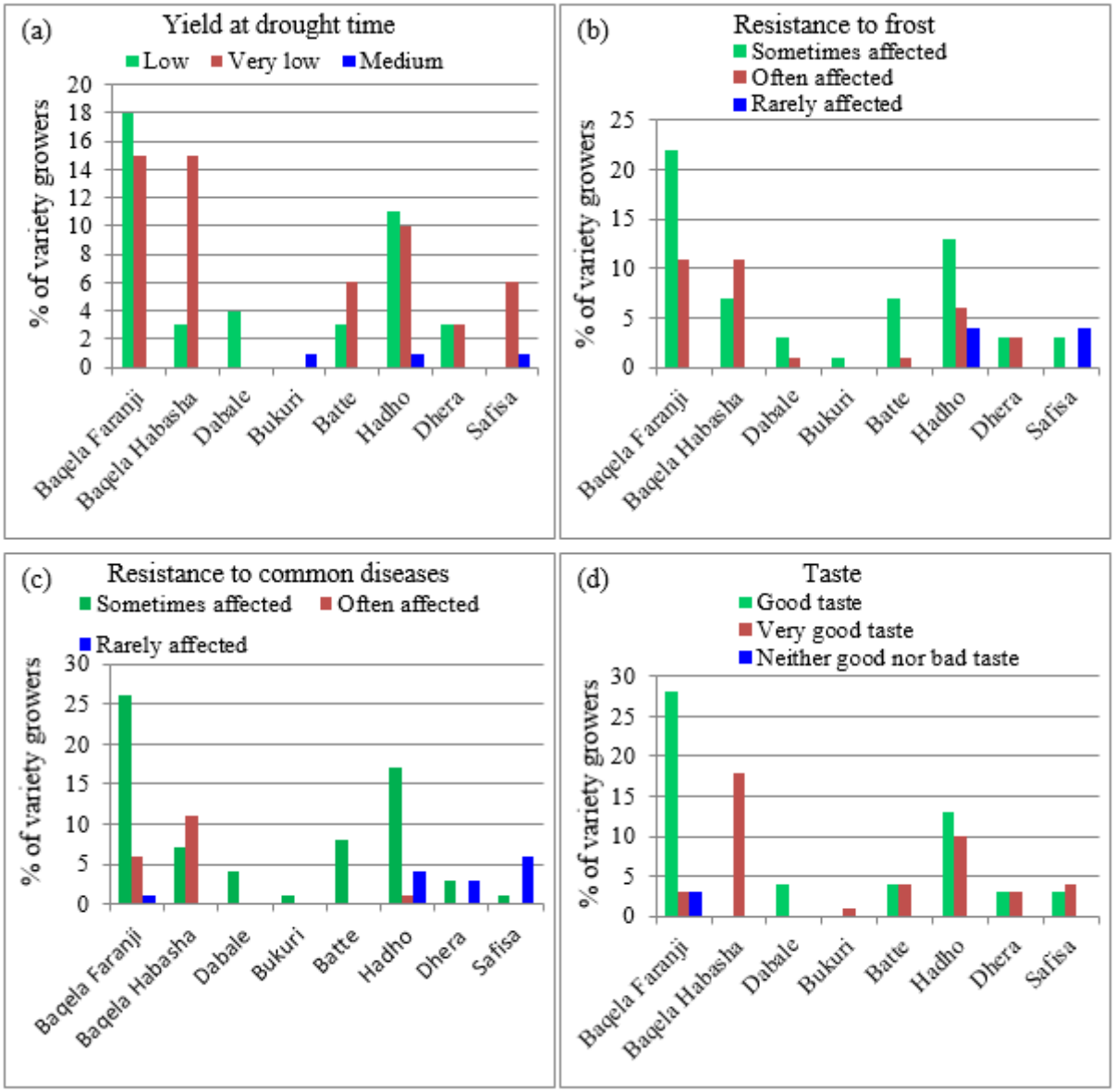

Figure 7

Ranking of faba bean farmers' varieties by the growers: (a) ranking by yield during drought time, (b) ranking of varieties by their resistance to frost, (c) ranking of varieties by the ability to resist common diseases, (d) ranking by taste

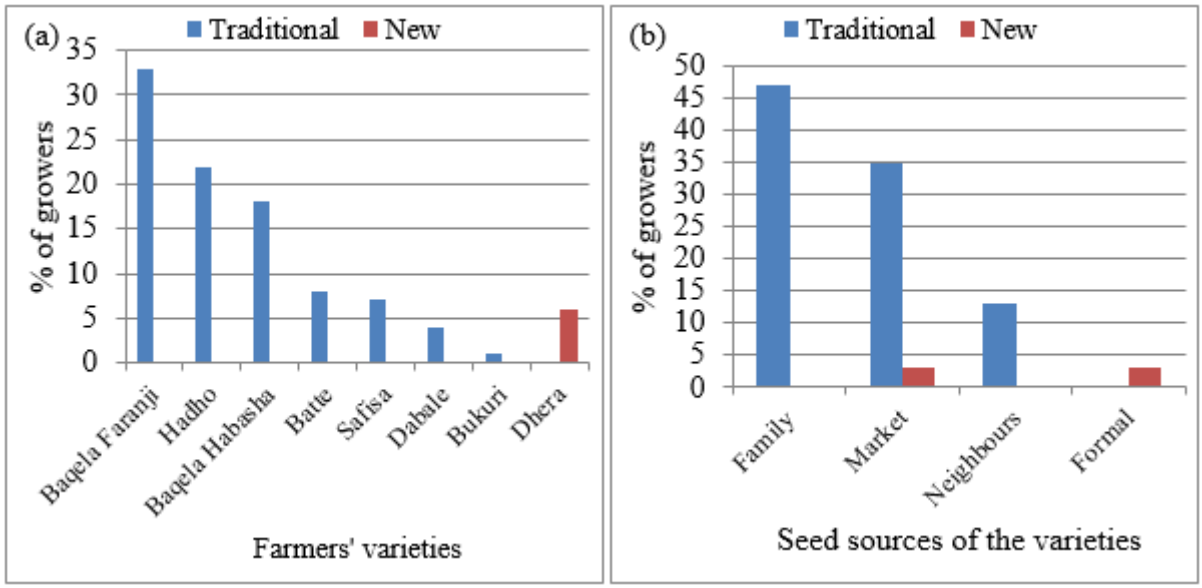

Figure 8

Proportions of respondents growing the varieties and their seed sources in east Hararghe Zone (n=72): a) proportions of respondents growing variety type, b) seed source

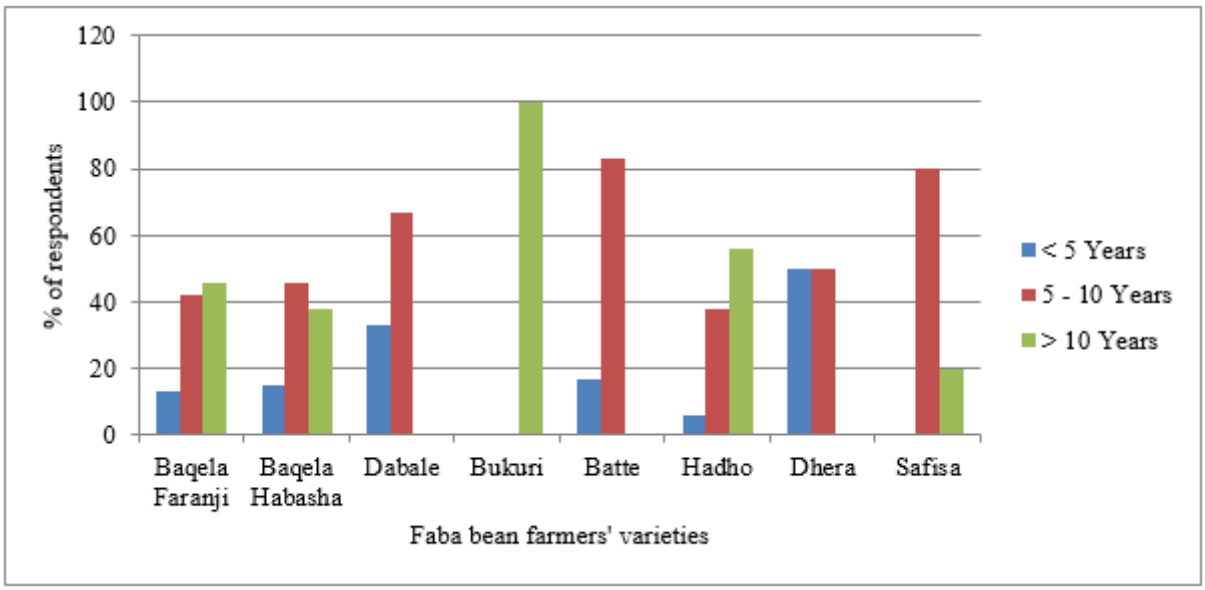

Figure 9

Percentage of general respondents and range of growing years of faba bean varieties in east Hararghe Zone (n=72).

Figure 10

Planting locations and soil fertility in six kebeles of east Hararghe Zone of Ethiopia (n = 72): (a) planting location where farmers plant faba bean, (b) soil fertility status on which farmers plant faba bean varieties

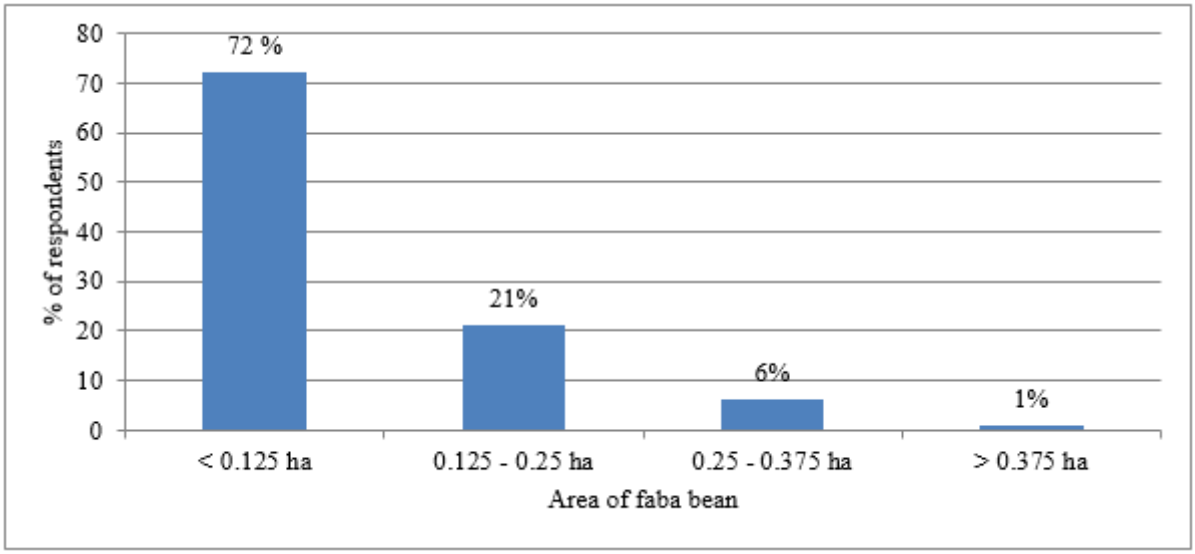

Figure 11

Proportion of faba bean farm land size per farmers in eastern Hararghe Zone (n = 72)

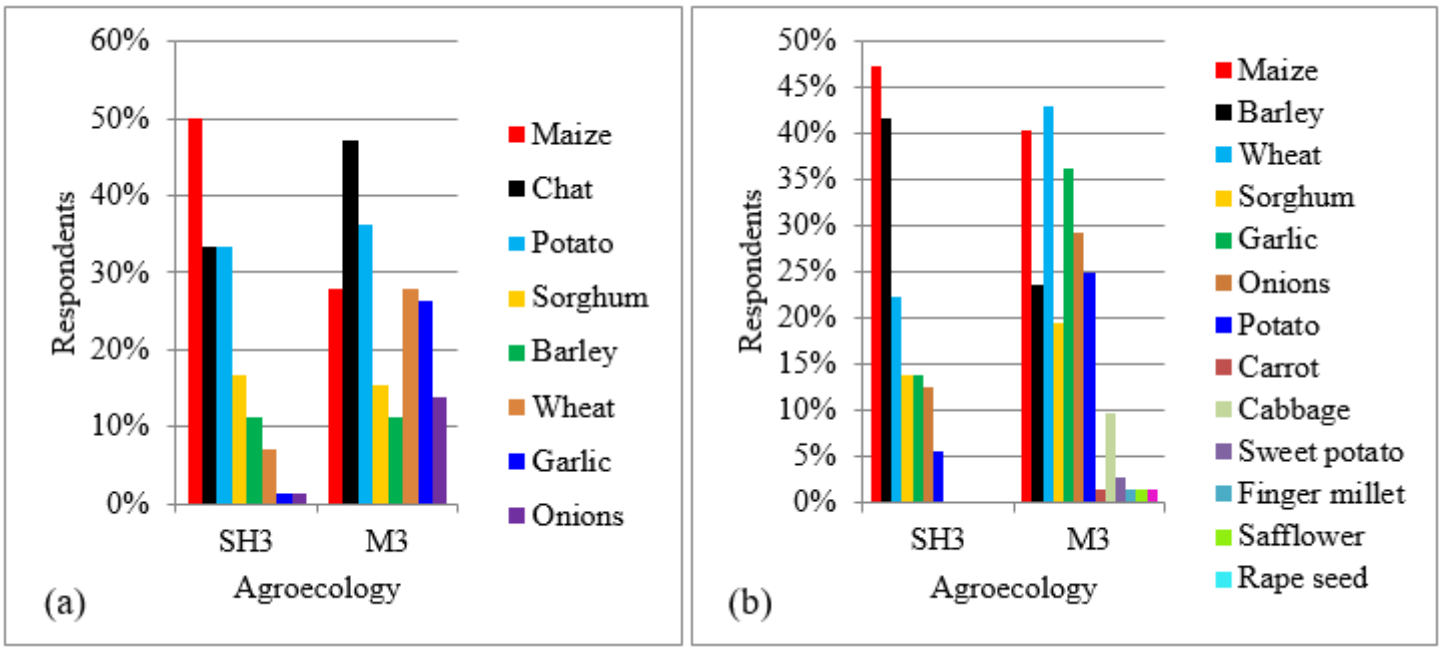

Figure 12

Proportions of general respondents: (a) Intercropping with different crop species, and (b) crop rotation of faba bean with different crop species in two agroecologies in eastern Hararghe Zone, eastern Ethiopia (n = 72)

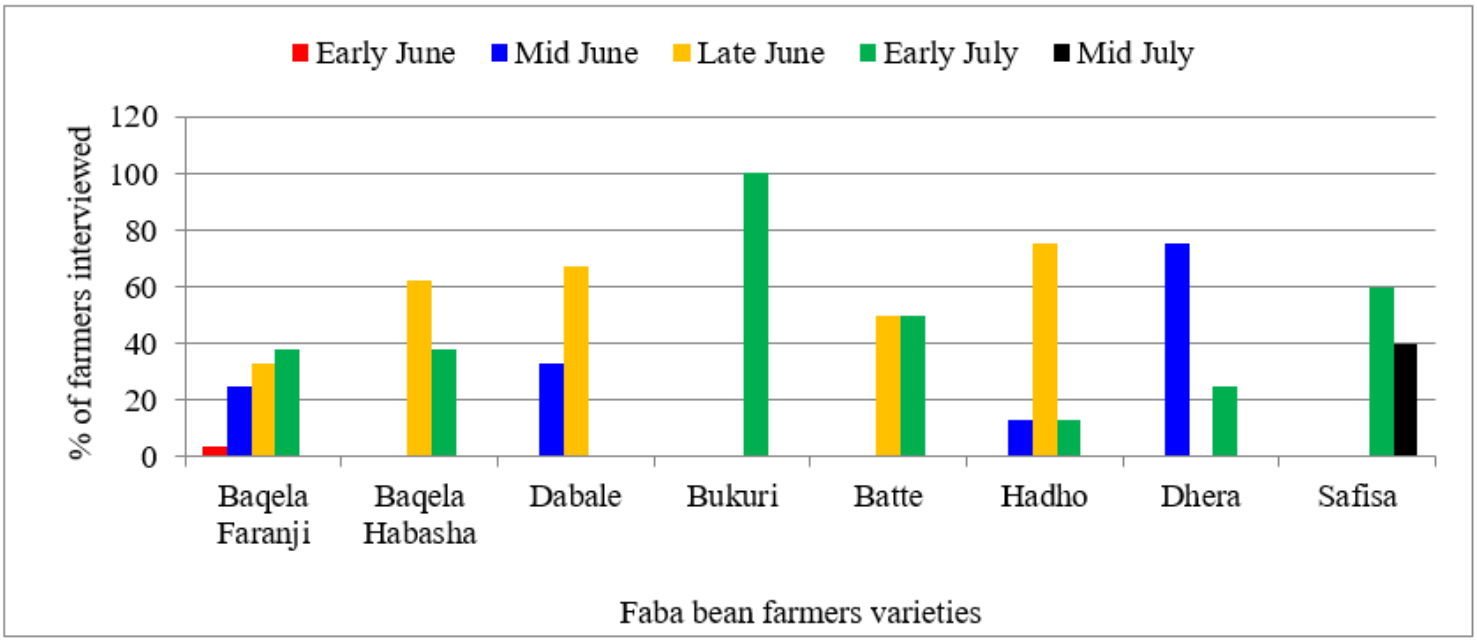

Figure 13

Proportion of general respondents and planting time of faba bean varieties in east Hararghe Zone (n=72)

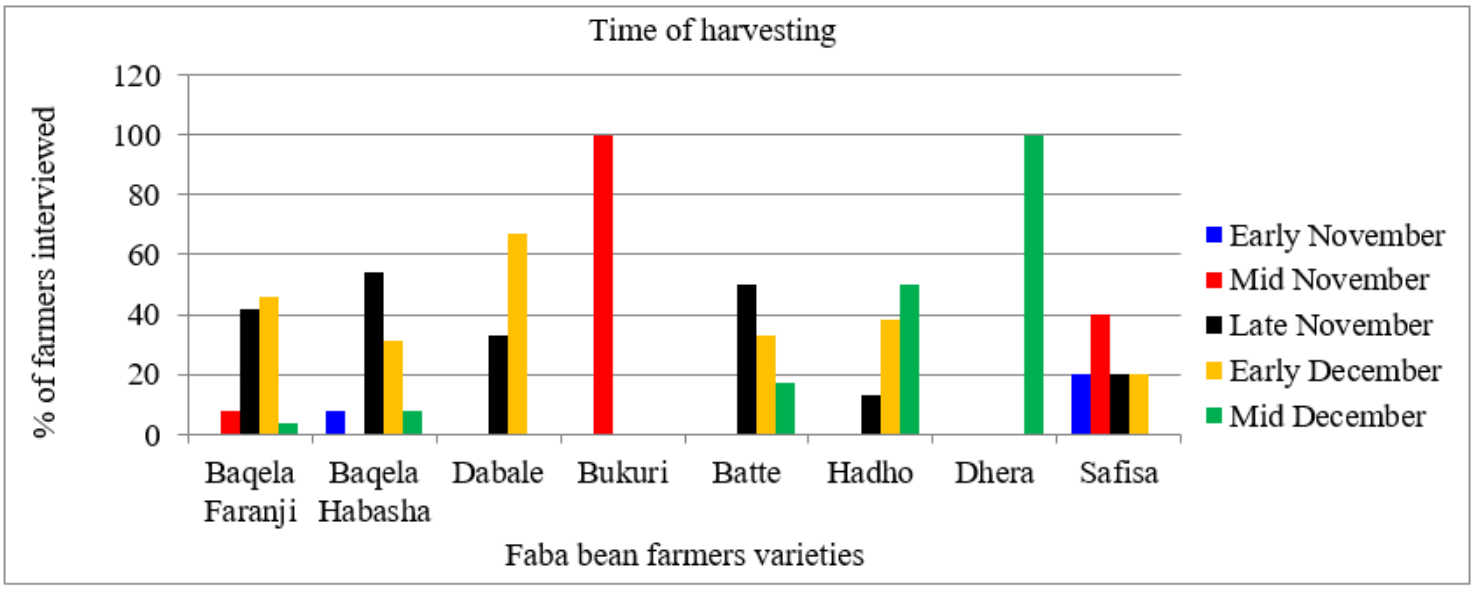

Figure 14

Proportion of general respondents and harvesting time (month) of faba bean varieties in east Hararghe Zone (n=72)

Figure 15

The average yield of faba bean farmers' varieties harvested in 2018 and 2019 cropping seasons in east Hararghe Zone.

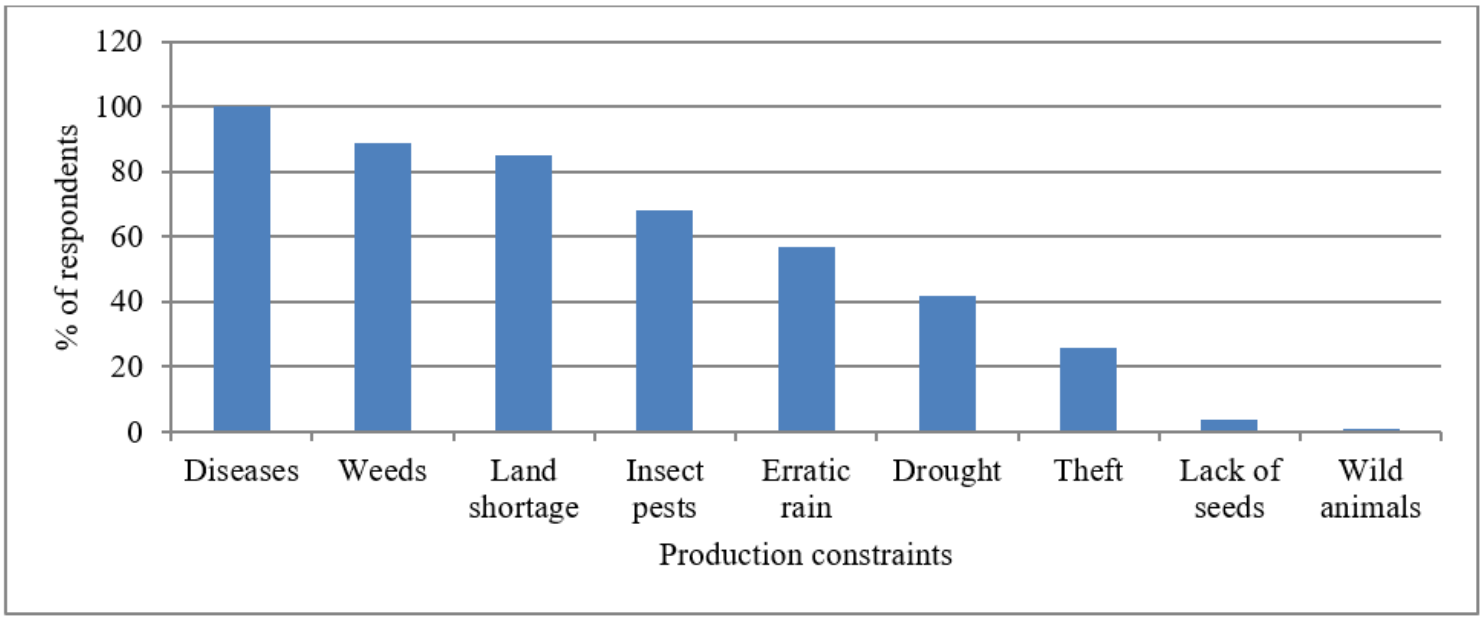

Figure 16

Proportion of general respondents and production constraints of faba bean in east Hararghe Zone (n = 72)

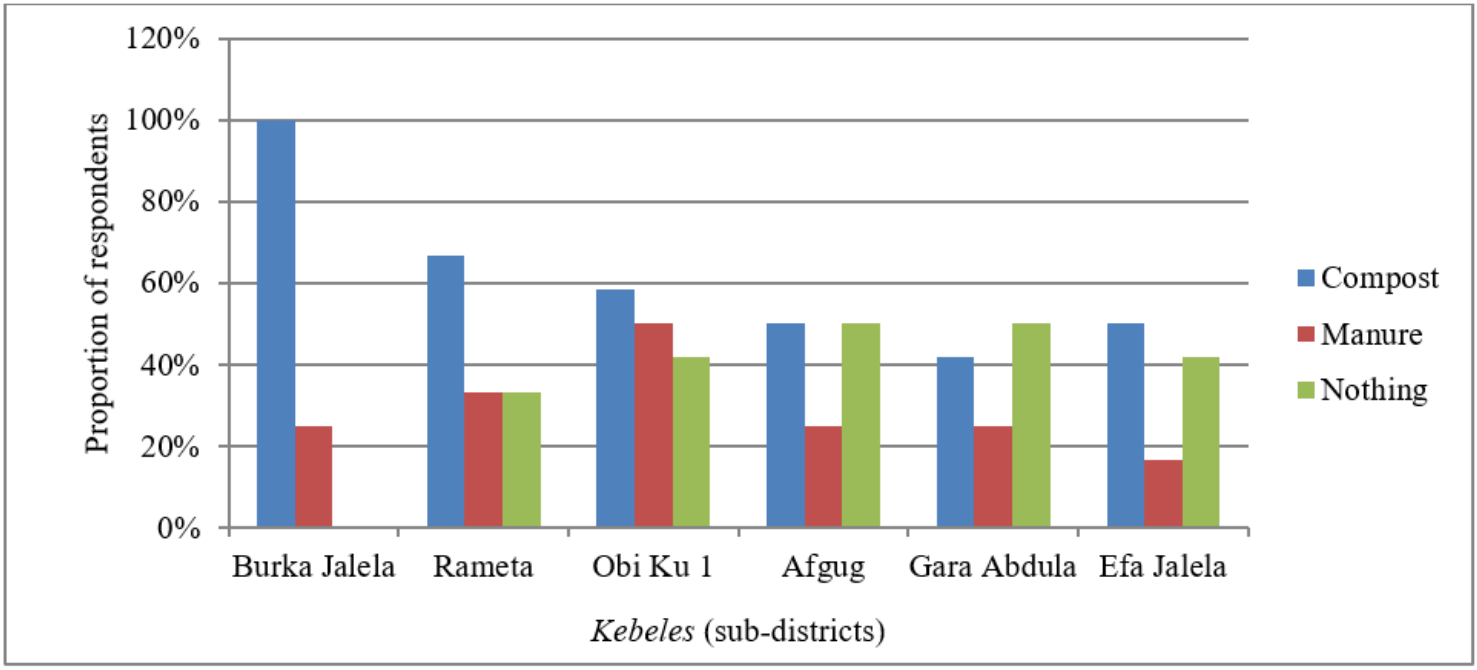

Figure 17

Proportion of respondents using different soil fertility management practices for faba bean production in eastern Hararghe Zone (n = 72)

Figure 18

Proportions of the available labour force of the family members for the production of faba bean in the study area (n = 72)