Grain legumes are an important component of agricultural crops contributing to smallholder crop production, nutrition and income across the world. Ethiopia has a favorable and diverse agro-ecology for grain legumes production making the country one of the major grain legumes producing and supplying country. The annual production and productivity of grain legumes has been showing an increasing trend which is mainly attributed to high demand for nutrition and strong prices resulting from local and international market. Faba beans, haricot beans (white and red), field peas and chickpeas are the four leading grain legumes both in area of production and grain yield. In agricultural system of the country, legumes have been used in a mixed cropping system with cereals and other crops, mainly in crop rotation and intercropping. Grain legumes have also been used for various purposes including improving food and nutrition security, generation of income, soil fertility improvement, providing livestock feed, soil erosion control, water conservation and as a source of fuel. Despite their widespread production and multiple benefits, the production and productivity of grain legumes in Ethiopia is...
below potential. This is mainly due to low input usage, limited availability of seed, market problems and poor extension services. However, the country has huge potential to produce different grain legumes. Therefore, Ethiopia should more recognize the grain legume sectors, promotes modern agronomic practices and improved legume technologies that boost the production and productivity.

Subjects: Agriculture & Environmental Sciences; Soil Sciences; Nutrition

Keywords: crop rotation; grain legumes; intercropping; nutrition; productivity; soil fertility

1. Introduction

Agriculture is the fundamental driver for Ethiopia’s economy and long-term food security as it offers about 80-85% of employment, more than 61% of the total export and 38.5% of gross domestic product of the country (Degaga & Angasu, 2017). Ethiopia has diverse agro-ecology that permits different agricultural systems and production of different crops. The existence of this diverse agro-ecology together with diverse farming systems, socio-economic, cultures and climate zones provided Ethiopia with various biological wealth of plants, animals, and microbial species, especially crop diversity (Atnaf et al., 2015).

Among the various crops, grain legumes contribute to smallholder crop production, nutrition as a cost-effective source of protein accounting for about 15% of protein consumption and income as a high-value crop being the third-largest export crop next to coffee and sesame (Getachew, 2019). In addition, legumes have functions such as soil fertility improvement through biological nitrogen fixation (BNF), livestock feed, soil erosion control, source of fuel and a range of other benefits (Muoni et al., 2019). In agricultural system, grain legumes are potential sources of plant nutrients that can complement and/or supplement inorganic fertilizers for cereal crops. This is due to their ability to fix biological nitrogen and indirect supply of manure-based nitrogen inputs when included in the cropping systems such as intercropping and crop rotation (Snapp, Rahmanian, & Batello, 2018; Teshome, Wassie, & Abatineh, 2018).

As legumes constitute a critical component of the agricultural system in Ethiopia, about 12 legume crops are grown in the country. Of these, faba bean (Vicia faba L.), field pea (Pisum sativum L.), chickpea (Cicer arietinum L.), lentil (Lens culinaris Medik.), grass pea (Lathyrus sativus L.), fenugreek (Trigonella foenum-graecum L.) and lupine (Lupinus albus L.) are categorized as highland legume crops and grown in the cooler highlands. On the other hand, haricot bean (Phaseolus vulgaris L.), soya bean (Glycine max L.), cowpea (Vigna unguiculata L.), pigeon pea (Cajanus cajan L.) and mung beans (Vigna radiata L.) are categorized as lowland legume crops and predominantly grown in the warmer and low land parts of Ethiopia (CSA, 2018; Getachew, 2019; Tegegne, 2017; Yirga et al, 2010).

The area coverage of grain legumes is about 13% of the total cultivated land which is 1.6 million hectare (ha) and providing 11.89% of the total crop production of the country, which is 2.67 million tons (CSA, 2015). The production of grain legumes by volume has been increased by 71.92% for the duration of nearly 20 years and with a growth rate of 3.78% per annum. Participation of farmers in cultivation of legumes in the country has been increased nearly by twofold from 4.5 to 8.5 million farmers for the last 20 years (Atnaf et al., 2015; Ferede et al., 2014).

Though increased production of legumes would be expected to increase farm household income and contribute to greater household food security, the production and productivity of legumes in Ethiopia is below potential due to different reasons. The major constraints accounting for this low production and productivity are low input usage, limited availability of seed and limited familiarity with the variety of existing legumes, and limited usage of modern agronomic practices, market
problems and poor extension services (Asfaw et al., 2010; Atnaf et al., 2015; Getachew, 2019; Habte et al., 2018; Kabota et al., 2017).

However, Ethiopia still has different opportunities for enhancing the productivity of legumes including varied agro-ecology, diversity of grain legumes, population and urbanization trends, increased demand for animal feed and processed foods (Getachew, 2019; Habte et al., 2018; Koroma et al., 2016; van Loon et al., 2018). The enhanced legume production can create opportunities for local value-added processing, stimulate domestic demand, and provide off-farm employment, sources of income, and enriched diet for resource-poor and smallholder farmers (Getachew, 2019).

Therefore, the promotion of legumes which are adapted to different areas of the country and legume-based production technology will contribute to enhanced agricultural productivity and improved nutrition of people living in the country especially smallholder farmers. As a result, there is a need to address appropriate production practices and critical knowledge gaps that will boost the production and productivity of grain legumes and expand their presence in smallholder

| Crop/Year | 2013/14 | 2014/15 | 2015/16 | 2016/17 |
|-----------|---------|---------|---------|---------|
| Faba beans| 992     | 839     | 849     | 855     |
| Red kidney beans| 259     | 312     | 380     | 355     |
| Field peas | 380     | 343     | 323     | 347     |
| Chick peas | 424     | 459     | 473     | 343     |
| Grass peas | 317     | 251     | 288     | 239     |
| Lentils    | 159     | 137     | 134     | 172     |
| White pea beans| 199     | 202     | 160     | 123     |
| Other grain legumes | 69      | 57      | 82      | 109     |
| Total      | 2,798   | 2,600   | 2,688   | 2,542   |

Source: USDA Foreign Agricultural Service (2018).
agricultural system. The aim of this paper was (i) to review the production and productivity of grain legumes and their potential as a component of smallholder agricultural system and livelihood in Ethiopia and (ii) to review constraints affecting grain legumes production, existing opportunities and the way forward in enhancing the production and productivity.

2. Methodology
The paper is based on review and use of secondary data published in journals, research centers, annual reports, technical and consultant reports available in the studies conducted by various researchers, institutions and organizations. The review focused primarily on literature search and restricted to articles and report papers published between 2000 and 2019. A literature search for this review focused primarily on studies conducted in Ethiopia, African countries and grain legumes producing countries. Published articles were searched and identified from different electronic databases such as Web of Science, AGRIS (agris.fao.org), Research Gate (https://www.researchgate.net), Science Direct, Taylor and Francis, Springer, different African and Ethiopian Journals, and libraries of the Ethiopian research institutes. The

| Legume types     | Common name | Scientific name | Food (kg ha⁻¹) | Feed (kg ha⁻¹) | Soil fertility (BNF ha⁻¹) |
|------------------|-------------|-----------------|---------------|----------------|--------------------------|
| Grain, seasonal  | Common bean | Phaseolus vulgaris | 290-1561 | 760-4039 | 10-81 |
|                  | Cowpea      | Vigna unguiculata | 187-3850 | 646-4770 | 21-201 |
|                  | Faba bean   | Vicia faba       | 321-6100 | 653-10,400 | 39-350 |
|                  | Field pea   | Pisum sativum    | 1314-7400 | 946-12,280 | 4-204 |
|                  | Groundnuts  | Arachis hypogaea | 109-4540 | 2903-8875 | 12-200 |
|                  | Chickpea    | Cicer arietinum  | 472-2180 | 1181-5554 | 12-186 |
|                  | Soybean     | Glycine max      | 300-3334 | 1910-6821 | 36-165 |
|                  | Mung bean   | Vigna radiata    | 433-2171 | 1133-7478 | 20-63 |
|                  | Sweet lupin | Lupinus lupsins  | 400-2420 | 2300-8600 | 119 |
|                  | White lupins| Lupinus albus    | 800-5798 | 1400-13,395 | 19-359 |
|                  | Bambara groundnut | Vigna subterranea | 311-3597 | 1543-2030 | 24-83 |
| Cluster bean     | Cyamopsis tetragonoloba | 504-2093 | 1214-8900 | - |
| Grain, perennial | Pigeon pea  | Cajanus cajan    | 530-3000 | 2110-10,940 | 6-250 |
| Herbaceous, seasonal | Velvet bean | Mucuna pruriens | 166-3090 | 804-10,740 | 30-171 |
|                  | Persian Clover | Trifolium resupinatum | - | 8800-17,950 | 37-128 |
|                  | Common vetch | Vicia sativa    | - | 1800-10,200 | 46-154 |
|                  | Black sunnhemp | Crotalaria ochroleuca | - | 1561-15,140 | - |
|                  | Lablab      | Lablab purpureus | - | 1707-8701 | - |
|                  | Silverleaf desmodium | Desmodium uncinatum | - | 514-3221 | - |
|                  | Lucerne/Alfalfa | Medicago sativa | 70-630 | 3891-23,445 | 38-407 |

Source: Muoni (2019).
secondary data available at the Food and Agriculture Organization (FAO) Corporate Statistical Database (FAOSTAT) and Central Statistical Agency of Ethiopia relevant to the review were also used.

Based on the review objectives and content types, articles and published reports were retrieved from databases mainly focusing on empirical results reported on production and productivity of grain legumes in Ethiopia and grain legumes producing countries across the world. Following a critical review, data and literatures were compiled on existing and detailed grain legumes production and productivity, their importance and contribution in agricultural system, their practicality in agricultural production and overall contribution to livelihoods. Available and detailed data on the share and total cultivated land area, overview of domestic trade and export, opportunities and constraints of grain legumes production and productivity in the country has been critically reviewed and described in the paper. Research and technical gaps on the overall production aspects of grain legumes were identified and recommendations are forwarded for the future endeavor of enhancement in agricultural production system.
3. Results and discussions

3.1. Grain legumes production and productivity in the World and Ethiopia
Grain legumes are the second most important family of agricultural crop species after grasses worldwide. They are considered a vital crop for achieving food and nutritional security for both poor producers and consumers. It is estimated that, on average, the mean annual world grain legumes production was nearly 75.68 million tons during 2008–2017 (FAO, 2019). During 2006–2012, India was the largest producer of legume crops accounting for about 24% of the global legume production, followed by Myanmar, Canada, and China contributing 7% each. The first five leading grain legumes producing countries (India, Myanmar, Canada, China, and Brazil) alone accounted for 50% of the world grain legumes production. In terms of area, India stands first being the world’s biggest producer of grain legumes, holding 32% of the world grain legumes harvested land and accounting for more than a quarter of global production (Ferede et al., 2014). Africa as a whole account for 22% of the global production of grain legumes (Koroma et al., 2016). The mean annual global production of major grain legumes is indicated in Table 1 and the share of major legume-producing countries in terms of production and acreage are shown in Figure 1.
Grain legumes were grown on 14.5% of the global arable cropped area in 2014, accounting for 12.5% of the production of all grain crops (cereals, pulses, and oilseeds) (Watson et al., 2017). Globally, soybean, faba bean, and groundnut have the highest yields, ranging between 1.5 tons/ha
and 2.4 tons/ha. Chickpea, pigeon pea, lentil and dry bean have yield levels of about 850 kg/ha. Cowpea has comparatively low yields at 0.5 tons/ha, but its yield levels are growing at an average rate of 2.9% per annum. The legume crops' yields in the developing regions are very low. However, in the case of chickpea, dry bean, lentil, pigeon pea and soybean, some developing regions have exceeded the developed countries in terms of yield levels (Nedumaran et al., 2015). During 2014, dry beans accounted 33% and 38% of the production and area coverage, respectively, followed by chickpea which accounted 16% in production and acreage of global grain legumes production (Figure 2).

Grain legumes are Ethiopia's second most important group of crops, after cereals, (Figure 3) and together they provide food and income to more than 10 million households. The current data showed that Ethiopia belongs to the major legume-producing areas with marginal contribution in term of grain legumes production (3%) and area (2%) which means overall output of 3 million tons and overall acreage of production close to 2 million hectares (Atnaf et al., 2015; Ferede et al., 2014). Besides, Ethiopia is one of the top 10 producers of total grain legumes in the world, the second-largest producer of faba beans after China, the fifth- or sixth-largest producer of chickpeas and is the second-largest producer of grain legumes in the common market for eastern and southern African countries (COMESA region) following Sudan. Sudan and Ethiopia have 32% and 22% share of the total COMESA grain legumes production, respectively. The favorability of soil and climate conditions of Ethiopia for grain legume crops cultivation makes the country to be a huge producer and supplier of grain legumes in the international arena (GAIN, 2018; Getachew, 2019).

Reports have indicated that about 12 grain legume species are grown in the country. Faba bean (Vicia faba L.), field pea (Pisum sativum L.), chickpea (Cicer arietinum L.), lentil (Lens culinaris Medik.), grass pea (Lathyrus sativus L.), fenugreek (Trigonella foenum—graecum L.) and lupine (Lupinus albus L.) are categorized as highland legumes and grown in the cooler highlands of Ethiopia whereas, haricot beans (Phaseolus vulgaris L), soy beans (Glycine max L.), cowpea (Vigna unguiculata L.), pigeon peas (Cajanus cajan L.) and mung beans (Vigna radiata L.) are predominantly grown in the warmer and low land parts of the country (CSA (Central Statistical Agency), 2018; Getachew, 2019; Tegegne, 2017; Yirga., 2010). Of the different legumes, faba beans (horse beans) account for nearly one-third of entire legume production, followed by haricot beans, field beans, and chickpeas (each around 14% of production), while other grain legumes such as grass peas, lentils and white pea beans make up the remaining 25% (ITC, 2019).

The annual production of grain legumes is estimated at 2.5 million metric tons while year-to-year production levels vary mostly because of weather conditions. Overall grain legumes production during the last decade has increased about 700,000 metric tons. This increment is mainly accredited to increased cropping due to strong prices resulting from steady local and international demand (USDA Foreign Agricultural Service, 2018). In addition, legume production has been showing an upward trend during the past 13 years, ranging from 1.10 million tons in 2000/01 to 2.75 million tons in 2012/13. The role that Ethiopia now plays in the international grain legumes market can also be attributed to significant growth rates in grain legumes production over the last nearly 20 years (Atnaf et al., 2015).

According to CSA (2018) report, grain legumes grown in 2017/18 covered 12.61% (1,598,806.51 hectares) of the grain crops area and about 9.73% (29,785,880.89 quintals) of the grain production was obtained from legume crops. Faba beans, haricot beans (white), haricot beans (red), and chickpeas were planted to 3.45% (about 437,106.04 hectares), 0.71% (about 89,382.68 hectares), 1.71% (about 216,803.91 hectares) and 1.91% (about 242,703.73 hectares) of the grain crop area, respectively. The production obtained from faba beans, haricot beans (white), haricot beans (red), chickpeas and field peas were 3.01% (about 9,217,615.35 quintals), 0.48% (about 1,482,128.42 quintals), 1.22% (3,727,664.85 quintals), 1.63% (4,994,255.50 quintals) and 1.20% (3,685,190.65)
of the grain production, respectively. The production trends (’000 metric tons) of major grain legumes in Ethiopia during the year of 2013 to 2016/2017 is shown in Table 2.

While legumes are grown throughout Ethiopia and account for about 13% of cropped land grain area, Oromia, Amhara, Southern Nations, Nationalities and Peoples region (SNNPR), and Tigray regions are the first four leading regions in producing grain legumes in the country. Considering the volume of production, Oromia, Amhara, SNNPR and Tigray regions take the largest percentage proportions which are 43.7; 39.47; 13.31 and 1.19, respectively. The total cultivated area under grain legumes in Amhara, Oromia, SNNPR, and Tigray regions is 0.68 (42.40%); 0.62 (39.91%); 0.24 (14.75%) and 0.037 (2.33%) million hectares of land, respectively (Getachew, 2019).

According to Atnaf et al. (2015), the production of grain legumes is mainly concentrated in the Oromia and Amhara regions which together account for 92% of chickpea production, 85% of faba bean production, 79% of haricot bean production, and 79% of field pea production. In wider, Getachew (2019) also indicated that Amhara and Oromia regions alone produce 83.17% of total grain legumes. During the last 11 years, Oromia region has been the largest producer of faba beans, field peas and haricot bean, whereas Amhara region is the leading region to produce chickpeas, lentils and fenugreek. Next to Oromia region, SNNPR is the largest producer of haricot beans (Figure 4).

According to a report by Fikre (2016) based on the Ethiopian Central Statistical Agency (CSA) data between 1996 and 2015, the area of production has been expanded from 910,000 to 1,559 000 ha (71%); the productivity has increased from 0.89 to 1.72 t/ha (93%) and the total production increased from 802,000 to 2,671,834 metric tons (233%). With regard to the production sector, smallholders are the backbone of legume-producing sector and account for about 95% of the sector’s production (ITC (International Trade Centre), 2019). Getachew (2019) also reported that grain legumes production by volume has been increased from 17.83 million quintals to 29.79 million quintals with an annual increment of 6.86% for the same duration. Total legumes productivity, which is the volume of production per unit area, has also been increased from 11.75 quintals per hectare to 18.63 quintals per hectare which is 58.55% increment in productivity. The trends of land size cultivated (in million hectares) and volume of production (in million quintals) of different grain legumes in Ethiopia during the production year of 2007/2008 – 2017/2018 are shown in Figure 5 and Figure 6, respectively.

Among the legume crops, faba beans and field pea are grown during the main season on both red and black soils primarily in Amhara, Tigray, Oromia and SNNPR regional states. Haricot beans are concentrated in the relatively dry and warmer parts of the country mainly along the Rift Valley. Production of haricot beans is also increasing in Gambella and Benshangul Gumuz regional states. Chickpeas, grass peas and lentils are primarily grown on dark soils on residual moisture in west and north Shewa zones of Oromia; north and south Gonder, south Wollo, north Shewa, east and west Gojam zones of Amhara; Goro zones of SNNPR; and the east Tigray zone (Getachew, 2019; Yirga et al., 2010).

Grain legumes are, thus, critical to smallholder livelihoods in Ethiopia (Atnaf et al., 2015; Ferede et al., 2014; van den Broek et al., 2014). However, the current production and productivity of legumes falls significantly below the potential. For instance, global grain legumes yield varies between regions and countries, with Canada producing over 2 tons per hectare on average and most of the African and South Asian countries have yields of less than 0.5 tons per hectare from 2011–2013. However, Ethiopia stands as an exception with yields of close to 1.5 tons per hectare (ITC (International Trade Centre), 2019).

According to Atnaf et al. (2015), the current average haricot beans yield is 12 quintals per hectare, but research demonstrated potential accompanied by the appropriate inputs in Ethiopia is 34 quintals per hectare. In addition, the current average chickpea yield is 20.6 quintals per hectare (CSA (Central Statistical Agency), 2018) which is below the demonstrated potential (29 quintals per hectare) if accompanied by the appropriate inputs (Yirga et al., 2010). According to Schneider and
Anderson (2010) and Getachew (2019), it is possible to produce 14–50 quintals of lentils per hectare on research fields and 9–30 quintals per hectare on farmers’ fields, and 40–60 quintals of peas per hectare on research fields with improved varieties in Ethiopia.

3.2. Importance of grain legumes in agricultural system

Legumes have multiple functions in the agricultural systems of many countries ranging from human nutrition, animal feed, export commodities, soil fertility maintenance and provide environmental health services. According to Watson et al. (2017), introducing legumes into agricultural systems often positively affects the nutrient status, organic matter, soil structure, and disease inoculum levels in the soil increasing subsequent crop yields. Stagnari et al. (2017) also indicated that legumes are competitive in terms of environmental and socioeconomic benefits, with potential to be introduced in modern agricultural system.

Grain legumes have been used for many years by Ethiopian farmers in agricultural system to maintain soil fertility due to the ability of the crops to fix atmospheric nitrogen into the soil. This feature reduces fertilizer cost and improves productivity in subsequent cereal crops. Legumes role as part of the cropping is very well recognized and most legumes are grown in a mixed cropping system with cereals and other crops under smallholder agricultural system of the country. Inclusion of legumes in agricultural system increases total food production per unit of land and farm diversification, and reduces risks of food shortage (Mashungwa, 2019).

The demand for legumes integration into different agricultural systems is expected to increase as consumers’ income increases with a likely shift in preferences from cereal grains to more nutrient-dense foods (Muoni et al., 2019). This requires improved agricultural practices that overcome current crop production constraints which include erratic rainfall patterns, poor soil fertility status, and limited access to adequate inputs. Consequently, intercropping and crop rotation with grain legumes are an important agricultural practice which improves nutrition, soil fertility status, water efficiency by saving water for subsequent crops or by providing soil coverage, minimizing soil evaporation, soil erosion, and reduce diseases and other pests, which makes crop production feasible (Vidigal et al., 2019).

3.3. Intercropping with grain legumes

Intercropping is the most common practice in east Africa including Ethiopia which involves a multiple cropping practice that includes two or more crops on the same piece of land and at the same time (Muoni, 2019). The rationale behind intercropping is that the different crops planted are unlikely to share the same insect pests and disease-causing pathogens and to conserve the soil (Degaga & Angasu, 2017). In most smallholder agricultural system, the primary reasons for intercropping are shortage of land (shrinking of cultivated areas per household as a result of rise in population), to maximize profit, risk minimization against total crop failure, soil conservation and improvement of soil fertility, weed control and balanced nutrition (Degaga & Angasu, 2017; Matusso et al., 2014; Workayehu, 2013).

Intercropping of cereal crops with grain legumes is a widespread focus for current research in Ethiopia as it increases farm income and reduces pressure on land resources (Degaga & Angasu, 2017; Kassie, 2011). Degaga and Angasu (2017) further indicated that intercropping is very important for the intensification of crop production and contributes to increased returns to smallholder farmers having a limited land holding. Furthermore, intercropping offers higher yield than sole cropping, greater yield stability, more efficient use of nutrients, better weed control, provision of insurance against total crop failure and improved quality by variety (Matusso et al., 2014). Especially, most farmers prefer to include legumes as intercrops with carbohydrate-rich staple food crops such as maize (Zea mays L) and sorghum (Sorghum bicolor L). The most common legumes used as intercrops are common bean and cowpea (Muoni et al., 2019).
For instance, intercropping of maize and pigeon pea gave land equivalent ratio (LER) of 1.73 indicating 73% higher land productivity of intercropping over sole cropping (Fikre, 2016). Matusso et al. (2014) revealed that the nitrogen contribution of groundnut to the growth of maize in intercropping systems is equivalent to the application of 96 kg of N/ha at a ratio of plant population densities of one maize plant to four groundnut plants. However, the efficient use of basic resources in the intercropping system depends partly on the inherent efficiency of the legume crops that make up the system and partly on complementary effect between the crops.

3.4. Crop rotations with grain legumes
The high productivity of cereal-legume rotations has long been recognized by Ethiopian farmers, for as far back as 2000 years. Grain legumes production is an integral part of smallholder farming systems where farmers commonly practice crop rotation of cereals with legumes. This mainly enables more intensive and productive use of land, particularly in areas where land is scarce and the crop can be grown as a second crop using residual moisture (Asfaw et al., 2010).

The rotation of cereal crops with legumes is essential when soil fertility, soil health and the sustainability of production systems are to be maintained. Available evidences showed that legume crops can reduce the amount of fertilizer application on the subsequent cereal crop by up to 60% (Yirga et al., 2010). When such a cropping system is practiced in combination with good agricultural practices, it brings about more beneficial system intensification than each of the component crops alone. Fikre (2016) indicated that legumes rotation saves 30% of N fertilizer need of the next cropping, which can be applicable to 1.5 million hectares of legume system that have significant value.

However, selecting the right legume for a specific agricultural system is extremely significant, as different legume species and varieties growing in the same location and season can differ significantly in dry matter production, nitrogen fixation and accumulation, and residue quality. It is believed that long-season legumes are biologically superior at fixing significant amounts of nitrogen and enhancing phosphorus availability and yields of subsequent cereal crops as compared to short-duration legumes (Kerr et al., 2007). There is also a research report showing sustained and top yield with less bio-threat pressure when best teff varieties of three seasons are rotated with one season of growing of chickpea varieties in central highlands of Ethiopia (Fikre, 2016). Sanginga (2003) also reported that the actual amounts of nitrogen fixed by soybeans and their residual N benefits to subsequent cereal crops varied between 38 and 126 kg N ha$^{-1}$ in crop rotation system.

3.5. Contribution of grain legumes to smallholder livelihoods
Grain legumes hold a vital consequence in Ethiopia with various roles at diverse levels ranging from the farm household to the national economy at large. According to a report by Ferede et al. (2014), more than 8.5 million smallholder farmers are engaged in grain legumes production to generate their livelihoods. This is due to the fact that most legumes produce several products and serve for various purposes, during their growth or after harvest and are often referred to as being multipurpose (Muoni et al., 2019). These benefits include improving food and nutrition security, supplying income, soil fertility improvement, providing livestock feed, improving soil fertility, controlling soil erosion, water conservation, acting as a source of fuel and a range of other benefits. The contributions of various legume types and species to human food (kg ha$^{-1}$), livestock feed (kg ha$^{-1}$) and soil fertility (BNF ha$^{-1}$) are illustrated Table 3.

3.5.1. Provision of household food and nutrition
Grain legumes are well known for their nutritional values. Their seeds contain protein, soluble and insoluble fiber, slowly digested starch, micro and macronutrients, vitamins and numerous bioactive phytochemicals, such as flavonoids and other antioxidants (Watson et al., 2017). In terms of household consumption, grain legumes provide a cost-effective source of protein that accounts for approximately 15% of protein intake in Ethiopia (Yirga et al., 2010). A recent study by van den
Broek et al. (2014) indicated that grain legumes are much more cost effective than other protein sources like beef and chicken. As a protein source, legumes are more affordable for smallholders than meat, fish, and dairy products. Especially, grain legumes become the single largest source of protein during the fasting period for the 40% of Ethiopians who practice orthodox Christianity religion (Yirga et al., 2010). In terms of cost, legumes offer a cheap protein source for those low-income consumers who do not have access to animal products. For instance, soybean ranks first among grain legumes with 918 g of protein for 1 dollar whereas chicken has 76 g of protein for 1 dollar (Figure 7).

In Ethiopia, grain legumes are used for the preparation of various traditional foods although the methods of utilization of these food legume crops show somehow a sort of variability. For instance, “Wot” (grain legume stews) is the most widely served traditional dish in Ethiopia prepared from whole or dehusked and split legume seeds and/or its flour which can also be mixed with other food grains to prepare different traditional food items such as “Shiro” and bread. Legumes are also an important component of humanitarian assistance programs in the country (USDA Foreign Agricultural Service, 2018).
Most legume crops are widely considered as healthy foods and constitute an important component of the vegetarian dietary system for millions of low-income people in the developing world. It is estimated that, on average, legume crops contribute to 7.5% and 3% of the total protein and calorie consumption in developing countries, respectively (Ferede et al., 2014). Therefore, the nutritional study of the legume crops is of paramount importance, and accordingly, nutritional profile of the major food legumes has been analyzed, and existing varieties have been ranked according to their nutritional qualities. Breeding efforts on micronutrient (iron, zinc) enrichment in lentils and common beans have also resulted in the release of some micronutrient dense legume cultivars (Fikre, 2016).

### 3.5.2. Income source and generation

Current socioeconomic indicators showed that the Ethiopian economy is more of agricultural where agriculture accounts for 44% of GDP while the share of industry is limited to 11% of the economy. Besides, Ethiopian export is currently dominated by agricultural commodities that account for, on average, 75% of the total export earning of the country (Ferede et al., 2014). Grain legumes are important export commodity and sources of cash income for smallholder farmers as they are highly demanded in local and export markets. They have an income benefit both in terms of diversification and as they produce a higher gross margin than cereals. According to Yirga et al. (2010), grain legumes are generally more profitable than cereals, giving smallholders an economic incentive to their livelihood. This report, for instance, indicated that Faba beans provide the highest net return among the crops produced in Ethiopia, while chickpeas provide higher returns than barley and teff, but comparable returns to wheat.

The trends in the share of income generation of the three major commodities (coffee, oilseed and grain legumes) to total export earnings of Ethiopia is shown in Figure 8. Income generation from grain legumes can be through selling the products from legumes including grain, construction poles, livestock feed or livestock products derived from better feeding (Muoni, 2019). Besides, grain legumes gained the momentum to become strategic export commodities in diversifying and generating the sources of Ethiopian foreign exchange earnings (Yirga et al., 2010).

According to a report by Ferede et al. (2014), there has been a major improvement in export performance and income generation in terms of grain legumes value, volume and composition. For instance, the export revenue from grain legumes has increased from 35 million USD in 2005/06 to 160 million USD in 2011/12 with a corresponding growth in volume from 110 metric tons to 226 metric tons. Further, Ethiopia exported 340,000 metric tons of grain legumes in 2016/17, earning
255 million USD of which dried kidney beans (haricot beans) were the top-exported grain legumes, accounting for about half of all export volume (USDA Foreign Agricultural Service, 2018).

Ethiopian grain legumes export has been increasing significantly over the last decade mainly due to the ongoing promotion of commercialization of smallholder farmers and better incentives from global legume markets. For instance, in terms of composition of export, haricot bean stands first by contributing about 45% and 43% of the total grain legumes export volume and value, respectively, followed by chickpea (24%), faba bean (20%) and mung bean (6%) (Figure 9). Lentil is the fifth major legume export commodity by accounting for nearly 4% of the total legume export volume. Moreover, there is a varying trend in the composition of grain legumes export where legume export commodities such as chickpea, faba bean, and lentil have emerged to take a significant position in export trade.

Generally, smallholder income could be increased by at least 40–70% per hectare of legumes planted with better inputs and sound agronomic practices. In other words, there is an opportunity to stabilize and increase supply by improving production up to the full potential which would meet domestic demands. In addition, Ethiopia could expand its foreign market presence through increased production levels, which will lead to at least doubling of its current annual exports (Atnaf et al., 2015; Getachew, 2019).

3.5.3. Soil fertility improvement
Grain legumes serve as an important crop in different cropping systems for maintaining soil fertility through fixing atmospheric nitrogen into the soil and enhancing the biological turnover of phosphorous. It is estimated that globally, about 190 million ha of grain legumes contribute around 5 to 7 million tons of nitrogen to soils (Vidigal et al., 2019). Legumes have nitrogen-fixing properties that can reduce fertilizer usage for cereals in the next season by up to 60%. Given that cereal production causes higher soil nutrient depletion, intercropping and rotating between legume and cereal contribute towards maintaining soil health and can also reduce fertilizer usage (Yirga et al., 2010).

Legumes used as green manures can also provide considerable amounts of nitrogen to the soil that can greatly benefit subsequent crops. Leaf fall during crop legume development in the nodulated roots is also reported to contain up to 40 kg nitrogen ha$^{-1}$ (Srinivasaraao et al., 2012). There is fast evidence that using grain legumes in agricultural system increases organic matter and improves soil structure (Vidigal et al., 2019).

However, soil fertility benefits of legume depend on the legume–cereal ratio, the duration of legume biomass production and residue management. For instance, edible legumes are usually harvested and their leaves are used as a vegetable or for forage thereby reducing nutrient input to the soil. The nitrogen benefit of including a grain legume in a rotation has been estimated as 0–90 kg N ha$^{-1}$ for short or medium-duration soybean and generally higher for a longer-duration legume, such as pigeon pea that grows for about 180 days (Kerr et al., 2007).

3.5.4. Livestock feed and fodder
In addition to human consumption, legumes can be used for fodder due to their high protein content compared to many other fodders that are used to feed livestock. The fact that most legumes have a dual purpose (i.e., human and animal feed) makes them ideal for inclusion in crop-livestock systems that characterize smallholder agricultural system. Grain legumes can be utilized flexibly in diets of all ruminant species either in concentrate compound feed or as whole-crop forage (Watson et al., 2017). Moreover, the value of grain legumes in livestock production has been explored for forage legumes such as alfalfa (Medicago sativa), clover (Trifolium spp.) and vetch (Vicia sativa) (Chibarabada, Modi, & Mabhaudhi, 2017).

Inclusion of grain legumes in animal feed reported to be critical for sustainable meat and dairy production (Graham & Vance, 2003). Ibeawuchi (2007) reported that legumes are widely grown across
the continents and the seeds contribute to human nutrition while the crop residues are usually superior in nutritive value for livestock nutrition compared with the residues of cereals and other crops.

In Ethiopia, especially in the mixed farming systems of Ethiopian highlands, legume crop residues provide an important source of animal feed. Especially, smallholder farmers use grain legume residues for fodder in such a way that harvested pods, leaves and husks of grain legumes such as chickpea, lentil, cowpea, common pea, soybean, faba bean and lablab left in the field are used for animal grazing. This is mainly due to residue from grain legumes provides an excellent source of high-quality feed to livestock especially during the dry season, when animal feeds are in short supply (Vidigal et al., 2019).

Legumes have also been shown to improve both the quantity and quality of fodder, and thus, sustain feed production during the dry season and increase livestock productivity. Research in Ethiopian highlands also showed that forage legumes significantly increased the total fodder yield of barley and maize straw plus forage (Kassie, 2011). Grain legumes can also be used to make concentrates for livestock feed. For instance, unprocessed seeds of lupins and cowpea among others can be used to feed livestock. Groundnut is a potential livestock feed is where both haulms and seeds can be fed to livestock. The haulms may be fed directly or mixed with other fodder crops (Muoni, 2019).

3.5.5. Soil protection from erosion and water conservation
Legumes contribute to soil and water conservation in several ways including provision of soil cover during and after cropping seasons. The soil cover could be from crop residues laid as mulching material or from the live crop. High soil cover blocks the sun from directly heating the soil which reduces evaporation of water (Muoni, 2019). The residues from grain legumes cultivation can also preserve soil moisture, prevent soil erosion, and increase yields in the same piece of land (Vidigal et al., 2019).

In the intercropping system, legumes control soil erosion by preventing rain drops from hitting the bare soil where they tend to cover surface pores, prevent water from entering the soil and increase surface runoff. In maize-cowpea intercropping system, cowpea act as the best cover crop and reduced soil erosion. Similarly, sorghum-cowpea intercropping reduced runoff by 20–30% compared with sorghum sole crop and by 45–55% compared with cowpea monoculture. Taller legume crops act as wind barrier for short crops and controlling soil erosion especially in intercrops of taller cereals with short legume crops (Matusso et al., 2014; Nweke, 2018).

3.5.6. Provision of fuel
Approximately 80% of households in Sub-Saharan Africa use solid fuel for cooking and this results in a high demand for wood energy (Muoni, 2019). Hence, legumes are an integral part of household subsistence needs providing fuelwood. Especially, fast-growing legumes are commonly used for fuel wood. Additionally, crop residues of grain legumes including soybean, cowpeas and beans are used as kindling and occasionally for cooking (Duncan et al., 2018).

3.6. Major constraints of grain legumes production in Ethiopia
Although Ethiopia has huge potential to produce different grain legumes and benefit from their multiple uses, the production and productivity of grain legumes in the country is affected by a number of constraints and considerable gaps. Research and extension services in Ethiopia are very often weak and information provided to farmers is usually limited (Koroma et al., 2016). Due to this, grain legumes have got less attention as compared to cereal crops in terms of crop management and input utilization by different development actors’ especially smallholder farmers (Atnaf et al., 2015; Muoni et al., 2019).

Getachew (2019) indicated that the production and productivity of grain legumes in Ethiopia appears to be severely constrained by four major factors. These are limited or no use of chemical fertilizers, improved seeds, limited use of conventional agronomic practices, and human factors...
such as access and control over resources. Mainly, the limited availability of chemicals to control plant diseases and pests caused low productivity of legume crops. Smallholder farmers encourage monocropping and continuous cultivation of the same piece of land with limited use of agricultural inputs and soil amendment practices which result in soil nutrient depletion and create better conditions for pests and diseases thereby reducing the production and productivity (Habte et al., 2018; Koroma et al., 2016).

The available high-yielding legume varieties with market-preferred traits have not reached farmers on a large scale, and hence, the productivity of the crop has remained one of the lowest in the world. Farmers use local landraces which do not meet the quality and quantity requirements of international market despite their preference by domestic markets. Poor and inadequate seed systems, shortage of quality seed, lack of timely delivery and insufficient access to production credit to farmers are also major constraints of producing legumes in larger (Asfaw et al., 2010). Besides, declining soil fertility, insect pests and diseases are constraints limiting the production of grain legumes (Habte et al., 2018; Schneider & Anderson, 2010).

Marketing and connected problems are another reason for the low production of grain legumes in Ethiopia. The link between producers and the export markets is weak due to a large number of ineffective intermediaries operating in the value chain. The intermediaries have failed to acquire large scale and only operate in limited geographic areas. The fragmentation of intermediaries between the producer and consumer markets also creates a lack of transparency in markets (Yirga et al., 2010). High operational costs due to high transport costs, inadequate and poorly designed storage facilities, inadequate flow of market information, quantity and quality of supplies are among the sources of high marketing costs affecting the production and marketing of grain legumes (Atnaf et al., 2015; Habte et al., 2018).

In wider, Muoni et al. (2019) indicated that legumes production and productivity is lower than expected in east Africa including Ethiopia due to five important constraints viz.: (1) farmer unwillingness to test legumes species that are new to them due to limited resources and technologies; (2) insecure land tenure system in smallholder farms; (3) limited access to inputs and output markets; (4) high disease and pest incidences associated with management of legumes and (5) cereal dominated farming system. Generally, the low potential of grain legumes production and productivity is primarily due to low input usage, limited availability of seed and limited familiarity with the variety of existing legumes, and limited usage of modern agronomic practices, market problems and poor extension services.

3.7. Opportunities and the way forward in improving grain legumes production and productivity

Nowadays, grain legumes are receiving relatively better attention in research and development due to its importance for household consumption and national economy. Available evidences suggested that the legume sector has huge potential to reduce poverty and contribute to sustained economic development. This could be a great opportunity for increasing production, export earnings and other benefits accrued to the farm households. As a result, improving the availability of chemical fertilizers, pesticides and insecticides, improved seeds and financial services may improve the volume of production and yield of grain legumes in Ethiopia. Thus, the government of Ethiopia should more recognize the potential of legume sectors and promotes modern agronomic practices and improved legume technologies that boost the production and productivity.

There is a large diversity of grain legumes that fit into various agro-ecologies of Ethiopia implying that grain legumes can be grown in various environments. However, a few specific grain legumes are focused on leading farmers with limited choices and forcing farmers to grow them in unsuitable environments and risk crop failure. Thus, grain legumes should be promoted to increase both production and dietary diversity. These necessitate to broaden the grain legume production and productivity by increasing research, development and innovation on grain legumes.
With increased promotion of grain legumes, thus, there is an opportunity to exploit these genetic resources. Thus, there should be a policy to strengthen, promote and create positive awareness about the existing improved technologies.

The population of Ethiopia is expected to double by the year of 2050 compared with 2010, and the per capita domestic grain legumes demand is expected to increase by 62% in Ethiopia (van Loon et al., 2018). The rising population density and increased demand for grain legumes and, then, declining of land holding sizes are compelling smallholder farmers to practice the integration of different cropping systems and crops for intensively using their land and to sustain the demand of food. Thus, introduction of improved cereal-legume cropping technology should be given special emphasis to improve farmers’ profit and feed the increasingly growing population. On the other hand, decline in soil fertility in the high potential crop production areas is a major problem, while fertilizer use on legume crops is usually low (Asfaw & Shiferaw, 2009). To improve soil fertility, legumes should be incorporated into cropping systems through relay cropping, intercropping, crop rotations or double cropping.

The importance of indigenous knowledge has been realized in the design and implementation of sustainable development. Integration of appropriate indigenous knowledge into development programs has already contributed to efficiency, effectiveness and sustainable development impact. In Ethiopia, absence of effective linkage between indigenous knowledge and conventional ones has been identified as one of the major problems that hinder effectiveness of the development of the agriculture in general, and agricultural research and extension system in particular (Degaga & Angasu, 2017). Therefore, emphasis should be given on the use of available indigenous technical knowledge especially the legume-based agricultural systems which will enhance the production and productivity, improve the agricultural sector and increase the sector contribution.

Despite the country's potential and continued development efforts to enhance the legume sector, the competitiveness of this sector and its sustained contribution to economic development is hampered by low on-farm productivity, inefficient marketing system and inconsistent supply that does not meet quality export. Thus, different production technologies should also be supplied to farmers, along with knowledge on how to use them effectively, seed multiplication should be increased to adequately supply the needs of farmers, exporters and domestic demand. Besides, legumes sector should be strengthened to enhance on-farm productivity by developing a more efficient chain of inputs and off-take, establishing strong and stable export and ensuring consistent international demand.

Stronger linkages between exporters and farmers’ are essential for efficient marketing. Communicating the demand signal and market information to the producers ensure proper production of the necessary marketing system. In addition, smallholder farmers should be targeted and encouraged to grow varieties that meet quality standards, which will require appropriate cultivation and post-harvest handling practices to ensure the production and delivery of quality products. Moreover, enhancing the efficiency of grain legumes aggregation and trading activities will eliminate bottlenecks and ensure that an adequate amount of grain is produced and supplied to both domestic and international markets.

Given the importance of legumes for food and nutrition security and their key role in sustainable agricultural practices, promoting different packages which enhance the production of legumes is important for the national, regional and continental agricultural and food security policy. Consequently, legume platform could be an effective mechanism to promote increased promotion, production and trade, and to facilitate the development of an inclusive and effective regional value chain. Therefore, different national and regional platforms for grain legumes should be established to address specific bottlenecks affecting the production and trade of grain legumes. A well-designed promotion strategy and effective extension service platforms are also important in bringing different actors along the value chain and their interests together, thus, need to be further established and strengthened.
4. Conclusions
Agriculture is the fundamental driver for Ethiopia’s economy and long-term food security. The country has diverse agro-ecology that permits different agricultural systems and production of different crops especially grain legumes. Grain legumes are Ethiopia’s second most important group of crops, after cereals and contribute to smallholder crop production. Ethiopia is also one of the top 10 producers and suppliers of total grain legumes in the world. Besides, legumes have been used for many years by Ethiopian farmers in crop rotation and intercropping to maintain soil fertility. Legumes also hold a vital importance in improving food and nutrition security, generation of income, soil fertility improvement, providing livestock feed, soil erosion control and water conservation, and as a source of fuel. Even though grain legumes are critical to smallholder livelihoods in the country, the current production and productivity of legumes falls significantly below the potential. Low input usage, limited availability of seed and limited familiarity with the variety of existing legumes, and limited usage of modern agronomic practices, market problems and poor extension services are the major constraints accounting for this low production and productivity. However, Ethiopia has still different opportunities for enhancing the productivity of legumes including varied agro-ecology, diversity of grain legumes, population and urbanization trends, increased demand for animal feed and processed foods. Therefore, there should be a policy to strengthen, promote and create positive awareness and implementation of grain legumes production technologies.

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