SOIL & CROP SCIENCES | REVIEW ARTICLE

The challenges and prospects of Ethiopian agriculture

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Abstract: In the coming decades, ensuring food security is one of the greatest challenges in Ethiopia. Most Ethiopians practice mixed agricultural activity which represents about 33.88% of the country’s GDP. Therefore, this paper is devoted to reviewing the existing agricultural challenges and future prospects in the country. Majorly, it focused on the shortage of farmland, climate change, fragmentation and degradation of farmland, unevenly distributed constructions and urbanizations, pests, lack of integration among stakeholders, political instabilities, and its prospects. Despite the numerous challenges, Ethiopia has marvelous opportunities like the commercialization of fruit, vegetable, and ornamental plant productions. The country has also ample opportunity in the areas of animal production that ranks first in Africa in the number of livestock heads. The country has a huge labor force and water resources. It is proximity to Middle East markets is valuable to transport fresh products within a short period of time to the needed destination. However, Ethiopia’s current fruit, vegetable, and animal production for export are very limited because of fragmented cultivation and lack of quality. The country has also a great variety of climate and soil types that enables it to grow a diversity of horticultural crops. Therefore, emphasizing agriculture in Ethiopia requires the political as well as the economic commitment of all parties concerned.

Subjects: Agriculture & Environmental Sciences; Conservation - Environment Studies; Biodiversity & Conservation; Environmental Policy

Keywords: Challenges; climate change; deforestation; landlessness; lack of integration; land fragmentation; land degradation; urbanization

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PUBLIC INTEREST STATEMENT

Agriculture is the backbone of the Ethiopian economy. The majority of the Ethiopians are farmers but they have not yet secured food at large. This is constrained by abiotic and biotic factors. Therefore, it requires taking critical actions to solve it. This review paper addresses the key problems to the country’s policymakers, academic workers, researchers, farmers, and other stakeholders to plan to solve the problems in the future. Furthermore, it is used for utilizing the country’s agricultural productivity growth, political commitment, and scrutinize the necessity of mechanized farms at the national level.
1. Introduction

In the coming decades, ensuring food security for the Ethiopians will face great challenges. This is because of the rapid increment of population, change of fertile farmland to construction for the urban dwellers, climate change, decline of available natural resources, inflation of basic needs, young unemployment, political turmoil, and civil conflict (Alemu & Mengistu, 2019; FTF (Feed the Future), 2018; Simane et al., 2016). Overcoming these challenges requires a greater commitment of the governments, nongovernment, and other international organizations to assure the people's basic needs and inspire the citizens to commercialize agriculture through improving infrastructures, provision of incentives, and export the agricultural commodities.

International governments and organizations could support the country not only by the provision of credit and donation but also should make sure that the political and economic environment for permitting the intended goals. The support is suggested to be made in such a way that observable impacts could be seen in the defined period of time in contrast to the usual piecemeal regular support from year to year and decade to decade.

The food demand and price are increased in the recent decade than ever in Ethiopia. The variability of food price increment occurs within a short period of time, season, and years. For instance, the wholesale price unit of maize grain in the capital city of Ethiopia (Addis Ababa) alone increased from 1,469 to 5,013 from 2005 to 2012 in Ethiopian Birr (ETB) per ton (FAO (Food and Agricultural Organization of the United Nations), 2015) and the price is tripled in the last five years. The overall food prices in Ethiopia were inflated from 7.4 to 15.8% between the years of 2014–2019 (http://knoema.com/atlas). Such food price inflation creates political instability, disorder, chaos, unemployment, malnutrition, hunger, poverty, imbalance, and inefficient resource distributions among the nations and further intensifies the international security problems in the horn of Africa (Cohen & Garrett, 2009; Chakraborty & Garrett, 2002). The urgency and complexity of the problem of lack of food self-sufficiency, the inefficiency of economic development forced the Ethiopia government to secure food at very high cost (FAO, 2011; USDA (United States Department of Agriculture), 2010). On the other hand, the agricultural problems in the developed and developing countries like Ethiopia are not the same. In Ethiopia, it is characterized by high-input and resource-intensive farming systems that harmoniously caused losses of important microorganisms, massive deforestation, freshwater scarcities, soil nutrient depletion, and high levels of greenhouse gas emissions and then hindered agricultural outputs (FAO, 2017).

Ethiopians have dominantly practiced a mixed agricultural activity. Their livelihood is mainly based on tilling and herding of mammals and birds with little transformation for a long period of time in history because of religion and cultural preference (Diriba, 2020). However, agriculture is still the backbone of the country which represents about 33.88% of its GDP (Plecher, 2020). The agricultural sector of Ethiopia has shown remarkable resilience over many centuries though it is now increasingly failing. The country is known for the regular food shortage that occurred due to droughts, sudden outbreaks of natural disasters, pests, lack of rainfall, and shortage of technological advancement in the past centuries. Therefore, improving the implementation of extension service in agronomic practices, afforestation, protection of livestock and crop plants, accessing financial support, and accessing time-based markets can improve the livelihood of the community (UNCTAD, 2017). Political instability, weaknesses of successive strategic development policies and shortage of financial assistance in the country is the root cause of the problem. Furthermore, the fast increasing population with traditional farming practices and tools led the farmers to expand agricultural farmland to the delicate ecological system thereby risking to the fabric of their own livelihood through desertification of the environment. Lack of sustained and intergenerational commitments to transform the legal or constitutional system for millennia made the country liable. In Ethiopia, agriculture is started during the Neolithic revolution era, ten thousand years ago. It began with the domestication of crops and animals. The farmers continued to utilize their ancient system of production despite changing ecological and population pressures. Ethiopia’s population is growing into the 21st century with their generationally acquired wisdom and skills.
Ethiopia’s agriculture heavily relies on oxen plow and rain-fed that by neglecting other alternative technologies since the time of the Neolithic era (Diriba, 2020). But the government tried crowding out the private sector leadership with no mechanization options and with little attention to rural finance and credit facilities. It also did not indicate methods of curbing environmental degradation that could result from the lease of the natural resources to private investment be it agriculture or mining. The problems related to basic infrastructures like roads, hydroelectric generation plants, irrigation tools, and other farm equipment availability in the country and limitation of foreign currencies for importation also limited the attractiveness of the agricultural sector to private investors (Diriba, 2020). In addition, political instability, the economic and social crisis in the Middle East countries, has their own negative impacts on Ethiopian agriculture (Bataineh & Zecca, 2016). According to Diriba (2020), the practice of mechanized agriculture in Ethiopia is estimated at 0.7% for land preparation while it is less than 0.8% for crops thresher machines. These still indicated very little transformation in the utilization of technologies in production. Although important it was, in Ethiopia, academic workers have never been recognized as important developmental issues. A little modification has been made to bring internal transformation in the thinking and working habit of the people in the past century. However, traditional agriculture is inefficient to feed these populations unless further modifications are implemented in the policy of the country. These policy regulations may include changing the current fragmented agricultural activities into unified mechanized farming systems as a strategic developmental plan. Such developmental policy should take into account religious preference, cultural habits of the people, and protection against losses of biodiversity by strengthening the successive strategic plans. Generally, the Ethiopian agriculture outputs are challenged by complex production constraints of biotic and biotic factors. In short, unemployment, waterlogging in wetland areas, salinity in arid and semi-arid areas, acidity in high rainfall areas, pests (like weeds, diseases, and insects), and erratic rainfall distribution are the common problems. In addition, the country’s agriculture highly depends on rain-fed. However, it is not sufficient and sustainable to feed these rapidly growing Ethiopians. The impacts of the mentioned problems vary across the country, and from place to place. For instance, waterlogging is highly problematic in Vertisols of the highlands while salinity is in lowland areas of the country (Merga & Ahmed, 2019). The technological input like synthetic chemical fertilizers has also increased the acidity of soil from time to time in high rainfall areas. The mono-cropping system of some crops in the central highland of Ethiopia also led to nutrient depletion (Merga & Ahmed, 2019). Therefore, this paper is devoted to reviewing agricultural challenges and prospects in Ethiopia based on the available literature.

2. Challenges

2.1. Shortage and landlessness of arable farm land in the highlands
Arable land refers to the potential of land where its soil and climatic conditions are suitable for growing crops and rearing animals. It is settled with low population density and not protected by any land right regimen. Arable land is the most basic resource for farmers’ life which the majority of the energetic Ethiopians lacked or too small to use because it is divided into a number of small-sized parcels, degraded, fragmented and infertile. Nevertheless, arable land is an indispensable resource for Ethiopians to secure food and food self-sufficiency. It is projected that by 2050 the Ethiopia population will be estimated to be 171.8 million by increasing at a rate of 2.5% annually (Bekele & Lakew, 2014). This will demand an additional billion tons of cereal grains and 200 million tons of meat to be produced annually (FAO, 2017). It increased by around 70% based on the current estimation backgrounds. Ethiopia will be ranked fifth in the rate of population increment globally (UNDESA (United Nations Department of Economic and Social Affairs), 2019). This report indicated that India, Nigeria, Pakistan, the Democratic Republic of Congo, Ethiopia, Tanzania, Indonesia, Egypt, and the United States of America in descending order of population increment. This report also indicated that around 2027, India will be ranked first in the world by the population followed by China. The population of Sub-Saharan Africa countries projected to be doubled by 2050 (increased by 99%) (UNDESA, 2015).
Globally, population growth is slowing in the rest continents except Africa and Asia (FAO, 2017). Furthermore, feeding the population in the near future in developing countries like Ethiopia is expected to increase production and productivity. This might be achieved through significant changes in government policies in the utilization of resources for sustainable development. Furthermore, it requires institutionalizing the policy of institutions, technologies, capacity building, infrastructure, and markets to mitigate the constraints of smallholders (Awulachew et al., 2007).

In Ethiopia, the scarcity of arable farmland and landlessness increased than ever in general and very high in the highland areas in particular (Diriba, 2020). It is a serious problem of rural livelihood (Belay et al., 2017). It is also complicated by unequal distribution among the householders. This influenced the levels of income, opportunities, and ownership of assets. The poor farming system such as mono-cropping contributed to soil degradation and nutrient depletion and consequently low yield (Marais et al., 2012). But there is a critical lack of comprehensive study on the extent of landlessness, its effects, and coping mechanisms in the country (Adugna, 2019).

In Ethiopia, the land is allocated to farmers by the state. Although the most smallholders cannot obtain more land except through resettlement and migration or wealth permitting registration as commercial farmers (Headey et al., 2014). However, in recent times in Ethiopia resettlement of farmers to the new arable farmland or to other national regional states of Ethiopia are unthinkable. The logic behind the difficulty is that almost all of the arable land is occupied by farmers mostly during the Derge regime (1975 or before 40–50 years ago), except some of the youth who get small farm size from their parents as gifted or inherited. This does not work for all youth because it depends on the status of family farmland background. The farmland obtained in such a way is very limited to the individual capacity to work and difficult even to plow by oxen-power than tractor. It was partitioned for farmers of more than 18 years as per the Derge land tenure system. This is frequently partitioned up to 1991. It also reduced the plot size of farmland (Crewett et al., 2008). Based on this background, the state farmland provision for the farmer is more than 30–45 years and on average the current landowner is above 48–50 years of age at a minimum level. It is too old in the case of the current context or generations. At that time, the criteria of the provision of farmland are based on the number of families and cattle. The one who owns a large family and cattle received more.

Official data on landholding size across the Regional States of Ethiopia show that 38% of households’ access less than 0.5 hectares of land, 23.65% access between 0.51 and 1.0 hectares, 24% between 1 and 2 ha, and 14% have more than 2 hectares of land (Diriba, 2020) (Tables 1 and 2). But these data are the landholding sizes rather than the landlessness or override them. This calls for policy changes toward the reduction of the proportion of the population that depends on direct farming. Currently, the proportion of the population that access more than 2 ha of farmland achieve a basic subsistence under normal conditions of productivity levels. But even these 2 ha of land is not enough to produce an adequate supply of food for the average family (Lebeda et al., 2010; IFAD (International Fund for Agricultural Development), 2008; Gebresellassie, 2006). The persistent decline in the size of farmland also represents formidable challenges for mechanized farming and obtaining long-term capital investment (Diriba, 2020). The coping mechanism so far is sharecropping. Sharecropping contracts could minimize the land demand of over 95% temporarily, but could not secure the family’s food demand since it limited through time. Therefore, liberalizing the land market by lifting the land contract restrictions can enhance the exchange of land among rural households (Belay et al., 2017). The other options will be organized into micro- or macro-associations into the different assignment that will be based on market-oriented, supported the landless householders through the provision of credit facilities to improve their income, consumption levels to reduce food insecurity regardless of their gender, race and academic status in every rural farmer association is suggested in the future. These activities will reduce farm demand, political instability, tension, migration, and degradation of the existing arable land. Therefore, multiple stakeholders including farmers, agricultural organizations, political authorities, development practitioners, researchers, technology innovators, businessmen, investors, and entrepreneurs
## Table 1. Land use and household holding by region, 1997–1998

| Ethiopian National Regional States | households | holders | Total land use | Average land use/ household (ha) |
|-----------------------------------|------------|---------|----------------|----------------------------------|
|                                   | No. (000)  | %       | No. (000)      | %                               | Area (000 ha) | %        |
| Tigray                           | 588.78     | 6.34    | 603.71         | 6.35                            | 579.89       | 6.40     | 0.89     |
| Afar                             | 31.21      | 0.34    | 31.83          | 0.33                            | 20.76        | 0.23     | 0.67     |
| Amhara                           | 2802.62    | 30.16   | 2870.81        | 30.17                           | 2789.07      | 30.78    | 1.00     |
| Oromia                           | 3533.53    | 38.02   | 3630.73        | 38.16                           | 4309.89      | 47.57    | 1.22     |
| SNNP                             | 93.34      | 1.00    | 94.36          | 0.99                            | 81.50        | 0.90     | 0.87     |
| SNNP                             | 114.02     | 1.23    | 119.77         | 1.26                            | 147.84       | 1.63     | 1.30     |
| Gambela                          | 27.21      | 0.29    | 27.97          | 0.29                            | 15.98        | 0.18     | 0.59     |
| Harari                           | 11.64      | 0.13    | 11.66          | 0.12                            | 6.29         | 0.07     | 0.54     |
| Addis Ababa                      | 5.06       | 0.05    | 5.39           | 0.06                            | 8.56         | 0.09     | 1.69     |
| Total                            | 9292.87    | 100.00  | 9513.91        | 100.00                          | 9060.64      | 100.00   | 0.98     |

Source: CSA (Central Statistics Authority) (1998); ELPAA (Ethiopia Land Policy and Administration Assessment) (2004)
Table 2. Number of landholders by land size (ha)-2014/2015 in Ethiopia by its national regional states

| Regional States | <0.1    | 0.1–0.5 | 0.51–1.0 | 1.01–2.0 | 2.01–5.0 | 5.01–10.0 | >10     | Total    | %share  |
|----------------|---------|---------|----------|----------|----------|-----------|---------|----------|---------|
| Tigray         | 61,989  | 242,870 | 245,102  | 256,116  | 120,235  | 7,908     | 1,158   | 935,378  | 5.51    |
| Afar           | 479     | 4,124   | 2,683    | 1,717    | 416      | -         | -       | 9,419    | 0.06    |
| Amhara         | 315,832 | 924,145 | 1,089,212| 1,423,634| 718,963  | 35,558    | 2,033   | 4,509,377| 26.57   |
| Oromia         | 295,494 | 1,376,669| 1,516,824| 1,772,376| 1,169,506| 143,707   | 7,483   | 6,282,059| 37.01   |
| Somali         | -       | 21,695  | 21,991   | 27,893   | 16,525   | 1,623     | -       | 89,727   | 0.53    |
| Benishangul-Gumuz | 27,008 | 55,186  | 46,041   | 47,057   | 37,393   | 5,958     | 1,172   | 219,815  | 1.29    |
| SNNP           | 595,716 | 2,477,863| 1,067,941| 539,482  | 147,127  | 9,187     | 1,681   | 4,838,997| 28.51   |
| Gambela        | 9,184   | 20,227  | 7,399    | 3,931    | 1,190    | -         | -       | 41,931   | 0.25    |
| Harari         | 1,328   | 9,309   | 8,239    | 5,167    | 989      | -         | -       | 25,032   | 0.15    |
| Dire Dawa      | 646     | 9,033   | 9,345    | 3,772    | -        | -         | -       | 22,796   |        |
| Total          | 1,307,676| 5,119,426| 3,992,786| 4,053,252| 2,195,819| 202,318   | 13,527  | 16,974,531| 100     |
| % age          | 7.70    | 30.29   | 23.65    | 24.04    | 13.03    | 1.20      | 0.08    | 100      |        |

Source: CSA (Central Statistics Authority) (2015) and Diriba (2020)
should be working for hand in coordination and collaboration to deal with and solve these complex problems.

Generally, the landless farmers become at risk in Ethiopia at this moment than the previous feudal systems or before the Derge regime. This is because the land rent becomes unavailable and the government police are also inefficient on this side. Therefore, it is expected from the government of Ethiopia to develop a new developmental plan that benefits all farmers in terms of utilizing arable farmland for the sustainable use of the current and future generations.

2.2. Land fragmentation
The already small size farmland of a family is further fragmented into very small pieces of land when the children inherited since it divided among themselves. This is an impediment to increasing yield and rather leads to poverty and food insecurity. Because many family members will be becoming jobless since the land is not enough to engage them as full-time farmers. It has been discovered from the Ethiopian national survey that the relationships between yield, farm size, and land fragmentation have an inverse relationship that is, a positive association between yield and land fragmentation (Paul & Githinji, 2018). In contrast to this finding, Knippenberg et al. (2020) reported that in Ethiopia, land fragmentation resulted in food insecurity and increased the amount of time spent moving from one parcel to another that lowered agricultural output and reduced productivity. It is also difficult to implement mechanize farms, inefficient to work on it to secure the families demand because the small farm size cultivated is yielded lower. Therefore, farm size affects agricultural sustainability in the economy, social aspects, and environmental performance of agricultural production, for instance, increasing farm size has a positive impact on farmer’s net profit, economic benefits, technical and labor efficiency with mean coefficients of 0.005, 0.02, and 2.25 in China, respectively (Ren et al., 2019). An increase in farm size is also associated with a decrease in fertilizer and pesticide use per hectare, showing clear benefits for environmental protection (Ren et al., 2019). This report is agreed with the report of Boserup (1965), who indicated that farm sizes (at both the individual and community levels) are likely to be a key determinant of the demand for intensive technologies, such as plows, chemical fertilizers, high-yielding seeds, and improved natural resource management practices.

Fragmentation of farmland affects the smallholder communities highly to produce in a sustainable manner following an inadequate policy that used to respond with the available endogenous technological changes and population growth (Headey et al., 2014). In Ethiopia, the farmland is highly fragmented in the central northern parts than other parts (Figure 1).

Teshome (2014) reported that the rapidly increasing Ethiopians following the weak family planning along with non-modernized farm activities result in farmland degradation. Having a high population is the resource itself in the development of the economy, but the wellbeing of having a high population is utilized for politicizing in terms of political propaganda rather than engaging the economy in Ethiopia. Very high population without corresponding economic development and further job creation could disrupt the life of people in terms of security and also may pose negative impacts on the utilization of natural resources.

The vast majorities of smallholder farmers of Ethiopia living in perpetually substandard conditions, relying on traditional systems, undercapitalized; farm on fragmented land, depleted soil fertility with high competition of pests, and low investment in agricultural inputs (chemical fertilizer, improved seeds, and pesticides) (ATA, 2014). This made the farmers unable to withstand seasonal risks of crop failure or animal deaths that even worsen the problem and force them to live in continuous poverty and are hopeless. Many are now forced to rely on welfare assistance aid and dependent on imported cereals (Diribo, 2020).

Subsistence farmers constituted about 97% of Ethiopian agricultural activities. They farm on very small plots of fragmented land and often are used unsuitable primitive techniques that are not
effective for their agro-ecological zones (Lebeda et al., 2010). This report also argued that the farmers are barely able to feed their families and contributed to further environmental deterioration. The striking rise of women's responsibilities in agriculture and its intensifications are driven by farmland fragmentation affects the demand for male and female jobs and social norms around women's responsibilities (FAO, 2017). Most of the Ethiopian farmers have farmland that is fragmented into two to three plots or parcels (Table 3).

2.3. Climate change
Ethiopia is vulnerable to climate change. It posed a huge challenge to Ethiopians. Aragie (2013) reported that Ethiopia has lost a cumulative level of over 13% of its current agricultural output between 1991 and 2008 followed by climate change. For instance, rainfall is one of the most noticed climate variables in the country. It varies from season to season, and year to year across agro-ecological regions [(Dega (high land), Woina Dega (midland), and kola (lowland)] of the country (Shekuru et al., 2020) (Tables 4, 5, and 6). Its distributions over the country are strongly

| Table 3. Farmland fragmentation in Ethiopia |
|--------------------------------------------|
| Number of plots per farm | Number of farmers (%) | Average farm size per plot (ha) |
|----------------------------|-----------------------|-------------------------------|
| One plot                   | 44                    | 0.34                          |
| Two plots                  | 23                    | 0.37                          |
| Three plots                | 13                    | 0.36                          |
| More than three plots      | 20                    | 0.33                          |
| More than four plots       | 11                    | 0.32                          |
| Average number of plots (=2.3)| 50                        | 0.35                          |
| N                          | 4589                  |                               |

Source: Gebreselassie (2005)
Table 4. Monthly, seasonal and annual rainfall variability by Agro-ecological zones from 1979 to 2013

| Month | Dega | | | | Woina Dega | | | | Kolla | | |
|-------|------|---|---|---|---|---|---|---|---|---|---|---|
|       | Min (mm) | Max (mm) | Mean (mm) | % | Std. D | CV (%) | Min (mm) | Max (mm) | Mean (mm) | % | Std. D | CV (%) | Min (mm) | Max (mm) | Mean (mm) | % | Std. D | CV (%) |
| Jan.  | 0.0 | 71.1 | 17.3 | 1.1 | 17.3 | 100 | 0.0 | 15.3 | 4.7 | 0.7 | 4.4 | 94 | 0.0 | 3.6 | 0.8 | 0.2 | 1.1 | 128 |
| Feb.  | 0.0 | 124.0 | 29.9 | 2.0 | 33.6 | 112 | 0.0 | 37.5 | 7.9 | 1.1 | 9.5 | 121 | 0.0 | 16.6 | 2.4 | 0.6 | 3.8 | 161 |
| Mar.  | 0.3 | 246.0 | 68.9 | 4.5 | 52.0 | 75 | 0.1 | 95.0 | 23.6 | 3.3 | 19.7 | 84 | 0.0 | 55.3 | 10.9 | 2.7 | 13.7 | 126 |
| Apr.  | 8.0 | 195.3 | 85.2 | 5.6 | 54.0 | 63 | 1.9 | 57.3 | 24.9 | 3.5 | 17.5 | 70 | 0.0 | 354 | 9.4 | 2.3 | 10.4 | 112 |
| May   | 1.9 | 193.9 | 67.8 | 4.5 | 56.5 | 83 | 0.3 | 95.2 | 28.2 | 4.0 | 27.5 | 97 | 0.0 | 790 | 12.5 | 3.1 | 19.2 | 154 |
| June  | 44.5 | 421.2 | 195.6 | 12.9 | 81.2 | 42 | 18.2 | 204.8 | 88.4 | 12.4 | 42.0 | 48 | 3.6 | 125.1 | 37.7 | 9.2 | 24.6 | 65 |
| July  | 199.1 | 604.8 | 423.6 | 27.9 | 73.8 | 17 | 76.7 | 288.0 | 214.9 | 30.2 | 42.5 | 20 | 41.2 | 223.2 | 141.0 | 34.6 | 37.1 | 26 |
| Aug.  | 299.5 | 583.1 | 400.5 | 26.3 | 68.6 | 17 | 145.2 | 331.5 | 210.1 | 29.6 | 42.3 | 20 | 77.0 | 237.2 | 145.9 | 35.8 | 32.5 | 22 |
| Sept. | 72.4 | 276.9 | 178.0 | 11.7 | 50.2 | 28 | 22.8 | 134.5 | 84.5 | 11.9 | 27.4 | 32 | 7.2 | 813 | 39.7 | 9.7 | 17.6 | 44 |
| Oct.  | 0.1 | 158.6 | 36.4 | 2.4 | 37.9 | 104 | 0.0 | 81.6 | 17.5 | 2.5 | 19.4 | 111 | 0.0 | 328 | 6.3 | 1.5 | 8.7 | 138 |
| Nov.  | 0.1 | 55.2 | 9.5 | 0.6 | 14.8 | 156 | 0.0 | 20.6 | 3.6 | 0.5 | 5.6 | 156 | 0.0 | 7.2 | 1.0 | 0.2 | 2.1 | 209 |
| Dec.  | 0.0 | 31.6 | 7.8 | 0.5 | 8.9 | 115 | 0.0 | 9.7 | 2.3 | 0.3 | 2.6 | 111 | 0.0 | 2.3 | 0.4 | 0.1 | 0.6 | 147 |
| Belg  | 82.3 | 535.1 | 251.8 | 16.6 | 111.7 | 44 | 28.9 | 190.9 | 84.7 | 11.9 | 42.4 | 50 | 3.5 | 114.5 | 35.1 | 8.6 | 27.6 | 79 |
| Kiremt| 761.7 | 1513.8 | 1197.7 | 78.8 | 172.0 | 14 | 330.7 | 823.3 | 597.9 | 84.1 | 99.6 | 17 | 170.5 | 494.6 | 364.3 | 8.93 | 68.2 | 19 |
| Annual| 921.6 | 2019.2 | 1520.4 | 100 | 242.5 | 16 | 375.7 | 1006.5 | 710.6 | 100 | 128.5 | 18 | 186.0 | 584.1 | 407.9 | 10 | 84.9 | 21 |

Source: Shekuru et al. (2020)
inconsistent in each season (Kew et al., 2017; Fekadu, 2015; McDonald, 2010). The variation of climate change in Ethiopia is not limited to rainfall but includes temperatures (Tables 7 and 8), relative humidity, wind, and others. The lowlands are vulnerable to increased temperatures and prolonged droughts, while the highlands suffered from more intense and irregular rainfall. This aggravated soil erosion, low agricultural output, conflict, and food insecurity in the country (MoFAN (Ministry of Foreign Affairs of the Netherlands), 2018). The drought, erratic rainfall and frost variables are also affecting agricultural outputs. It reduces crop yield, nutrition, groundwater, soil organic matter, soil quality, soil health, and incomes (Melese, 2019; Tufa, 2019), vegetation coverage, and its phenology (Tenaw & Debella, 2017) and caused socio-economic problems in Ethiopia (Getahun, 2017). The reduced precipitation and rise of temperature could influence agricultural practices and their results widely (Shekuru et al., 2020).

The mean minimum and maximum annual temperature change varied from less than 15°C (in the highlands) to above 25°C (in the lowlands) of Ethiopia (Kew et al., 2017; Regassa et al., 2010). It is reported that over the last 40–50 years, the mean annual temperature of Ethiopia increased from 0.2°C to 0.28°C per decade (McSweeney et al., 2010). Whereas the temperature increased by 1.3°C from 1960 to 2006 (Asaminew & Diriba, 2015). However, in contrast to this finding, Aragie (2013) reported that in the past four decades the annual temperature increased by 0.37°C per decade. This report also indicated that much of the temperature increment happened in the dry and hotspots of the country. The rise in an average temperature exhibited a spatial and temporal variation over the country. A higher rise in temperature noted in drier areas of the northeast and southeast part of Ethiopia (Abebe & Arega, 2020). Notably, the variability is higher between July and September. The number of hot days and hot nights increased in this duration of the season (Asaminew & Diriba, 2015). Consequently, the country’s minimum temperature has increased by 0.37°C to 0.4°C per decade (Astawseg, 2014). Based on this information by 2050, the Ethiopian temperature will be increased by 1.7–2.1°C than the present (Befikadu et al., 2019).

Shekuru et al. (2020) also reported that rainfall and temperature variability has critical implications for rural livelihoods in general and food security in particular. Variations and fluctuations in rainfall and temperature compromise, among others, the productive performances of the agricultural sector and make rural households at risk. Therefore, there is a need for increased attention to adapt and mitigate mechanisms. The adverse impact of climate variability varies. Furthermore, mitigating the variability of climate change helps the most vulnerable group of the society to stabilize farmer’s income during drought and poor output (Shekuru et al., 2020).

The northern part of Ethiopia is highly affected historically by drought/famine several times. For example, in 1913/14 (Northern Ethiopia), 1920/22, 1932/34, 1953, 1957/58, 1964/66, and 1973/74 (Tigray and Wolo), 1983–1984, 1987–1988, and 1990–92, 1993/94 (Wolde-Georgis, 1997) and recently in 2015/2016 (Eastern parts of Ethiopia followed by ElNiño).

Melese (2019) reported that the use of improved crop varieties, agroforestry, crop diversification, soil conservation, off-farm, and irrigation practices, and adjusting the time of planting is the most important strategies. These strategies are required to be adopted by smallholder farmers. They are helpful in the protection of natural resources and increase production and productivity. Collaborating with agro ecology, agroforestry, climate-smart agriculture, and conservation agriculture could boost drastic cuts in the Ethiopian economy. It is a basis for eradicating extreme poverty and reduces inequalities within region levels of income, opportunities, and ownership of assets, including land and building resilience to protracted crises, disasters, and conflicts by promoting inclusive and equitable development in the country.

Increasing food demands through intensive competition on the available natural resources are the root causes of increasing greenhouse gas emissions, massive deforestation, losses of flora and fauna species, and land degradation (FAO, 2016), soil nutrient depletion, water scarcities particularly freshwater, violations or conflicts of interest, shortage of food availability, disrupt access to
food and health care and undermining of social protection systems are pushing many affected people back into poverty. Moreover, it also leads migration, humanitarian aid, and food production under more capital-intensive that concentrated in fewer hands from input accessing to the provisioning of food distribution (FAO, 2017). Small-scale producers and landless households are the most vulnerable to climate change in Ethiopia. Following climate change, the small-scale, and landless farmers migrate to the urban to seek other employment opportunities, especially male members of rural households, which is leading, in turn, to the feminization of farming in many parts of the world (FAO, 2017).

2.4. Land degradation and deforestation

More than 85% of the Ethiopian land is degraded to various degrees (Gebreselassie et al., 2016). This report also indicated that in the past three decades, 23% of the land area is degraded based on estimation using satellite imagery spots that could be translated to 54 USD billion, and the annual cost of land degradation associated with land use and change of cover is estimated to be about 4.3 USD billion. It is also estimated that over 1.5 billion tons of soil per year are lost by erosion and flooding which could have added about 1.5 million tons of grains to the Ethiopian products (Lebeda et al., 2010). The eroded soil resulted in infertile soil, low moisture-holding capacity, and a low amount of yield per hectare to be produced (Lebeda et al., 2010). It also declines the levels of arable land availability (Campbell, 2011; Pender et al., 2006). Hitherto the most of the existing literature on Ethiopian agricultural development has focused on resource degradation as the root cause of constraints to sustainable production and productivity (Headey et al., 2014).

Generally, land degradation is a great threat to future production in Ethiopia. It caused severe loss of fertile soil and disturbs the sustainability of land resources due to the low supply of organic matter (Gashaw et al., 2014; Taddese, 2001). Its rate has increased with increasing of Ethiopians, overgrazes, deforestations, utilizes of dung, and crop residues for fuel and other uses. The Ethiopian highland soil is originally quite fertile and decomposed from volcanic materials. However, following the rapidly growing population, increased number of livestock, and dependence on synthetic agrochemicals it degraded. Organic materials such as organic manure and

| Month | Min. | Max. | Mean | % | Std. D | CV (%) | Z (M-K) | P-value | Slope |
|-------|------|------|------|---|-------|--------|---------|---------|-------|
| Jan.  | 0.00 | 30.37| 8.38 | 0.89 | 8.09 | 0.9656 | -0.852 | 0.394 | -0.08 |
| Feb.  | 0.01 | 56.29| 14.50| 1.54 | 16.46| 1.1356 | -2.56**| 0.011 | 0.557 |
| Mar.  | 0.16 | 139.41| 37.03| 3.94 | 28.55| 0.7710 | -0.852 | 0.394 | -0.354 |
| Apr.  | 3.89 | 99.50| 42.92| 4.56 | 27.90| 0.6500 | 0 | 1 | -0.007 |
| May   | 8.83 | 125.96| 39.32| 4.18 | 35.49| 0.9027 | -0.256 | 0.798 | -0.122 |
| June  | 25.05| 266.33| 117.35| 12.48 | 52.08| 0.4438 | -2.073**| 0.038 | -1.46 |
| July  | 112.80| 381.86| 274.65| 29.21 | 50.83| 0.1851 | 1.136 | 0.256 | 0.179 |
| Aug.  | 188.78| 402.78| 265.01| 28.19 | 48.14| 0.1816 | -0.256 | 0.798 | -0.170 |
| Sept. | 37.99| 174.85| 109.68| 11.67 | 33.21| 0.3027 | -0.54 | 0.589 | -0.443 |
| Oct.  | 0.05 | 100.03| 22.28| 2.37 | 24.00| 1.0773 | -0.852 | 0.394 | -0.172 |
| Nov.  | 0.06 | 30.27| 5.20 | 0.55 | 8.14 | 1.5647 | -0.91 | 0.363 | 0.027 |
| Dec.  | 0.00 | 15.73| 3.89 | 0.41 | 4.37 | 1.1243 | -0.114 | 0.910 | -0.002 |
| Belg  | 45.71| 281.24| 133.77| 14.23 | 61.56| 0.4602 | -1.562 | 0.118 | -1.761 |
| Kiremt| 453.01| 1001.16| 766.69| 81.55 | 117.26| 0.1529 | -0.568 | 0.570 | 0.993 |
| Annual| 532.40| 1287.75| 940.20| 100 | 157.78| 0.1678 | -1.28 | 0.201 | -2.830 |

** is statistically significant at p < 0.05
Table 6. Annual, Kiremt (summer) and Belg (autumn) Precipitation Index (PCI) for 1979–2013

| PCI (%) | Description | Observation years (%) |
|---------|-------------|-----------------------|
| ≤10     | Uniform rainfall distribution/low concentration | - | 57.1 | 11.4 |
| (10–15) | Moderate rainfall distribution | - | 42.9 | 65.7 |
| (15–20) | High concentration/irregular rainfall distribution | 28.6 | - | 20 |
| >20     | Very high concentration/irregular rainfall distribution | 71.4 | - | 2.8 |

...straw has been used for soil amelioration. But this has been used for fuel as the forest trees diminished. These are the combined constraints that reduce the soil mass, productivity, health, soil quality, and fertility (Woreka, 2004).

Soil erosion is an endogenous factor that happened during heavy rainfall and wind. In fact, the soil erosion caused by rainfall is severe on the topography of the land that has a slope of more than 16%. But this situation is exacerbated by man-made factors like deforestation, cultivation, or plowed vertical along a downslope direction that increases runoff and soil erosion (Bishaw, 2001).

Soil erosion is a serious problem in Ethiopia and requires urgent intervention to secure the food demand of the people (Woreka, 2004). The annual rate of soil loss is higher than the annual rate of soil formation.

Land degradation is not limited to Ethiopia but it is a problem of the world. Globally, the total degraded land area was estimated from a range of fewer than one billion hectares to over six billion hectares with the variation of its spatial distribution (Gibbs & Salmon, 2015) (Figures 2 and 3). It accounts for about 33% of the land area (FAO, 2015). It was highly aggravated in the Middle East countries of the world (Figure 2). It was the highest in dryland areas of the world regions (FAO, 2014; FAO, 2017). Twenty-four (24) % of the degraded areas are found in Africa, South-East Asia, and South China, North-central Australia, Pampas, Swaths of the Siberian and Northern American taiga; 1.5 billion people live in these areas (Bai et al., 2008). FAO (2011) and https://blog.agrivi.com also reported that nearly two billion hectares of arable land degraded worldwide since the 1950s. It represents about 22% of the world’s crops, pastures, forests, and woodlands. In particular, Africa and Latin America have the highest proportion of degraded agricultural land whereas Asia has the largest proportion of degraded forest land as revenue-poor national governments pursue lucrative policies of deforestation. As FAO (2010) report indicated, the soil erosion hazard, aluminum toxicity, soil shallowness, and hydromorphone are constraining 13–16% of the global arable land areas. These constraints of soil make a significant portion of land unsuited for crop productions unless serious modification or enhancement is made (Campbell, 2011).

Globally, about 3.2 billion people are affected by land degradation (https://www.thegef.org/topics/land-degradation) (Figures 2 and 3). Worldwide, it expences more than 18–20 USD trillion USD annually (UNCCD (United Nations Convention to Combat Desertification, 2019). It also affects the natural ecosystem, soil organic carbon, and soil health which is estimated to reach 212 Gt by 2050 (UNCCD, 2019).
The global soil organic carbon net’s primary production is reduced at least by 5% due to the loss of natural ecosystem functions, which is estimated at an economic value of between 6.3 USD-$10.6 trillion per year (or 10–17% of global GDP) (UNCCD, 2019). Furthermore, it resulted in unsustainable land-use practices. Excessive use of chemical fertilizers, mono-cropping; deforestation, soil erosion due to poor soil management practices such as over-cultivation of soils or overgrazing added to the problem. Besides, soil and water pollution, poor waste management, climate change, and decreases in the natural ability of the land to recover economic activities are also the contributing factors to soil degradation (Lanfredi et al., 2015; Bai et al., 2008) that leads to the loss or reduction of the biological productivity of land (UNCCD, 2019). Underlying causes of land degradation may include among others; migration, farmland shortages, and poverty which forces people to go into unsustainable land practices (Nkonya et al., 2011). Weak institutional and policy frameworks further may fail to enforce proper land administration and use (Dubovyk, 2017).

Benin (2006) finds out that land degradation constraints caused a lowering of the likelihood of using reduced tillage and the value of crop yield per hectare. At the same time, the net farm income per hectare is not responsive to the rising of constraints. In general, land degradation is an impediment to realizing food security in reducing hunger (FAO, 2017). The above-raised problems contributed a picture of increased degradation of existing arable land, as well as difficulties with making new arable land in the future.

The increased population and landlessness of the subsequent farming generations led to unwise use of natural resources in general and forest in particular. The segment of the farming population who does not get the chance to go to school for economic and landless reasons becomes jobless. They may force to cut down the tree to make charcoal. The deforestation rate in Ethiopia accounts for 1.25% of forest and other woodlands 1.8% annually per year (GFRA (Global Forest Resources Assessment), 2015). Sutcliffe (2009) reported that in western Ethiopia, in the Baro-Akobo basin areas alone the average annual net loss of forest through deforestation is estimated to be $42-5 million. Deforestation impacts agriculture through natural disturbance, including biodiversity loss (Oljirra, 2019; Bishaw, 2009), damaged habitat, aridity, adverse soil erosion, degradation of wasteland, extinction of life, and displacement of populations (Culas, 2006).
Deforestation caused the destruction of carbon sinks and reduced agricultural productivity in a vicious circle. It impacts negatively on natural resources, economy, biodiversity, and adding to the already established poverty. It accelerates soil erosion, flooding, and drought. It reduces yield, flora, fauna, and soil productivity and affects the hydrological balances negatively.

2.5. Unevenly distributed constructions and urbanizations
The fertile arable land in rural, sub-town, town, sub-cities, and cities of Ethiopia is grabbed by different government authorities and individuals for construction of the house, school, road, etc. These are reducing the farmland and increasing displacement of the farming community. Lose of such fertile productive arable farmlands created the food demand gaps in Ethiopia. A rural community settlement has another negative impact on the utilization of farmlands for mechanization. More than 80% of the population lives in rural areas where farming (i.e. crop productions and animal rearing) took place. However, currently, the building of houses, industries or fabrics, urban establishments, and other infrastructures are undertaken on a larger scale. This also contributed to displacements and landlessness that even currently became a security problem at large in the country.
2.6. Pests
Crop and animal diseases such as fungi, bacteria, viruses, and nematodes; insect pests, rodents, and birds are common problems in Ethiopia. The maize lethal necrotic viruses, leaf and fruit spot of citrus (Pseudocercospora angolensis), Bacterial wilt (Pseudomonas solanacearum) of ginger (Duressa, 2018), garlic rot (Sclerotium cepivorum Berk), Bacterial wilt of ginger (Ralstonia solanacearum), and new races of wheat stem rust (Puccinia graminis f. sp.tritici (1b) are among the major crop diseases (MoANR, Ministry of Agriculture and Natural Resources, 2016). There are a number of weed species that are invasive, introduced, into Ethiopia at different times are including parthenium (Parthenium hysterophorus L. ( Asteraceae)); water hyacinth (Eichhormia crassipes (C. Mart.)), Solms (Liliales: Pontederiaceae); mesquite, Prosopis juliflora (SW) DC (Fabacea) and parasitic weed (Crenata broomrape, Orobanche crenata Forskal on fava bean and witchweed, Striga hermonthica (Delill) Benth, Orobancheaceae) on sorghum are affecting the country’s economy (MoANR, 2016).

Arthropod pests such as locust (Schistocerca gregaria), fall armyworm (Spodoptera frugiperda), African armyworm (Spodoptera exempta), stalk borer (Busseola fusca, Chilo partellus and Sesamia calamistis), cutworm, fruit flies (Ceratitis cosyra, C. fasciventris, C. rosa, C. ananae, and C. capitata, Bactrocera dorsalis, B. invadens), termites (Macrotermes, Odontotermes, Microtermes, etc), weevils ([Sitophilus spp.], grain moths (Sitotroga cerealella), and bean bruchids (Acanthoscelides obtectus, Bruchus pisorum, and Zabrotes subfasciatus), aphids, thrips, two-spotted spider mites (Tetranychus urticae), white mango scale insects (Aulacaspis tuberculatis), etc.), Tomato leaf miner (Tuta absoluta) (Duressa, 2018) are the most important in Ethiopia when they occur. Monkeys, apes, rodents (rats and mice), and birds (e.g., Quelea quelea) are also causing severe crop losses in Ethiopia. In 2018–2020 years alone the locust caused high-yield losses in the rift valley, eastern, north-central, and northern parts of Ethiopia. The majority of insect pests of economic importance in Ethiopia belong to the category of regular based on their occurrence as indicated in Table 9.

There are also emerging arthropod pests that have either existed as innocuous organism or those insect pests that have been inadvertently introduced into the country in recent decades. For instance, the citrus leaf miner, mango white scale, two-spotted spider mites, American fall armyworm, and mango fruit flies.

Ticks (species of Rhipecephalus appendiculatus, Boophilus decolaratus, Rhipecephelus evertsi, and Amblyomma variegatum), Tsetse Fly (Glossina pallidipes), Mange (Choripotes bovis, the Sarcoptes), biting flies (Stomoxys calcitrans (stable Fly)) are vector-borne parasitic diseases of livestock and endoparasites such as helminths (nematodes: Haemonchus, Ostertagia, Trichostrongyulus (chaerbertia, oesophagostomum), Nematodirus, Bunostomum (hookworm), Toxocara vitulorum, cooperia, Dictyocaulus, estodes: moeniezia genus, cysticercus, Echinococcus granulosus), Trematodes (Fasciola hepatica, and Fasciola gigantica) and Coccidia are directly constrained livestock production in Ethiopia (Diriba, 2020; Welay et al., 2018; Ministry of Agriculture, 2014).

| Agro ecology | Mean (°C) | Std.D | Min (°C) | Year | CV(%) |
|--------------|----------|-------|----------|------|-------|
| Dega         | 8.46     | 0.52  | 9.52     | 2010 | 7.41  | 1984 | 6.12|
| Woina-dega   | 9.81     | 0.51  | 10.93    | 2010 | 8.84  | 1984 | 5.18|
| Kala         | 10.86    | 0.49  | 11.66    | 2010 | 9.84  | 1984 | 4.49|
Table 9. Examples of major regular insect pests in Ethiopia

| Scientific name | Common name     | Crop(s) attacked          | Geographical distribution                      |
|-----------------|-----------------|---------------------------|------------------------------------------------|
| *Busseola fusca*, *Chilo partellus* and *Sesamia calamis* | Stalk borers | Maize and sorghum | Cosmopolitan                                    |
| *Helicoverpa armigera* | African boilworm | Cotton, vegetables and pulses | Cosmopolitan                                    |
| *Acrithosiphon pisum* | Pea aphid | Field pea and faba bean | Cosmopolitan                                    |
| *Pachnodia interrupta* | Sorghum chafer | Sorghum and maize | Amhara, Afar, Oromia, and Tigray               |
| *Diuraphis noxia* | Russian wheat aphid | Wheat and barley | Amhara, Oromia, and Tigray                     |
| *Several species* | Grasshoppers | Tef                         | Amhara and Oromia                               |
| *Decticoides breipennis* | Welo bush cricket | Tef                         | Amhara                                         |
| *Ophiomyia phaseoli* and *O. spencerella* | Bean stem maggot fly | Haricot bean | Cosmopolitan and most important in Southern parts of Ethiopia |
| *Phytothoraima opercula* | Potato tuber moth | Potatoes and tomatoes       | Awash valley                                    |
| *Thrips tabaci* | Onion thrips | Onions and shallots | Cosmopolitan                                    |
| *Brevicoryne brassicae* | Cabbage aphid | Cabbage                     | Cosmopolitan                                    |
| *Ceratitis capitata* | Med fly        | Citrus                      | Awash valley                                    |
| *Anoniella aurantii* | Red scale      | Citrus                      | Cosmopolitan                                    |
| *Cryptophlebia leucotreta* | Codling moth | Citrus                      | Awash valley                                    |
| *Antestiopsis intricata* | Antestia bug | Coffee                      | Cosmopolitan                                    |
| *Stephanodares hampei* | Coffee berry borer | Coffee                      | Cosmopolitan                                    |
| *Leucoptera spp.* | Leaf miners    | Coffee                      | leucotreta                                      |

Source: Esheteu et al. (2006)

2.7. Age structure of rural populations

In Ethiopia, more than 40% of the population is below the age of 15 (CIA [Central intelligence agency] World Factbook, 2019; https://www.indexmundi.com). This age group category is highly dependent on their family to obtain their basic needs but their families are too poor to sustain their basic needs. Rural aging has major implications on the rural labor force in patterns of agricultural production, land tenure, the social organization within communities, and socioeconomic development (FAO, 2017).

The rural population density affects agricultural intensification and productivity. Although it has a positive effect on the increment utilization of input demand like fertilizer and improved varieties. But increased input alone does not increase the food supply and staple crop yields, and thus farm income declines as population density increases. This is why they are unable to sustain the demand of rising rural population density as the farm sizes declined (Josephson et al., 2014).

Perhaps, environmental degradation, climate change, and limited advanced agricultural technology tend to be affecting much more the older farmers than their younger, healthier, and better-educated counterparts. These older farmers might be discriminated against accessing credit, training, and other income-generating resources (FAO, 2017). They are also not motivated in the utilization of the innovated or new agricultural technologies like improved seeds and modern agricultural tools. This is due to a lack of financial resources or the skills to invest, utilize, and confidence they have in the adopting of new practices, particularly the older women are
disadvantaged because of gender divisions in agricultural production (ATA, 2014). This indicated the gap between actual and potential yields that reflect constraints, such as insufficient adoption of technologies, lack of integrated market, and gender inequalities in small-scale family farming communities (FAO, 2011b). This is true in the case of Ethiopia, where the youngsters are more motivated to buy and use the innovated and improved agricultural technologies than older generations even in recent times. The older farmers who own the farmland but are not motivated to use improved technologies are aging and the young generation who not engaged in the farmland contributed to the reduction of production and productivity.

Therefore, rectifications of the agricultural policies across the country that support the young generation might be important to increase production and productivity (Anriquez & Stloukal, 2008). These activities may include the provision of social services to accommodate the new generation (FAO, 2017).

Globally, it was forecasted that in the coming decades, the world is likely to be not only more populous and urban but also demographically older (FAO, 2017). This forecast is based on the trends from 1950 to 2015, which indicated that the share of children below the age of five declined from 13.4% to 9.1%, while above 65 years’ life expectant increased from 5.1 to 8.3% (FAO, 2017). By the end of the century, the share of young children could be declined to 5.8%, while the proportion of older people may rise to 22.7% (UNDESA, 2015).

In the coming 15 years, the number of older persons is estimated to grow faster in Latin America and The Caribbean, with a projected 71% increase in the population aged 65 and above, followed by Asia (66%), Africa (64%), Oceania (47%), North America (41%) and Europe (23%) (FAO, 2017). If this has come to the fact, the proportion of energetic productive man is decreased and negatively impacts on world production and productivity due to their retirement. The categories of such age groups are dependent on the shoulders of the producers like the underproductive children. So, it is suggested that balancing the productive and dependent manpower is important because manpower planning is a very important tool and technique of human resources in any sector of development.

2.8. Lack of integration

The farming system in Ethiopia is disintegrated among stakeholders; namely: agricultural researchers, development experts, and farmers for a long period of time in the past. The disintegrated practices cost more budget and even may not meet their purpose due to mismanagement along the multiple channels. The allocation and utilization of resources through the channels mainly face corruptions that ultimately resulted in food insecurity through jeopardizing crop and livestock production and fisheries. Hence, integration of all the concerned bodies including market channels, and reviewing the poor and weakest strategic development may partly solve the productivity and agricultural production problems. Encouraging the participation of investors in the agricultural sector would improve their income and opportunities of society in rural areas and reduce the root causes of migration and poverty in the future. Vertically coordinated, more organized food systems offer standardized food for urban areas and formal employment opportunities for both rural and urban areas. Such integration of agricultural stakeholders may improve smallholder livelihoods; shorten food supply chains and impact biodiversity through inclusive and resilient food production way.

Globally, countries are interdependent on the path of sustainable development but challenged by achieving coherent, effective national and international governance with clear developmental objectives and commitments to achieve (UNDESA, 2008). Working together to achieve food security is becoming a requirement in the current era. Governments must ensure all policy areas, including trade, education, finance, and health in integrations. The integral agricultural practices to sustain its growth include the use of farmland, labor, other inputs through technological progress, social innovation, and new business models in efficient and effective ways by
Conservational agriculture approaches seek to reduce soil disturbance by minimizing mechanical tillage, maintain a protective organic cover on the soil surface, and cultivate a wider range of plant species both annuals and perennials in associations, sequences, and rotations that may include trees, shrubs, pastures, and perennials, for example, rotation cropping systems of pulses or legumes build up and maintain soil nitrogen levels (FAO, 2017). But its adaptation varies across countries and intercontinental level, for example, it is adopted highly in the cropland of Australia, Canada, and the southern cone of South America (above 50%) and low in Africa, Central Asia, and China (FAO, 2011a).

Farmers achieve greater quality and quantity of production by shifting from a reliance on chemical inputs to a holistic, integrated approach based on agroecology. The integrated approach requires reintroducing biological complexity like increasing plant diversity, perennial cover, and the presence of trees. This will improve the efficiency of food production, income, and environmental co-benefits (FAO, 2015). It enhanced the integration of researchers affiliated on the crop improvements, conservation agriculture, agroecology, agroforestry, and the development of crop varieties that are more tolerant to pests, diseases, drought, waterlogging, and salinity (FAO, 2013).

Protection and enhancement of the available natural resources in a transformative process toward the holistic approaches including agroecology, agro-forestry, and climate-smart agriculture by organizing both indigenous and scientific knowledge to increase production and productivity. It improves the drastic cuts in economy-wide and agricultural fossil fuel use by addressing climate change, prevent emerging transboundary agricultural threats like pests and natural hazards, which affects all ecosystems and every aspect of human life through International collaboration (FAO, 2017).

2.9. Political unrest
It is almost unbelievable that policymakers, scholars, and practitioners of the most advanced technologies failed to anticipate the problems of food security and agricultural development before they unfolded in Ethiopia (Diriba, 2020). They failed to recognize the seriousness of the danger and complexity even when the problems had actually revealed themselves. Ethiopia is the country where political unrest occurred for a long period of time that affected agricultural productivity and production in the past and at present. These situations have resulted in the losses of resources, the rising tide of hunger and poverty. The political unrest was expressed in frequent protests that resulted in the loss of the existing resources of both private and public such as mechanized farm equipment, shelters, floriculture, personal house, shops, materials, other farm equipment, and tools of the researcher’s institute and campaigns are a real crisis of visions that could bring a total failure of understanding, and unwilling to work devotional following this unrest and harassment especially discouraging private investors in the agricultural sector (FAO, 2019; ILRI (International Livestock Research Institute), 2017; ATA, 2014; ATA, 2013).

Hunger and extreme poverty are reduced globally since the 1990s (FAO, 2016). But around 700 million people, most of them living in rural areas are still live in extreme poverty, and more than 800 million people are chronically hungry and 2 billion people suffer micronutrient deficiencies in the whole world.

Alleviation of poverty and food, insecurity requires increasing smallholder productivity through the development and distribution of new seed varieties, chemical fertilizers, mechanized farm tools, and equipment, eco-friendly pesticides; electricity and credit facilities (Byerlee & Spielman, 2007; Dorosh & Rashid, 2013; Stefan et al., 2008). Governments are expected to enact socio-economic plans, such as reducing rural fertility rates (Pörtner et al., 2012), and developing secondary cities and towns. Working and investing toward changing the behavior, attitudes, and
beliefs of Ethiopians have become important in the future to boost agricultural production and productivity.

3. Prospects
Despite numerous challenges of agricultural activities, Ethiopia has marvelous opportunities like a commercial farming investment on fruit, vegetable, ornamental plants, and beef; the huge number of the labor force, water resources, and proximity to the Middle East and other African countries to ship products within a short period of time. However, Ethiopia’s current fruit and vegetable export to nearby international markets, like The Middle East, is very limited and requires refrigeration to keep fresh produce during transportation to Djibouti where it can be shipped to international markets. Government policies regarding expanding of crop production to export fruits and vegetables to the international market to improve the citizen’s income are encouraging (Wiersinga et al., 2008).

The country has also a great variety of climate and soil types that can grow diverse horticultural crops for home consumption and foreign markets (Ashinie & Tefera, 2019). The total land under fruits and vegetable cultivation is estimated to be only about 0.45 million hectares, which is less than 5% of the total cultivated land (MoARD (Ministry of Agricultural and Rural Development), 2009). Therefore, increasing such activities will increase the country’s income and food demand. Furthermore, these activities need to be digitalized in online platforms and improvements are required in the areas of artificial intelligence (AI) (DMFA (Dutch Ministry of Foreign Affairs), 2018/19).

Ethiopia is known as the water tower of East Africa. The country is endowed with ample water resources in central, western, and southwestern parts, except dry parts of the northeastern and eastern parts which may even be supplied from the water-rich areas of the country. About 0.7% of the country is covered with natural water bodies or lakes (MoWR (Ministry of Water Resources), 2002) which is around 744, 400 ha (IUCN (international union for conservation of nature), 2010), and the amount of water it holds is estimated to be 70 billion cubic meters. The amount of river-based water in Ethiopia could be 124.4 billion cubic meters (Berhanu et al., 2014). It has also plenty of groundwater (Ayalew, 2018). In some parts, utilization of the water resources is hindered because of the undulating topography of the country. However, Ethiopia is almost rainfall-dependent as there are no practices of water harvesting technology (Ayalew, 2018).

FAO (2016) indicated that in Ethiopia the water flows along the Nile Basin, Rift valley, Shebelli-Juba, and the Northeast coast has the potential to irrigate about 5.7 million ha., but at present, about 2.7 million ha is utilized. The reason for the underutilization of the resources and water resources, in particular, are many, among which lack of technology and finance is just to mention a few (Table 10). This report also indicated that the Ethiopian government planned the development of small-scale irrigation to 1.7 million ha between 2015 and 2020. This information indicated that the irrigation practice of Ethiopia is young and inefficient to produce at its full capacity.

Most of the Ethiopian water flows to the Western direction (69.83%), following to Eastern (33.34%) as indicated in Table 11. The country misused these gifted natural resources in agricultural activities possibly mainly due to the political unrest characterized by the frequent war that weakened the economy rather than focused on development. Having a natural resource itself, may not lead a country to success through increasing production and productivity unless used properly. The future focus of the Ethiopian government and people will be investing in infrastructure including the promotion of water development technologies, especially investing in irrigation that provides an opportunity to improve the productivity of land and labor (Bekele et al., 2007).

Ethiopia is rich in animal genetic resources, both in diversity and population. Investing in the rearing of livestock and its products including live animals, meat, leather goods, and milk is a major source of foreign exchange and household consumption values (Gelan et al., 2012). Furthermore, this sector requires marketing opportunities to export to foreign countries. In addition, it is required that establishing a policy of investment that supports producing hybrid cattle, sheep, goats, and
poultry. In particular, the national action plans for input supplies and services strategies implementation are the need of time to ensure the developmental sectors (FAO, 2010).

Improving irrigation technology like water harvesting technology is the best option to reduce water losses and improve water use efficiency from the soil-plant system. The uses of improved drought-tolerant crop varieties are also helpful in saving water. Leaving crop residue in the farmland and adding organic matter is used for improving soil fertility and maximize the water-holding capacity of the soil (Pisante et al., 2012). To make a sustainable intensification of crop and animal production, conserving water resources, adoption of ecosystem-based approaches, such as conservation agriculture, applying environmentally safe agricultural inputs, keeping soil healthy, and use of improved genetic material and nutrient management are required to boost Ethiopian agriculture.

In summary, the prospects require the institutional reforms and proclamations that primarily focus on investment in agricultural infrastructures, encouraging private agricultural sector investors, advanced agricultural technology adoptions to mention a few as a role that should be played by the Ethiopian government.

| Major drainage system | River basin                  | Economical irrigation potential (ha) | As % of total potential |
|-----------------------|------------------------------|-------------------------------------|-------------------------|
| Nile basin            | Abay (Blue Nile)            | 523,000                             | 19.6                    |
|                       | Baro-Akobo                  | 600,000                             | 22.4                    |
|                       | Selit-Takeze/Atbara         | 189,000                             | 7.1                     |
|                       | Mereb                       | 500                                  | 0.02                    |
| Rift-valley           | Awash                       | 205,400                             | 7.7                     |
|                       | Denakl                      | 3,000                                | 0.1                     |
|                       | Omo-Gibe                    | 384,000                             | 14.4                    |
|                       | Central Lake                | 139,300                              | 5.2                     |
| Shebelli-Juba         | Wabi-Shebelle               | 204,000                             | 7.6                     |
|                       | Genale -Dawa                | 423,300                              | 15.9                    |
| Northern East coast   | Ogaden                       | 0                                    |                         |
|                       | Gulf of Aden                | 0                                    |                         |
| Total                 |                              | 2,671,500                           | 100                     |

Source: FAO (2016)

| Flow direction | Basins included in the section | Areacoverage share (%) | Surfacewater share (%) |
|----------------|--------------------------------|------------------------|------------------------|
| West           | Abay, Baro-Akobo, Mereb, and Tekeze | 38.75                  | 69.83                  |
| East           | Genale-Dawa and Wabi-Shebele     | 33.34                  | 7.58                   |
| South          | Omo-Gibe, Rift Valley lake basin | 5.15                   | 17.94                  |
| North-East     | Awash                          | 9.79                   | 3.95                   |
| No. flow       | Aysha, Dinakle, and Ogaden      | 12.96                  | 0.69                   |
4. Conclusion

Ethiopia is characterized by agricultural challenges and bright future prospects in the sector. Traditional farming systems and low production and productivity well express the current Ethiopian agriculture. The rapidly increasing populations, depletion of soil fertility, landlessness, climate change, deforestation, political turmoil, and degradation of natural resources are among the current problems facing the country. Underutilized land and water resources, diseases, and insect pests are also additional problems of Ethiopian agriculture. The rapid population growth and the higher proportion of the youth are the current challenges facing Ethiopia as these younger generations are landless. The same could be a blessing provided that natural resources could be utilized as it is needed by the labor force. The future of Ethiopian agriculture is bright because of the fact that the country is gifted with a variable climate ranging from tropics (growing tropical crops like citrus fruits) to subtropics (growing crops like apples). It is the water towers of East Africa that can be used for irrigation agriculture and more importantly hydroelectric power for East African countries in an attempt to address the problem related to global warming. Ethiopia is a preferred destination for many investors and tourists because of the unique climatic conditions it possesses. The rapidly growing population is a source of labor to exploit the existing resources for agricultural-sector investors.

The rapidly increasing populations, depletion of soil fertility, landlessness, climate change, deforestation, and degradation of natural resources are serious problems of developing nations that need urgent actions. Ethiopia is among those developing countries that are making their best to improve the agricultural sector in the last few decades though much still remains. Overcoming these challenges is not an easy task. Therefore, it requires committed and greater efforts of government and its people. Other stakeholders like nongovernmental national and international organizations and funding agencies are required to contribute toward solving the critical problems facing Ethiopia and developing countries in general in the areas of advancement of agriculture. The countries of the world are interconnected and a problem of a country obviously becomes a problem of the others in the interconnected world at present than ever. Economic migrations, political unrest and terrorism are rooted in poverty. An attempt to address the problem of food shortage in moderation of prices and enhancing distribution across a globe in addition to supporting the agricultural productivity through improved technology is becoming part of the solution. If critical issues are not addressed the food price inflation creates political instability, disorder, chaos, unemployment, malnutrition, hunger, poverty, imbalance, and inefficient resource distributions among the nations which may lead to migration. Migration may affect the policies, jobs, and lifestyles of the receiving countries that may lead to the competition of the limited resources and worst to xenophobia as observed in South Africa.

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