International Journal of Research Studies in Agricultural Sciences (IJRSAS)
Volume 8, Issue 3, 2022, PP 1-9
ISSN No. (Online) 2454–6224
DOI: http://dx.doi.org/10.20431/2454-6224.0803001
www.arcjournals.org

Coffee Production: Opportunities, Challenges and Genetic Diversity in Ethiopia

Gudeta Dida*

Ethiopian Institute of Agricultural Research, National Agricultural Biotechnology Research Center, Holeta, Ethiopia

***Corresponding Authors:** ***Gudeta Dida,** Ethiopian Institute of Agricultural Research, National Agricultural Biotechnology Research Center, Holeta, Ethiopia*

Abstract: *Coffee is one of the world's most important commodity crops. More than 90% of its production occurs in developing countries providing an income for millions of smallholder farmers around the world. Ethiopia has a wide range of coffee genetic diversity. It is an important commodity to the Ethiopian economy, with around 15 million of the people relying on it directly or indirectly for survival and the country is the leading coffee producer in Africa, and the 5th in the world. Ethiopian coffee is known for its unique characteristics, aroma and flavor. Ethiopia is endowed with a good production environment for growing coffee with a combination of appropriate altitude, temperature, and rain fall and soil type. Despite ideal climatic conditions and a diverse range of indigenous coffee types in Ethiopia there is a major threats to coffee production in the country. The major challenges facing the coffee sector is the threat of coffee genetic erosion and various production constraints like disease and pest prevalence, global climate change, shortage of labor, insufficient value addition, low productivity of coffee, replacement of coffee by other crops and coffee market price fluctuation. Moreover, Limited use of enhanced technology; land degradation and population pressure; limited access to inputs such as fertilizer, seeds, irrigation; and high costs of quality coffee production and processing are also mentioned as the major challenges of the coffee sector of the country. Enhancing infrastructure and institutional facilities, as well as upgrading coffee manufacturing techniques that include the introduction and development of new coffee varieties may help to overcome these challenges. Hence this review highlights opportunities and challenges of coffee production in Ethiopia, at center of origin.*

Keywords: *Arabica coffee; Genetic diversity; Climate change*

1. INTRODUCTION

Coffee is one of the most valuable commodity crops in the world trade. More than 90% of its production occurs in developing countries providing an income for millions of smallholder farmers around the world that are dependent on coffee for their subsistence (Tran *et al*., 2016). It contributes largely to the economy of more than 50 countries in Asia, Latin America and Africa. There are 25 million smallholder producers who rely on coffee for a living worldwide. Beside its tremendous contribution to the foreign exchange, it serves as a means of livelihood for millions of people and plays a vital role in their socio economic values (Stieger *et al*., 2002). The share of coffee in total export earnings has a positive and significant reflection on economic growth for developing and least developed countries (Al-Abdulkader *et al*., 2018).

Ethiopia is endowed with a good production environment for growing coffee with a combination of appropriate altitude, temperature, and rain fall and soil type. The country possesses a diverse genetic base for this Arabica coffee with considerable heterogeneity (Habtamu *et al.*, 2018) and is the center of origin for *Coffea arabica* (FAO, 1968). The total area coverage of coffee land in the country is 1.2 million hectare. Of which 900,000 hectare of land is estimated to be productive. According to some studies about 92-95% of coffee is produced by 4.7 million small scale farmers and 5-8 % large scale plantations. An annual coffee production in the country is 500,000-700,000 tones and an average national productivity is 7 quintal per hectare. Ethiopia accounts for around 3% of the global Coffee market. Coffee exports play an important role in Ethiopia's economy. Around 40% of foreign income comes from coffee. In 2017/18, Ethiopian exports are estimated to reach 3.98 million bags of coffee. However, international markets pose several challenges to coffee exporters from producing countries such as Ethiopia (Aigaforum, 2018).

The quality standards of Ethiopian coffee are classified according to their origin of production. Among the best-known coffee varieties in Ethiopia are Yirgachefe, Harar, Wolegga, Limu, Jimma, Sidama and others take the priority (Habtamu *et al.*, 2018). Within Ethiopia, there are some distinctive varieties that are highly sought after. The highest grown coffee comes from Harar, where the Long berry variety is the most popular, having a wine-like flavor and tasting slightly acidic. Another Ethiopian coffee comes from Yirgachefe is the highest premium coffee in Ethiopia as well in the world. In many ways Ethiopian coffee is unique, having neither excessive pungency nor the acidity (Dida *et al*., 2021). The country has suitable land, optimum temperature, diverse genetic base for this Arabica coffee with considerable heterogeneity and fertile soil. It can sustainably produce and supply fine specialty coffee with potential of producing all coffee types of the various world coffee growing origins. Other opportunities of coffee production in Ethiopia are: high demand of Ethiopian coffee on world market, increasing interest of private sector with high investment potential, high support by both regional and federal governments (Tesfaye *et al*., 2020).

In Ethiopia, coffee grows at various altitudes, ranging from 550 to 2,750 m above sea level. However, Arabica best thrives and produced between altitudes of 1,300 and 1,800 m, annual amount of rainfall ranging from 1,500 to 2,500 mm with ideal minimum and maximum air temperature of 15 and 30 °C, respectively. The average green coffee bean annual yield per hectare is 7 quintal, which is lower than the world average and the average of Brazil 8 and 1.3 quintal per hectare, respectively (FAOStat, 2012). This might be due to: - direct and increasing competition of Chat (*Cata edulis*), a plant with mild narcotic effects, with coffee for farmlands in different areas of the country particularly in the Hararge region. Chat is chosen by many farmers because it is more profitable and brings a consistent income during the year, the farm management system of coffee and the agronomic practices in Ethiopia are traditional and coffee producing farmers do not get adequate extension services.

In addition, poor management practices, low soil fertility and poor pricing, very low quality control, the deficiency of a strong coffee seed supply system, inadequate consideration to the input credit provision for efficiency and quality enhancement, and lack of strong vision and path in order to support the coffee sector. Limited use of enhanced technology; land degradation and population pressure; limited access to inputs such as fertilizer, seeds, irrigation; and high costs of quality coffee production and processing are also mentioned as the major challenges of the coffee sector of the country (Taye *et al*., 2013). The changes in climatic conditions are also predicted to profoundly influence the population dynamics and the status of agricultural insect pests and diseases development. The increase in temperature has a strong and direct influence on insect development, reproduction and survival (Ward & Masters, 2007). In general, different physical, biological and manmade factors; one of which is the lack of high yielding varieties at the farmers' hand, lack of using access to recent technology, Biological and institutional factors also play greater role in coffee production (Fekede & Gosa, 2015). Thus, this review aims to look at the challenges and opportunities of coffee production system in Ethiopia.

Table 1. Main coffee exporters' country in 2019

Rank	country	metric tons per year	60 kilogram bags	Pounds
1	Brazil	2652,000	44200,000	5714381000
2	Vietnam	1650,000	27500,000	3637627000
3	Colombia	810,000	13500,000	1785744000
4	Indonesia	660,000	11000,000	1455050000
5	Ethiopia	384,000	6400,000	846575000
6	Honduras	348,000	5800,000	767208000
7	India	348,000	5800,000	767208000
8	Uganda	288,000	4800.000	634931000
9	Mexico	234,000	3900,000	515881000
10	Guatemala	204,000	3400,000	449743000

Source; world atlas, 2019

2. OPPORTUNITIES AND VALUES FOR COFFEE PRODUCTION IN ETHIOPIA

The diversified agro- ecology in Ethiopia is suitable for coffee production. The opportunities and future prospectus of coffee production in Ethiopia indicated as follows:

2.1 Land suitability for coffee production

In Ethiopia, coffee grows at various altitudes, ranging from 550-2,750 m above sea level. However, the bulk of Arabica coffee is produced in the altitudes ranging from 1,300 - 1,800 m. Annual rainfall in the coffee-growing regions of the country varies from 1,500-2,500 mm. Where precipitation is less, as in the eastern part of the country (about 1,000 mm), coffee is supplemented with irrigation. Arabica coffee grows best in the cool, shady environment of Ethiopian highland forests (Aerts *et al*., 2013; Habtamu *et al*., 2018). The ideal temperatures for coffee production are considered to be 15-25 ºC. These temperatures prevail in most of the country's coffee growing areas. Arabica coffee requires fertile, friable, loamy soils, with a depth of at least 1.5 m and relatively high water holding capacity. The fertility of coffee soils is naturally maintained through organic recycling of litters falls from coffee, and shade trees. Relatively acidic soil is suitable for Arabica coffee pH (5-6.8). The soil of most coffee growing regions in Ethiopia satisfies these characteristics of coffee soil (Melkamu, 2015).

The main coffee growing areas are found within Oromia Region and Southern Nations, Nationalities, and Peoples' Region (SNNPR), with modest production in Amhara Region and minor output in Benishangul-Gumuz Region. Coffee beans that are grown in either the Harar, Yirgacheffe or Limu regions are kept apart and marketed under their regional name. These regional varieties are trademarked names with the rights owned by Ethiopian government. The majority of coffee production is comes from the largely forested main coffee zone of the South West, followed by the Sidamo (including Yirgacheffe) coffee area in the South East coffee zone and Harar (Friis *et al*., 2010).

2.2 Coffee market demand

Arabica coffee has its origin in Ethiopia and the country is the largest coffee producer in Africa and the fifth-largest producer in the world (Table 1.). Ethiopians are among the largest coffee consumers in Africa. Almost 50% of the country's coffee production is consumed domestically.

There is a good demand for Ethiopian coffee in the world market. Fine specialty coffee can be produced and supplied sustainably, with producing potentially all the various types of coffee in world coffee cultivating origins. Ethiopia has an ordinary benefit in organic coffee markets as over 90% of coffee production is *de facto* organic (Mekuria *et al*., 2004) and a major part of the Ethiopian coffee is exported in green coffee beans form, to the Rest of the World. This factor gives a key advantage to Ethiopian coffee in the international market.

Moreover, Ethiopia is the only producer of natural forest coffee Arabica, providing scope for shade-grown coffee sale, for instance, through the certification of Rainforest Alliance. The government's decision to allow cooperatives to directly export is significant because it opened a potentially new channel of value chain for export of coffee. Positive image of the country as origin of coffee and a strong indigenous coffee culture, well established coffee brand, prospective for expansion of volume and quality coffee due to existence of adequate land and low-cost labour, high commitment of government and favorable policy environment are among the major opportunities of the coffee sector in Ethiopia (MFA, 2016).

2.3 Genetic diversity in Ethiopian coffee

Ethiopia is the main storehouse of genetic diversity for Arabica coffee, and this has several key implications. For the coffee sector and consumers, the most notable of these is the broad diversity of flavour profiles exhibited by Ethiopian coffees. The quality standards of Ethiopian coffee are classified according to their origin of production. Among the best-known coffee varieties in Ethiopian are Harar, Wolegga, Limu, Sidama and Yirgachefe take the priority. Yirgachefe is the highest premium coffee in Ethiopia as well in the world. Yirgachefe coffee has medium size bean, with a greenish-yellowish color with medium level of acidity and a distinctive mocha flavor (Dida *et al*., 2021).

Genetic variability, which is due to the genetic differences among individuals within a population, is the core of plant breeding because proper management of diversity can produce permanent gains in the performance of plants and can resist against seasonal fluctuations and climate changes (Sharma, 1998). These genetic variations can be enumerated at three levels: species, populations and individual levels. Since Ethiopia is the only centers of origin and diversifications of *Coffea arabica,* there is a

high genetic diversity, which is mainly attributed to its diverse ecological features such as suitable altitude, ample rainfall, optimum temperature, fertile soils etc. and the presence of different indigenous methods used in Coffee production system in the country (Habtamu *et al.*, 2018).

More genetically diverse strains of Arabica Coffee exist in Ethiopia than anywhere else worldwide, which has lead many botanists, breeders, and scientists to consent that Ethiopia is the center for origin, diversification, and dissemination of the Arabica coffee (Mekuria *et al.*, 2004). Several phenotypic and molecular studies revealed that the populations of *Coffea arabica* from the south western part of Ethiopia have high genetic variability, which is suitable for *in situ* conservation of the species. Sylvian (1958) and Meyer (1968) observed a high diversity of several phenotypic characters among Ethiopian Coffee populations collected from different geographical area of the country. Montagnon and Bouharmont (1996) also found higher phenotypic diversity among the populations of *Coffea arabica* collected from Ethiopia as compared to cultivated populations of Arabica coffee species that collected from different parts of the world. According to the study of genetic variation among forty nine *Coffea arabica* accessions from Limu Ethiopia, confirmed the presence of trait diversity within coffee accessions (Olika *et al*., 2011).

The study of genetic variation among 100 *Coffea arabica* accessions from Hararge, Ethiopia were also confirmed the presence of trait diversity within 14 characters suggesting that the presence of high variability among the accessions (Mesfin & Bayeta, 2008). In south-western part of Ethiopia about 400,000 ha of an ancient forest where coffee occurs as understory shrubs still remain (Ervine, 1969). Moreover, there is also high genetic diversity of coffee in the region that is used as source of plant stock for the selection of disease resistance, drought resistance, high yields and top quality in terms of aroma and flavor (Melkamu, 2015).

Higher level of genetic variability with molecular markers was observed among spontaneous and sub spontaneous accessions of this species collected from Ethiopia (Anthony *et al.*, 2002). The existence of two subgroups of partial genetic differentiation within germplasm of *C. arabica* into accessions collected from West (Kaffa, Ilubabor and Wolegga) and East (Sidamo and Hararge) of Great Rift Valley was established by an analysis with molecular markers (RAPD) (Lashermes *et al.*, 1996) and also by a multivariate analysis of phenotypic characters (Montagnon and Bouharmont, 1996). In this perspective it would appear that the coffee cultivated in Yemen from where almost all cultivated *Coffea arabica* derive, had its origin in Ethiopia (Dessalegni, 2017). Dida *et al*. (2021) also reported wide genetic variability of Ethiopian coffee accessions that collected from different parts of the country using molecular (SSR) marker.

2.4 Economic importance of coffee

Coffee is the most important agricultural commodity in the world. More than 90% of its production occurs in developing countries providing an income for millions of smallholder farmers around the world that are dependent on coffee for their subsistence (Tran *et al*., 2016). Worldwide, an estimated 125 million people are dependent on coffee for their livelihoods. More than 121 countries including Ethiopia export and/or re-export coffee to more than 165 countries worldwide. More than 50 developing countries, 25 of them in Africa, export coffee in different parts of the word (NCA, 2017). In many coffee producing countries, beside its tremendous contribution to the foreign exchange, it serves as a means of livelihood for millions of people and plays a vital role in their socio economic values (Stieger *et al*., 2002). The share of coffee in total export earnings has a positive and significant reflection on economic growth and on the Gross Domestic Product (GDP) for most of the producing countries, particularly developing and least developed countries (Al-Abdulkader *et al*., 2018).

The agriculture-based Ethiopian economy is also highly dependent on coffee as foreign exchange earnings. Moreover the sector provides income for approximately eight million smallholder households which are participating in the various activities in the value chain of coffee (Melkamu, 2015). Coffee is grown in both highland and lowland conditions, nurtured with care by the farmers, giving the beans a range of unique flavors and textures. Like any commodity trade, the coffee trade has been characterized by boom and bust cycles mainly due to an imbalance of supply and demand. In the early 20th century, attempts to stabilize coffee prices rested on efforts of individual countries, especially in Brazil. In the following decades, the price of coffee has alternately soared and dived, with the market hitting the lowest at 40 cents per pound in New York, while farmers' production costs

amounted to about 70 cents a pound. This has led to poverty and food insecurity in countries where the majority of coffee producers are subsistence farmers (Thurston, 2013).

Coffee production is generally characterized by considerable instability, with a large crop one year followed by a smaller crop the next. In the world coffee market, as is the case for many commodities, price volatility is a major concern for all stakeholders. In exporting countries, price volatility leads to instability in producer incomes and uncertainty of export earnings and tax revenues. In importing countries, price volatility affects profit margins for roasters, traders, and stock holders. All these factors make the coffee crop less attractive throughout the supply chain, especially to growers, who will seek other, more remunerative crops to replace coffee. Despite these challenges, world coffee production has grown steadily since the 1960s, although it will be difficult to maintain this trend due to the continued rise in production costs, problems related to climate change, and the higher incidence of pests and diseases (Krishnan, 2017).

Coffee does not only have an economic benefit, but also has its own social values**.** Coffee plays a vital role in both cultural and social life of Ethiopian community. Among coffee producing countries in the world, Ethiopia is the first country in consumption of coffee. From the average total annual production about 50 % is consumed in the country. Preparation and drinking of coffee is a unique culture in Ethiopia; coffee ceremony. Coffee is not drunk alone. It is a social activity to be shared with others. Sharing coffee with others means you are at peace with them and cultivates community and friendship. Coffee is typically made by roasting and brewing on a small charcoal burner. Cups (cinis) are usually laid out in a square on a tray dressed with fresh grass and served with a snack such as fresh popcorn (Melkamu, 2015).

3. PREVAILING CHALLENGES FOR COFFEE PRODUCTION IN ETHIOPIA

3.1 Insect pests, diseases & fungi

Insect Pests, diseases and fungi have become a real threat for many coffee producers in Ethiopia.

Coffee leaf rust (*la roya*) is one of the most famous diseases and has been affecting coffee crops for over a century. Another big issue is the coffee berry borer beetle (*la broca*), which bores into the coffee cherry and lays eggs in the seed endosperm. But farmers have to watch out for far more than just *la broca*: other common pests include green coffee scale, mealybugs, termites, leaf miner, and many more. These all affect both the quality and yield of coffee crops. Coffee diseases cause considerable losses when not treated. According to Cerda *et al*. (2017), 57% yield loss was observed by the infection of disease causing organisms on coffee crop. Jima *et al*. (2017) also reported that the most economically important pathogenic coffee diseases are coffee berry disease (CBD), coffee wilt disease (CWD) and coffee leaf rust (CLR), and physiological disorder like coffee branch die back is caused by *pseudomonas syringe* and non-pathogenic agents. Similarly, CBD and branch dieback were causing high yield loss of coffee production.

In the same way, insect pests such as Anthestia bug and coffee blotch miner are the major ones causing considerable damage. The assessment carried out in Eastern Ethiopia indicated that diseases and insect pests are causing considerable crop losses. CBD is major disease observed while CWD was considered as minor on few farmers' coffee farms. Similarly, major insect pest that affects coffee production in Eastern Ethiopia were coffee stem borer and coffee berry borer. On the other hand, insect pests such as coffee trips, green scale and coffee cushion scale were reported as important coffee production constraints in the country (Fekede & Gosa, 2015).

3.2 Climate Change Problems

Agricultural commodities face substantial risk from climate change because of their sensitivity to and dependence on weather variables. Arabica coffee is more sensitive to climatic factors. This is because Arabica coffee is grown in specific climatic and biophysical envelopes coupled with a narrow genetic diversity. As such, there is evidence that climate change is reducing area suitable for coffee, limiting yield and increasing the risks of pests and disease (Chemura *et al*., 2021). Coffee farming in Ethiopia takes place over a vast area, under a wide variety of production systems and various growing conditions, with many different cultivation practices. Feedback from coffee farming communities, and observations on coffee production and coffee plant stress, indicate that climate change has already had a negative impact. In some coffee areas, there has been dramatic forest loss. Many areas that are

suitable for coffee growing in the present day will become less suitable in the future, and in some cases unsuitable. Conversely, substantial areas that was previously unsuitable for coffee farming will become suitable (MFA, 2016).

Coffee Producers have no power over changes in the environment, but when their harvest suffers as a result, they do too. They need their harvest season to cover the fixed costs they've incurred throughout the year. Currently, climate change is leading to rising temperatures and new rainfall patterns something that's placing the Arabica coffee species under threat. Arabica coffee is widely considered to be the best quality, thanks to its aromatic flavours, and so it attracts higher prices. It also accounts for roughly twice as much of the international coffee market (ICO, 2015).

However, Arabica is more sensitive to temperature increases, which reduce its growth, ability to flower, and consequent ability to produce fruit. It needs to grow at cooler temperatures than the other species. This means it's usually cultivated at higher altitudes. As climates change, the available fertile land for Arabica decreases (Dudu, 2012). What's more, pests that once found the high altitudes of Arabica farms too cold to survive are now able to thrive up there. And Arabica is more sensitive to these than others coffee species are. What's more, those sudden heavy rains do have a strong and immediate impact. Producers rely on a dry harvest season something that, at one point in time, in most countries they could take nearly for granted. Now, however, it is a different story (Chemura *et al*., 2021).

Rainfall is the most important factor governing the distribution of coffee farming and wild coffee forests in Ethiopia. The distribution of rainfall varies greatly across Ethiopia, according to season, altitude and physical features of the landscape. Clear annual patterns are evident, although rainfall is extremely variable. Heavy rain can cause issues during harvesting and processing: cherries splitting on the tree and losing their mucilage, fermentation during processing, and more. This is a particular concern when producers are honey or natural/dry processing coffee; since these need lots of time under direct sunlight to thoroughly dry. They can also lead to unpredictable harvests (Hailu *et al*., 2015). Coffee cherries ripen nine months after the coffee flowers blossom (with Arabica- it varies from species to species). Pickers also need to collect the coffee cherries at different times. If they mismanage it, they might end up picking unripe coffee cherries – which will have a negative impact on the coffee flavor and mean specialty buyers will be less interested. Alternatively, overripe fruit starts to develop less appealing herbal notes. And if cherries drop from the tree, because they have been left too long before picking, they may ferment on the ground and cause unpleasant flavours in the cup. In the worst of cases, it might result in full black or partial black green bean defects.

The mean annual temperature has increased by 1.3℃ between 1960 and 2006, at an average rate of 0.28℃ per decade, and The mean annual temperature of Ethiopia is projected to increase by 1.1–3.1℃ by the 2060s, and 1.5–5.1℃ by the 2090s, with the scale of the projections depending on the emission scenario (McSweeney *et al*., 2010). Some of Ethiopia's coffee growing areas are already poorly suited for growing coffee, and it is mainly these areas that have been impacted by climate change and will continue to be so in the future. Another importance consideration in coffee production is forest. Forest cover is important for coffee because it provides the right conditions for successful cultivation, by reducing daytime air and soil temperatures, increasing humidity and preserving soil moisture.

In general Climate change will negatively impact much of the current coffee farming landscape of Ethiopia. Air and soil temperature and moisture can be altered by specific farming interventions, and provide a buffer against inadequate growing conditions and extreme weather events. Improved cultivars and selections of indigenous Arabica coffee may provide some potential, especially for disease resilience and improved productivity (Belete *et al*., 2014)

3.3 Labor Shortages

One of the biggest risks in coffee production is the lack of labour. Coffee processing requires workers at every stage of the process. However, the average age of a coffee producer is growing, and the numbers of them decreasing. Children from coffee-producing families, seeing the struggles their families face, often choose to migrate to the city to find better opportunities. In most places, coffee picking is seasonal and sometimes even nomadic work. The pickers are paid based on the weight of the cherries they collect, and they need to work many hours a day on steep hillsides for their pay.

Then, at the end of the harvest, they have to find other jobs or move to other regions. It's easy to see why people might choose other forms of work (Tesfaye et al., 2020).

3.4 Price Fluctuation & Unreliable Incomes

Coffee producers are affected by price fluctuations, although there are differences in how, what's more, due to these fluctuations, producers are unable to predict pricing trends and plan ahead. The biggest fear of a producer that's considering working on specialty coffee is that they will not get enough in return for their efforts. Or that, perhaps they will one year, but the next, the weather will prevent them from producing quality coffee and they will lose the price premium (ICO, 2015).

3.5 Limited ability to value coffee

Linked to concerns over price and quality is the fact that many producers are unable to value their own coffee in the same way that buyers and consumers do. This can make it difficult to both improve farming methods and negotiate with buyers. This is especially difficult for smallholder farmers, who are primarily focused on their basic needs so that they can survive from day to day. For them, what a consumer wants is of little relevance to their life. And for those able to focus on coffee quality, they still need to acquire new skills: cupping and sensory knowledge, market understanding, and often marketing or at least a way to become visible to specialty coffee buyers. This is another reason why specialty coffee can be a risk. "Bigger farmers and bigger cooperatives do care, and they try to produce better coffee, if the price incentive is there. And although consumers actually do pay better prices, this is not channeled down to the producer. It is the importer that benefits, in most cases (Tesfaye et al., 2020).

Coffee farming provides a livelihood for millions of people around the world. These challenges have a real impact on their lives, whether they are large farm owners or smallholders' producers (Tran *et al*., 2016). There is no easy solution to these challenges. But as consumers, buyers, roasters, and baristas, we need to ask for more than a cup of coffee. We have the ability to choose where we spend our money and to ask how much producers are paid.

3.6 Low productivity of coffee

Ethiopian coffee is mainly grown under the shade of trees (shade or forest coffee), either within forest or forest-like environments, or in farming systems that incorporate specific shade plants – usually indigenous (native) trees, or sometimes fruit trees and other crop plants. In some areas coffee is grown with little or no shade (sun coffee). Forest (shade) coffee and sun coffee can be considered as the two main coffee production systems in Ethiopia. Large commercial plantations (e.g. over 500 hectares) are uncommon and contribute less than 5% of exportable production. Irrigation is confined to few locations and mostly where water is easily available and can be diverted to the farm using simple means (e.g. diversion from rivers using trenches). Irrigation is mainly practiced in Amhara and Benishangul-Gumuz Regions, and the north east part of Oromia Region in the Harar coffee zone. The use of chemical inputs, such as pesticides, fungicides and artificial fertilizers is rarely practiced, and although certification is not common (Tefera and Tefera, 2014), Ethiopian coffee can often be considered as organic by default, and may indeed exceed the standards set for organic certification.

4. Conclusion And Recommendation

Coffee is an economically significant agricultural crop in Ethiopia, accounting for the majority of the country's export earnings. Coffee is Ethiopia's most important product, and it is grown in nearly every part of the nation, providing a significant source of revenue for coffee farming household. However, Despite good climatic circumstances, a diverse range of indigenous coffee varieties for quality development, Land suitability for coffee production and a long history of production in Ethiopia, there are many obstacles to coffee production in Ethiopia include a lack infrastructure, Low productivity of coffee, global climate change, shortage of labor, Price Fluctuation & Unreliable Incomes, the outbreak of disease (Insect pests, diseases & fungi), low-value addition, limited market access, a lack of market promotion and a low price have all been identified as important constraints in Ethiopian coffee marketing. Developing better varieties coffee varietals that resist disease, The government should support the coffee production system, quality, and marketing, as well as to address the major barriers to capacity building, infrastructure, adequate knowledge transfer and support coffee research, increase

value addition, should provide special extension services for growers to improve their skill and knowledge and appropriate access to services is recommended.

ACKNOWLEDGEMENTS

The author would like to thanks "Jesus abbaa hundaa" for editing the manuscript.

REFERENCES

[1]. Aerts, R., Gazahegni, B., Gijbels, P., Kittessa, H., Van Glabeke, S., Vandepitte, K., Muys, B., Roldan-Ruiz, I. and Honnay, O., 2013. Genetic variation and risks of introgression in the wild *Coffea arabica* gene pool in south-western Ethiopian montane rain forests. *Evolutionary Applications*, *6*(2): 243-252

[2]. Aigaforum, 2018. Economic Benefit of Ethiopian Coffee. Retrieved 19 Feb. 2018, from http://www.aigaforum.com/article2018/Economic-Benefit-of-Ethiopian-Coffee.pdf)

[3]. Al-Abdulkader, A.M., Al-Namazi, A.A., Al Turki, T.A., Al-Khuraish, M.M. and Al-Dakhil, A.I., 2018. Optimizing coffee cultivation and its impact on economic growth and export earnings of the producing countries: The case of Saudi Arabia. *Saudi journal of biological sciences*, *25*(4):776-782

[4]. Anthony, F., Combes, M.C., Astorga, C., Bertrand, B., Graziosi, G. and Lashermes, P. (2002). The origin of cultivated *Coffea arabica* L. varieties revealed by AFLP and SSR markers. *Theory of Applied Genetics*, 104: 894–900.

[5]. Belete, Y., Belachew, B. & Fininsa, C., 2014. Performance evaluation of indigenous Arabica coffee genotypes across different environments. *Journal of Plant Breeding and Crop Science* 6: 171–178.

[6]. Cerda, R., Avelino, J., Gary, C., Tixier, P., Lechevallier, E. and Allinne, C., 2017. Primary and secondary yield losses caused by pests and diseases: Assessment and modeling in coffee. *PloS one*, *12*(1):e0169133.

[7]. Chemura, A., Mudereri, B.T., Yalew, A.W. *et al.*, 2021. Climate change and specialty coffee potential in Ethiopia. *Sci Rep* 11**:** 8097

[8]. Dessalegni, A., 2017. Review on Genetic Diversity of Coffee (*Coffea arabica L.)* in Ethiopia. *International Journal of forestry and Horticulture*, *3*(2):10.

[9]. Dida, G., Bantte, K. & Disasa, T., 2021. Molecular characterization of Arabica Coffee (*Coffea arabica* L.) germplasm and their contribution to biodiversity in Ethiopia. *Plant Biotechnol Rep 15***(**6):791–804

[10]. Dudu, V.P., 2012. Impacts of Climate Change on Coffee Farming in Ethiopia. LAP Lambert Academic Publishing, Saarbrücken, Germany. Pp 85.

[11]. Ervine, F.R., 1969. West African Agriculture: West African Crops, 3rd Edition, Vol. 2. 272p.

[12]. FAO, 1968. Coffee Mission to Ethiopian 1964-1965. Food and Agriculture Organization, Rome, Italy. 200p.

[13]. FAOSTAT (2012). (Available at: www.faostat.fao.org/).

[14]. Fekede G., Gosa A., 2015. Opportunities and constraints of coffee production in West Hararge, *Ethiopia. J. Agric. Econ. Rural Dev*. *2*(4):054-059

[15]. Friis, I., Demissew, S. & Breugel, P.V., 2010. Atlas of the Potential Vegetation of Ethiopia. Biologiske Skrifter 58: 1–307.

[16]. Habtamu, G., Gizachew, A., Meseret, D., Ashenafi A., 2018. Arabica Coffee *(Coffea arabica* L.*)* Hybrid Genotypes evaluation for Growth Characteristics and Yield Performance under Southern Ethiopian Growing Condition. *Acad. Res. J. Agri. Sci. Res. 6*(2): 89-96.

[17]. Hailu, B.T., Maeda, E.E., Heiskanen, J. & Pellikka, P., 2015. Reconstructing pre-agricultural expansion vegetation cover of Ethiopia. *Applied Geography* 62: 357–365.

[18]. ICO, 2015. International Coffee Organization. Historical Data on the Global Coffee Trade. http://www.ico.org/new_historical.asp?section=Statistics

[19]. Jima, D., Melka, T., Angasu, B., Alemu, G., Zewdu, A., & Amin, M., 2017. Constraints and opportunities of coffeeproduction in Arsi zone. The Case of Chole and Gololcha Districts, *European Journal of Business and Management, 9* (10): 8–17

[20]. Krishnan, S., 2017. Sustainable Coffee Production. Oxford Research Encyclopedia of Environmental Science. Retrieved 19 Sep. 2019, from, https://oxfordre.com/environmental science/view/10.1093/acrefore/9780199389414.001.0001/acrefore-978019 9389414-e-224

[21]. Lashermes, P., Trouslot, P., Anthony, F., Combes, M.C. and Charrier, A., 1996. Genetic diversity for RAPD markers between cultivated and wild accessions of *Coffea arabica*. *Euphytica*, 87(1): 59-64.

[22]. McSweeney, C., New, M. & Lizcano, G., 2010. UNDP Climate Change Country Profiles: Ethiopia. Pp. 27.

[23]. Mekuria, T., D. Neuhoff and U. Kopke, 2004. The Status of Coffee Production and the Potential for Organic Conversion in Ethiopia. Berlin: Conference on International Agricultural Research for Development, 5-7 October 2004. Deutscher, Tropentag.

[24]. Melkamu A., 2015. Ethiopian Highlands: Home for Arabica Coffee (*Coffea arabica* L.*).* pp. 58-65. In: Enyew, A., Mekete D., Jan N. (Eds). Tropical lakes in a changing environment: water, land, biology, climate and humans. Bahir Dar, Ethiopia, Bahir Dar University.

[25]. Mesfin, A. and Bayeta, B., 1987. Field evaluation of resistance to stress conditions in crosses and parents of *Coffea arabica* L. *EJAST*, 14:4-9

[26]. Meyer, F.G., Fernie, L.M., Narasimhaswamy, R.L., Monaco, L.C., Greathead, D.J., 1968. Food and Agriculture organization. Coffee mission to Ethiopia 1964–1965. FAO, Rome, 200p.

[27]. MFA, 2016. Coffee production in Ethiopia. The 4th World Coffee Conference in Addis Ababa, Ministry of Foreign Affairs of Ethiopia, Addis Ababa, Ethiopia

[28]. Montagnon, C. and Bouharmont, P., 1996. Multivariate analysis of phenotypic diversity of *Coffea arabica*. *Genetic. Resour. Crop. Evol*. 43: 221-227.

[29]. NCA (National Coffee Association) (2017). Coffee around the world. Retrieved 24 Sep, 2018 from (http://www.ncausa.org/About-Coffee/Coffee-Around-the-World).

[30]. Olika, K., Sentayehu, A., Taye, K. and Wayessa, G. (2011). Variability of quantitative traits in limmu coffee (*Coffea arabica* L.) in Ethiopia. *International journal of agricultural research*, *6***(**6): 482-493.

[31]. Sharma, J.R., 1998. Statistical and biometrical techniques in plant breeding. New Age International (P) limited, publishers. New Delhi, 432p.

[32]. Steiger, D., Nagai, C., Moore, P., Morden, C., Osgood, R. and Ming, R., 2002. AFLP analysis of genetic diversity within and among *Coffea arabica* cultivars. *Theoretical and applied genetics*, *105***(**2-3):209-215.

[33]. Sylvain, P.G., 1958. Ethiopian Coffee: Its significance to world coffee problems. *Botany,* 12: 111-139.

[34]. Szenthe, Adriana (2019). *"Top Coffee Producing Countries"*. World Atlas. Retrieved 2019-08-06.

[35]. Taye, G., Poesen, J., Wesemael, B.V., Vanmaercke, M., Teka, D., Deckers, J., Goosse, T., Maetens, W., Nyssen, J., Hallet, V. and Haregeweyn, N., 2013. Effects of land use, slope gradient, and soil and water conservation structures on runoff and soil loss in semi-arid Northern Ethiopia. *Physical Geography*, *34*(3):236-259.

[36]. Tefera, A. & Tefera, T., 2014. w. GAIN Report (number ET1402–13/5/2014). USDA Foreign Agricultural Service. Pp. 11.

[37]. Tesfaye, T., Bizuayehu, T. & Girma A., 2020. Coffee production constraints and opportunities at major growing districts of southern Ethiopia, *Cogent Food & Agriculture*, *6*(1):174198

[38]. Thurston, R.W., Morris, J. and Steiman, S., 2013. Coffee*:* A comprehensive guide to the bean, the beverage, and the industry. Lanham, MD: Rowman & Little field, 275p.

[39]. Tran, H.T., Lee. L.S., Furtado, A., Smyth, H., Henry, R.J., 2016. Advances in genomics for the improvement of quality in coffee. *J Sci Food Agric.* 96:3300–3312

[40]. Ward, N.L. and Masters, G.J., 2007. Linking climate change and species invasion: an illustration using insect herbivores. *Global Change Biology*, *13*(8):1605-1615.

Citation: *Gudeta Dida, (2022). "Coffee Production: Opportunities, Challenges and Genetic Diversity in Ethiopia." International Journal of Research Studies in Agricultural Sciences (IJRSAS), 8(3), pp.1-9 DOI: http://dx.doi.org/10.20431/2454-6224.0803003*