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Article

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GENERAL & APPLIED ECONOMICS | REVIEW ARTICLE

Spatial production distribution, economic viability and value chain features of teff in Ethiopia: Systematic review

Esubalew Tadele^{1*} and Tewabe Hibistu

Abstract: Teff is the most preferred and most commercialized cereal crop in Ethiopia. It's one of the underutilized crops. It's nutrient-dense and well-suited to Ethiopia's growing conditions, but little has been invested to tap into its domestic and international markets. This review focus on the regional teff production distribution, economic significance, and value chain of teff in Ethiopia. The country has a chance in teff specialization and value-added products will likely contribute to generating more incomes, reduce poverty and sustain growth. But unable to overcoming of constraints and seizing opportunities associated with the value chain and its components. Mainly due to teff producing and value addition practice is insufficient and generally depends on conventional practices, and its marketplace is restricted local and the government imposes an export ban on it to limit the upward pressure on domestic grain prices and address local food security. Hence, in a nutshell, value chain development aimed at stimulating economic growth and increasing competitiveness is a vital issue. To take advantage of growing domestic and international demand for teff, the domestic teff industry must invest heavily in improving teff production methods, opening up and expanding its international market to ensure its status as a superglobal food and a contributor to global food



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PUBLIC INTEREST STATEMENT

Teff is one of the stable and important cereal crops in Ethiopia. It is relatively risk-free, resistant to dry season, water-logging, and common pests and diseases, and favored by a large number of local smallholder farmers. It is produced as a purpose of consumption and is eminent for cash income sources. Locally teff is used for preparing foods like Injera (staples, a fermented locally processed flatbread), tella (local beer type), and bread, etc. Injera is the most likely food type in Ethiopian dishes. Consumers' preference of teff increased towards with the expansions of urbanization and the rise of healthy food consumers due to teff is nutritionally rich and high in carbohydrates. It is gluten-free and can easily be tolerated by patients suffering from celiac disease. However, teff's economic viability in Ethiopia is underutilized due to low productivity resulting in lack of improved variety of seed, infrastructure, large-scale processing and purchasing to capture economies of scale.

security gains. This needs simultaneously investments and policy support networks, which are coordinated with all relevant stakeholders.

Subjects: Development Studies; Population & Development; Sustainable Development; Development Policy; Rural Development; Economics and Development; Economics; Political Economy

Keywords: teff spatial production; economic viability; value chain; food and nutrition security and future demand

1. Introduction and background

Agriculture remains a key to Africa's future (Tadele, 2021). In Ethiopia, cereal crop production and marketing are the main means of livelihood for millions of smallholder households, where, teff (*Eragrostis Tef*) is the most widely important cereal grain and its origin is thought to be Ethiopia. It has emerged as a grain crop for human consumption between 4000 B.C. and 1000 B.C. (Getahun, 2018). As the most preferred cereal crop, especially in urban areas, teff fetches a relatively high price in the market, making it an attractive crop for farmers. Being marked as one of the most recent superfoods of the 21st century like the old Andean grain quinoa, its worldwide acceptance is quickly rising (Collins, 2013).

In Ethiopia, teff is a major staple food. It is the most important crop in terms of cultivation area and production value (Minten et al., 2016). Ethiopia is not only the biggest teff-producing nation but also the only nation to have adopted teff as a staple crop. Teff contains a high nutritive value and has unique dietary benefits due to its being gluten-free and is typically preferred by health-conscious consumers.

Because of its tiny grain size, the word teff likely originated from the Amharic word “tefa” which means lost, which is difficult to find once it is dropped while other evidence states that it was derived from the Arabic word tahf, a name given to a similar wild plant used by Semites of south Arabia during the time of food insecurity (Abraham et al., 2018).

Now, Ethiopia is the largest teff producing country, and the only country to have adopted teff as a staple crop and the country produces more than 90% of the teff in the world (Anadolu Agency, 2017). Teff is the only cereal crop the country has a comparative trade advantage. According to “FAO” (2018), 6.5 million smallholder farmers grow teff, and it is indispensable to the livelihoods of many Ethiopians. Today, teff fills in as a staple food for more than 50 million individuals in the Horn of Africa (Tadele and Assefa, 2012).

Teff is a significant staple food crop in Ethiopia, generally used to get prepare “enjera¹”, the primary public dish. It is one of the main yields for farm income and food security² in Ethiopia. It has high-income elasticity, mirroring that Teff demand rises when income rises (Berhane et al., 2011). As urbanization is expanding and earnings are expected to rise in Ethiopia (as appeared by a national household survey). Notwithstanding being a staple food for some people in Ethiopia and Eritrea for quite a long time, teff has just picked up prominence as a food crop in different parts of the world as of late (Araya et al., 2010; Gressel, 2008; Teferra et al., 2000).

Despite teff is produced by millions of producers and the largest production volume, Ethiopia's significant poverty, and food insecurity, along with the fact that agriculture is the primary source of income for the vast majority of Ethiopians, make agricultural transformation a critical development aims for the country. Increased production of teff, a calorie- and nutrient-dense but low-yielding staple, is one prospective improvement (Minten et al., 2018). Moreover, the country is not

capitalizing on its crop in the international market (FAO, 2015). On the other side, other countries are actively involving in teff production and marketing to capture its global rising markets. This is due to the teff production and value chain largely relies on traditional practices, and the teff market is limited by the government's export ban. Instead, other countries such as USA are increasingly participating in the teff market (Lee, 2018).

Tefera, M.M. (2011). Land use/land-cover dynamics in Nonno District, Central

Ethiopia. *Journal of Sustainable Development in Africa* 13, 123–141.

One of the pressing issues with this underutilized crop of teff is that, its inadequately recorded and frequently ignored by mainstream research because of way that they are not economically significant in the worldwide market (Naylor et al., 2004). Agricultural research has usually centered around major crops, explicitly, maize, wheat, and rice, with generally little consideration put resources into orphan crops, particularly among researchers in developed nations (Ji et al., 2013).

Teff research has been initiated in Ethiopia as early as the late 1950s. The research programs focused on breeding teff varieties to enhance production while not much emphasis is given to the value chain analysis and its economic outcomes. Likewise, it is well adapted to the growing conditions in Ethiopia, but little has been invested to improve the crop's productivity or to expand domestic or international markets.

Our main concern and initiative on review on value chain, economic viability and its spatial distribution of teff are motivated by the fact that researchers have predicted that this commodity will become a new super-crop, increasing demand on a global scale (Crymes, 2015). Teff may be the next super-grain, and Injera may be the next super-food worldwide (Fikadu et al., 2019).

In this view, we emphasize the economic viability of teff and its value chain that can help familiarize with the products feature and the preferences of producers and consumers towards adding value on teff for its economic significance. Hence, this review gives an overview of the foundation and teff production potential, challenges, and overall economic prospective of teff in Ethiopia and demand for future innovative research into the world's tiniest grain, teff; that is right now riding on the gluten-free wave as the next super grain in the market.

Specifically, to achieve the following objectives

- To review production status and spatial distribution of teff in Ethiopia
- To review economic and multiple roles of teff along in the value chain in Ethiopia
- To review supply gap and demand simulation of teff in Ethiopia

2. Review Methodology

A comprehensive review was carried out of empirical literature on the theories and empirical findings applied for teff production, supply chain, demand, and related actors. It has been used both temporal and spatial dimensions that able to filter information's focused on recent works that reflect countrywide verdicts.

3. Search engine used

The systematic review was carried out based on empirical findings. Both temporal and spatial dimensions by filtering information focusing on recent works that reflect countrywide verdicts were used. The study uses an integrative concept-centric technique that relies on the analysis of

current literature and deductive logical reasoning to generate a new comprehensive scientific understanding about a topic that can be informative. The information offered by google using major indexers of Web of Science and Scopus and many others typing basic words like “teff, teff value chain, Economics of teff, teff supply chain in Ethiopia, teff demand” etc. More than 105 academic journals, books, reports, proceedings, and thesis work, and international agencies were browsed and around 75 materials were filtered specifically to this title by using keywords fit for purpose of this review study. Different inclusion and exclusion criteria were applied and filtered pertinent to this study. Such as focus on recent studies, and written only English language, focus on Ethiopia, original studies, peer-reviewed, and grey literature.

3.1. Teff production and spatial distribution

Ethiopia has diverse agro-ecology zones; such as from extremely lowland up to highland throughout all regions. As can be seen from [Figure 1](#); Oromia and Amhara regions represent the largest teff producing regions; these accounted for about 87.8% of the national teff production volume and 85.5% of the area cultivated during the 2010/2011 cropping season. The third-largest teff producing region in the Southern Nations; Nationalities; and Peoples’ (SNNP) region (Fikadu et al., 2019).

The production coverage of teff accounted for about 24% of the nationwide grain-cultivated area, and nearly half of the smallholder farmers grew it between 2004 and 2014 (Central Statistical Agency, 2017; F. N. Bachewe et al., 2015). Hence, it is the most important cereal in Ethiopia in terms of agricultural land use and total value. Similarly, teff is most important crop by both volume of production and area planted, and the second most important cash crop after coffee. Economic viability of teff is equal to the three other main cereals combined in the country (wheat, sorghum, and maize; Abeje et al., 2019).

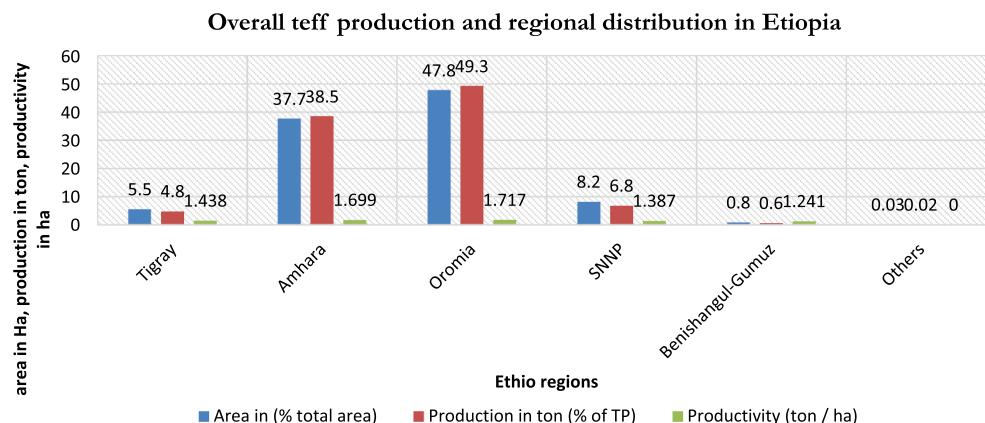
The crop is critical for income and food and nutrition security across the country and is grown by 6.5 million resource-poor smallholder farmers (“FAO” 2018). This implies that 43% of all Ethiopian farmers grow teff. Therefore; this sector is the most important in Ethiopia’s agricultural economy; which accounts for 72% of all cultivated land.

There is a significant difference in the production and productivity of teff in Ethiopia (Fikadu et al., 2019). Even if there is spatial production variation across the regions of the country, there is no observable difference in productivity across the region. This is due to the smallholder production system and approach used across the region are similar and there is no substantial difference in the productivity of teff in Ethiopia as can be seen from [Figure 1](#).

Moreover, the production of teff in the country is spatially distributed, and looking into more detail the regional variations of teff production as can be seen from [Figure 2](#), one can observe that within the region there are potential areas specific to teff production. This can be linked with agroecological advantage and land allocation for the teff product. It is adapted to a wide range of environments and is presently cultivated under diverse agro-climatic conditions.

Moreover, due to this spatial heterogeneity; there is great variation in the production and productivity of teff within this growing condition area. Particularly, Amhara and Oromia are the two major regions, and collectively, the two regions account for 85.5% of the teff area and 87.8% of the teff production (Lee, 2018). Teff is most commonly grown in the Ethiopian highlands, it is now being cultivated to grow in a wider range of conditions, from marginal soils to flood conditions. Particularly, East and West Gojjam of Amhara and East and West Shoa of Oromia are mainly known potential teff producing areas in the country (Demeke & Di Marcantonio, 2013).

Figure 1. Production distribution of teff in regions of Ethiopia.
Source: (Central Statistical Agency, 2017)



3.2. Type and user preference of teff for home consumption

On the consumption side, teff is more readily eaten by urban households (61 kg/person/year) than by rural households (20 kg/person/year; "FAO," 2018). As Fikadu et al. (2019) state that teff has a significant role in Ethiopian agriculture; food; and trade sectors. Therefore, Ethiopia has a great chance to assure food security by boosting teff production and exporting.

As a result, the demand for teff incredibly increases throughout the world. Additionally, with has numerous benefits. Teff is the most labor-intensive crop and its cost of production is relatively high compared to other cereal crops (Abraham, 2015). As a result, a comprehensive strategy for large-scale development, adoption, and maintenance of farm tools must be developed at the national level. Efficient and effective farm technology may be able to address the most difficult and time-consuming aspects of teff farming, as well as the high cost of production.

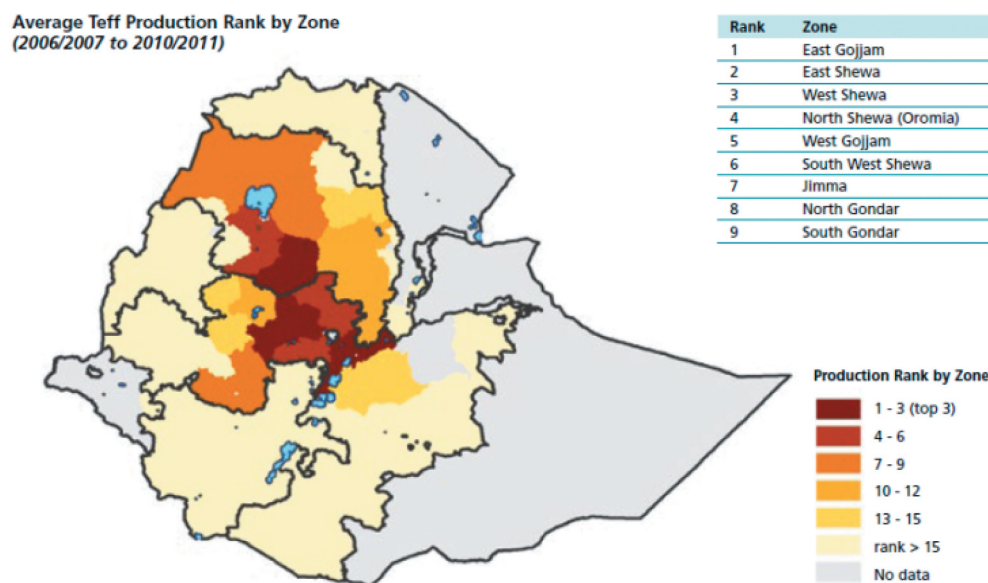
Over time, there are changes in the sorts of grown teff. The increase in white-colored teff at the expense of red and mixed-colored teff is a significant development. In 2012, white teff accounted for 69.6% of total teff production, up from 48.2% in 2002. During the same time, however, the share of red teff fell from 36 percent to 19.7 percent (Minten et al., 2016). Teff grains are graded for quality and price based on their type, which ranges from white to mixed to red. The white has the greatest price, while the red has the lowest. A sub-type of the white, the very white charges an even greater premium price (FAO, 2015).

3.3. Consumption and its income elasticity of teff in Ethiopia

According to FAO (2015), teff is the only cereal crop that Ethiopia has a comparative trade advantage. It can be grown in a large part of the country. A country grows more than 90% of the teff in the world. Therefore, the role of teff is vital for Ethiopian agriculture; food; and trade sectors. As a result, Ethiopia stands a good chance of ensuring food security by increasing teff production and exports. Despite its largest production volume, the country is not capitalizing on its crop in the international market.

Indeed, within the country, urban households more readily eat teff than rural households (Minten et al., 2013). Urban consumers use 81 kilograms of teff per year, more than three times the amount consumed in rural areas. This is partly due to the high price of teff relative to other

Figure 2. Spatial variation of average Teff production (2007 to 2011): adapted from (Central Statistical Agency of Ethiopia, 2015).



crops, the urban affluent consumers consume relatively more teff than the rural poor (Zhu, 2018). Teff is, therefore, an economically superior good that is relatively more consumed by richer than by the poor. According to (F. Bachewe et al., 2019), stated that teff shows income elasticities, i.e. 1.2 in rural and 1.1 in urban areas, which means that doubling of income responses to rising expenditure by 120% and 110%, respectively. Other crops like sorghum even have negative elasticity of income in the urban area, it indicates an inferior good in the urban environment. When the consumer becomes richer, the consumption of such goods is reduced. The importance of sorghum as food is, therefore, likely to reduce, and the importance of teff is likely to increase with the rise in income over time, as Ethiopia becomes wealthier and more urbanized.

In addition, the consumer in the cities prefers mixed teff types (28 kilos out of 81 kilos), whereas rural consumers prefer red teff (9 kilograms out of 24 kilograms). In urban areas, red teff accounts for 11 percent of all teff consumption expenditures, compared to 27 percent in rural areas. In urban regions, the consumption of injera and mixed teff is higher than in rural regions, with injera accounting for 9.1% of all food expenditures (Hassen et al., 2018).

Moreover, besides home consumption, teff has been shipped to a different country abroad. According to (Fikadu et al., 2019), teff export has varied, with a higher volume shipped in 1995–1997, 2001, and 2005, but exports have been decreased since January 2006, owing to high domestic pricing and a government ban on exporting unprocessed teff grain. The goal of the prohibition³ is to lower the domestic price of teff to the level that people could afford and address local food security. However, real-time experience at the time of writing this script the average price of 1 kg raw teff product surpasses 1 USD dollar and it is an indication of price skyrocketed without lifting export ban. This highly reflects that restricting export of the product alone might not bring such huge impact on the price of the product, rather enhancing production and productivity of the teff would lower domestic price and favor the consumers at different levels.

On the other side, scholars argued that, the removing the export restrictions would very certainly raise the price of teff in the local market to a higher international level (Abraham, 2015).

Nevertheless, it would be detrimental to domestic customers in the country though not uniform across regions due to spatial production capacity and time value of the product.

In addition, export prohibition protects teff producers from price fluctuation in the international market and deters multinational businesses from acquiring the local teff business. Otherwise, like with quinoa in Bolivia, their takeover would certainly drive smallholder farmers out of the teff market and lead to land conflicts. Likewise, exporting teff could compromise the nutritional status of Ethiopia. Poorer Ethiopians may be compelled to switch to less nutritional substitutes such as sorghum, barley, or wheat if teff becomes less plentiful and expensive (Crymes, 2015).

There is a possibility to wipe out teff consumption in certain regions of the country (for example, the moist lowlands). This happens because these regions then have an alternative crop like wheat, barley, or sorghum, which contributes to the utility of the consumer without forcing them to pay significantly higher prices.

A country grows more than 90% of the teff in the world. Despite its largest production volume, the country is not capitalizing on its crop in the international market as indicated by the Central Statistical Agency of Ethiopia (2015).

3.4. Economic and multiple roles of teff in Ethiopia

3.4.1. Economic role

Teff is Ethiopia's most important crop by area planted and value of production, and the second most important crop in generating income (after coffee), generating about \$500 million per year for local farmers (Fikadu et al., 2019). According to studies, Injera exports in 2015 were estimated to be worth around ten million dollars (Fikadu et al., 2019; Hassen et al., 2018). The commercial surplus of teff is equal to the commercial surplus of the three other main kinds of cereal (sorghum, maize, and wheat) combined in the country. Likewise, teff is an economically superior commodity in Ethiopia. It often commands a market price two to three times higher than maize, the commodity with the largest production volume in the country (FAO, 2015) thus making teff an important cash crop for producers (Abraham, 2015).

Nevertheless, teff has shortcomings to become an income-generating global commodity for Ethiopian producers. Some of the shortcomings are low yields compared to other major cereals, high labor-input requirement, lack of infrastructure, and limited or inefficient market (Amentae et al., 2016; Cheng et al., 2017). Similarly, the crop is being successfully introduced and cultivated in many other parts of the world including Australia, Cameroon, Canada, China, India, Netherlands, South Africa, the UK, Uganda, and the USA (Abraham, 2015). However, comprehensive statistics on its production, utilization, and trade are little available in those countries.⁴

Overall, the teff market lacks large-scale processing and purchasing to capture economies of scale. Little value is added to teff, and a lack of grade standardization causes uncertainty and additional costs at transactions. The existing export policy does not support teff producers to profit from the overseas market. The imposed restriction prevents the Ethiopian government, particularly farmers, from participating in and benefiting from rising global trade, which might boost GDP and transform producers' livelihoods. However, according to other reports, demand is expected to be quite high in the United States, the Middle East, and Europe due to the large number of Ethiopian immigrants living there (Fikadu et al., 2019). On the other side, restricted access to this crop product has hampered scientific investigation and the absence of worldwide consciousness of its potential health benefit and has restricted utilization (Fufa et al., 2013). Likewise, the 2006 export

ban of the raw Teff grains could limit production of Teff in Ethiopia and even be unable to meet the homegrown demand. As of now, the normal grain yield of Teff in Ethiopia is under 1.0 t/ha.

3.4.2. Nutritional value and health role of teff

Teff is nutritionally rich and high in carbohydrates. It is gluten-free and can easily be tolerated by patients suffering from celiac disease. It is the most important cereal in Ethiopia and it accounts for 15% of calories consumed in Ethiopia (Central Statistical Agency, 2016; Fufa et al., 2011). Most notably, teff contains a higher quantity amino acid and minerals than other cereals (Abraham, 2015; Hailu et al., 2016). Millions of individuals in industrialized countries suffer from gluten-related disorders (Roseberg et al., 2006), in western markets its demand has risen rapidly (Gebremariam et al., 2014). Teff grains have 357 kcal/per 100 g, which is comparable to rice and wheat (Cheng et al., 2017).

Moreover, with 11% of protein, teff is an excellent source of essential amino acids, especially lysine: the amino acid that is most often deficient in grains (Ayalew et al., 2011). Teff grains are low on the glycemic index, which makes them suitable for people with Type 2 diabetes. The grains are also gluten-free (FAO, 2015).

Furthermore, teff has equivalent protein level with other common cereals like wheat but it contains greater amount of amino acid lysine than other cereals. Teff is rich in fatty acids, minerals, fiber and phytochemicals including polyphenols and phytates (Baye, 2014). According to (Dekking and Koning, 2005, teff is vital in preventing pregnancy anemia due to its high content of fiber, calcium, and iron. The crop has a longer shelf life, and slow staling of its bread products compared to other cereal crops like wheat, sorghum, rice, barley, and maize. As Gebru et al. (2020) states that the grain is linked to several health benefits including prevention and treatment of diseases such as celiac disease, diabetes, and anemia.

As Zhu (2018) reveals that protein, dietary fiber, polyphenols, and certain minerals are all appealing ingredients in teff. The teff grain flour is becoming increasingly popular in the healthy food consumers, and it has been used to make gluten-free pasta and bread. Specifically, its composition from 100 grams of teff flour contains; Carbs: 70.7 grams, protein: 12.2 grams, Fat: 3.7 grams, Fiber: 12.2 grams, Iron: 37% of the Daily Value (DV), Calcium: 11% of the DV. It is important to know that the nutrient makeup of teff appears to vary greatly according to the variety, growing area, and brand (Koubová et al., 2018; Shumoy & Raes, 2017). Moreover, teff is an adequate source of each of the nine basic amino acids, including lysine, which is regularly missing in many kinds of cereal (Baye, 2014; Gebremariam et al., 2014).

3.4.3. Various used forms of teff

The most well-known use of teff in Ethiopia is the fermented flatbread called injera⁵ (Assefa et al., 2013; Baye, 2014; Zhu, 2018). Crymes (2015) portrayed this customary flatbread as a delicate, slender flapjack with a sour taste. The most favored type of injera is one produced using pure teff flour (Crymes, 2015). Injera blended in with other flour, for example, wheat or sorghum is viewed as inferior. Different uses of teff incorporate local alcoholic beverages called tela⁶ and areke,⁷ and porridge (Abraham, 2015). Moreover, teff plant residues such as its straw could be utilized as fodder for animals, and regularly used as construction materials to reinforce houses built from mud or plaster (Cheng et al., 2017; Ketema, 1997; Stallknecht et al., 1993). Likewise, outside Ethiopia, global consumers following the super-food wave, various teff-based products are developed to capture the premium market in the form of bread, porridge, muffin, biscuit, cake, casserole, and pudding. The crops' potential is also explored as a thickener for soup, stew, gravy, and baby food (Zhu, 2018).

3.5. Marketing performance and teff value chain in Ethiopia

Ethiopia has yet to develop an efficient teff marketing and value chain scheme. Its value chain is often described as unsophisticated or untraceable (Amentae et al., 2016; Minten et al., 2016). Currently, little evidence exists for modernized teff trading and retailing practices. For instance, the role of credit is minor, most of the transactions are on a cash basis, and standardization of Teff grading is virtually absent (Minten et al., 2016).

Along with the teff spatial prices in Ethiopia, the central market is the capital (Addis), given its large size and its central role (Getnet et al., 2005; Tamru, 2013). With adhering to the shadow prices and perfect market postulation of agricultural products, food prices elsewhere in the country move up or down with the prices in Addis Ababa after accounting for transportation costs, a crucial factor for spatial price integration (Jaleta & Gebremedhin, 2012), in which markets are all connected to Addis Ababa with the highest urban consumers and the highest volume of market size.

As Minten et al. (2016) examined the share of teff price structure in detail, one notable result is that teff growers obtained on average 79.4% of the final retail price of the raw product. Similarly, Urgessa (2011) reveals that teff producers took 78.7% of the consumer price while the assemblers, wholesalers, and retailers shared the rest of the price.

Despite teff, trade is highly profitable; little is known about the farm-level competitiveness of teff production and the distribution of the costs and value-added between the chain participants, which include farmers, traders, and processors. Although past studies in Ethiopia (Fufa et al., 2011; Minten et al., 2013) have looked at the value chain analysis of teff, literature on quantitative value chain analysis that captures the cost build-ups along the chain is scarce.

According to Demeke and Di Marcantonio (2013), teff is largely produced for market mainly because of its high price and absence of alternative cash crops (such as coffee, tea, or cotton) in the major teff potential areas of Gojjam and Shoa (Amhara, Oromia respectively). Assemblers in village markets and wholesalers in regional markets give substantial attention to the quality of teff. Its grade is based on its color, and there are three grades based on its color: white, mixed, and red. The white is the highest grade and takes the highest prices while the red one is the lowest grade and price. There are also sub-grades within each such as *Magna* (super white) and being sold at a premium price.

3.6. Why teff value chain is vital?

According to Fufa et al. (2011), the teff value chain program supports the doubling of teff production and ensures farmers access sufficient markets to capture the highest value from their production, increase incomes, and reducing the price to consumers within 5 years. In addition, various leverage points drive stakeholders to move into value addition streams. For instance, substantial changes are happening in agricultural and food markets worldwide and particularly in developing countries (Reardon et al., 2009; Tsakok, 2011). In a very sizable manner, supermarkets are taking off quickly (Reardon et al., 2003; Timmer, 2009), in the die of consumers, the share of high-value crops is increasing rapidly (Mergenthaler et al., 2009; Pingali, 2007). In worldwide, quality preferences by consumers are on the rise (Minot & Roy, 2007), for export agriculture the requirement of food safety from developing countries has vital effects on the value chain structure (Maertens & Swinnen, 2009).

Across the value chain of teff, it helps rising the adoption of modern farm inputs by farmers, rising willingness to pay for convenience in urban areas, upgrading of the foodservice industry, enhanced marketing efficiency and quality demands (Minten et al., 2013). Teff value chain is involved six key parts: exploration and reproducing; seeds and inputs; production; harvest and processing; exchange and promoting; and value addition and export (Fufa et al., 2013). Teff value chain has not arrived at its

maximum capacity due to systematic bottlenecks at each phase of the value chain. In addition, several existing challenges hinder the effective functioning of the teff value chain. These are very limited access to agricultural inputs, including high-quality seeds, fertilizer, or agrochemicals (certified seeds and other inputs are currently not available in sufficient quantity), lack of trade relations with the Addis Ababa market, and drought and erratic rainfall are among the most significant natural hazards and cause risks for smallholder's farmers (Weber & Tiba, 2017)

An important reason why growth opportunities are not taken by the country is market failure and dysfunctional business linkages. Market failures are major obstacles to value chain development that explain why the economic potential is not realized as well as coordination failures and asymmetries along the value chain. One way to improve, develop and make a value chain for the pro-poor is to 'strengthen mutually beneficial linkages among firms so that they work together to take advantage of market opportunities, that is, to create and build trust among value chain participants. It is commonly accepted that the inclusion of smallholder farmers and other vulnerable populations in value chain development (VCD) leads to an inclusive and pro-poor value chain (Andreas et al., 2019). Hence, this review gives an overview of the teff production trends, challenges, and teff value chain missing links.

3.7. Teff supply chain and its problems

For most of the individuals in Ethiopia, teff has been and keeps on being a basic means of food that contributes significant levels of nutrients. With its more noteworthy resilience to outrageous conditions, for example, dry season, water-logging, and common pests and diseases compared with wheat and maize, teff remains the staple crop in Ethiopia and Eritrea, favored by a large number of local smallholder farmers (Central Statistical Agency (CSA); Central Statistical Agency (CSA)).

Despite its considerable nutritional benefits, teff has its limitations as an essential food source. It produces lower yields than other significant grains because of several serious reasons, chiefly originating from its proneness to lodging, and minute seed size, and to an absence of continued innovative work endeavors and irregular social practices. Of these, lodging is viewed as the greatest hindrance to yield improvement in teff (Ketema, 1997). It causes the arrangement of a tall and delicate stem that is vulnerable to harm by wind and rain. The utilization of nitrogen composts further aggravates these delicate stems and therefore prevents mechanized harvesting.

Moreover, teff's shortcomings to become an income-generating global commodity are low yields compared to other major cereals, high labor-input requirement, lack of infrastructure, and limited or inefficient market (Amentae et al., 2016; Cheng et al., 2017). Teff's tiny seed additionally present several difficulties to its commercial efficiency, especially for planting (Ketema, 1997). At planting time, the small seed makes it hard to control population density and its appropriation (Juraimi et al., 2009). Moreover, the process of threshing sifting, winnowing, and crushing the seeds can be relentless and tedious, and labor-consuming (Ketema, 1997).

Another huge limitation to teff production is its defenselessness to frost at all growth stages. Although teff is moderately liberated from significant pests and disease, the plant is sometimes contaminated by rust (*Uromyces eragrostidis*; Assefa et al.). These joined, along with the absence of continued innovative work endeavors and improved strategies for research make up the fundamental variables adding to the moderately low quality and quantity of collected teff.

Moreover, according to (Abraham, 2015), many factors are associated with this low supply problem, such as restricted utilization of improved seeds resulted from inconsistent production of adequate seeds both in quality and quantity alongside more noteworthy postponements in distribution, supply and storage problems. An inefficient agronomic practice because of technical

inability and cost inaccessible of contributions for farmers and fragmented homestead plots further exasperates farmers' production capacity. The utilization of lime, which is utilized to treat profoundly acidic soil in Ethiopia, is restricted in access and expensive to bear for subsistence farming households. The existed farm equipment exploited by producers are the traditional ones utilized for quite a long time without slight change and the accessible improved instruments like row planters, broad bed centuries, and plough are additionally insufficient and not promptly accessible to farmers from one side of the country to the other

Accordingly, many problems restrict teff to boost its supply and maintain its quality with affordable price for the consumers. Among these, (1) restricted resource for teff research and breeding, (2) low improved seed selection and costly fertilizer, (3) insufficient agronomic practices, (4) high post-harvest handling loss rates, (5) a fragmented value chain that includes numerous players and (6) restricted value chain set-ups (Fufa et al., 2013).

3.8. Future demand simulation of teff

As it has been stated teff plays a vital role for Ethiopian food; and trade and agriculture sectors. As a result, Ethiopia stands a good chance of ensuring food security by increasing teff production and exports. Because of the local price increase and fast-expanding injera exports, the government recently granted authorization to a small number of commercial farmers to begin producing teff to meet this export demand (Fikadu et al., 2019).

Similarly, teff's popularity is rising quickly all around the world. Teff may also be the next super-grain, and Injera may be the next super-food in the world, because of its multiple benefits. Teff is the most labor-intensive cereal crop, with a relatively high production cost compared to other cereal crops (Abraham, 2015). As a result, a comprehensive strategy for large-scale development, adoption, and maintenance of farm tools must be developed at the national level. Effective and effective farm technology needs to address the most difficult and time-consuming aspects of teff farming, as well as the high cost of production.

According to (F. Bachewe et al., 2019), utilizing the income elasticities of teff demand for its products might involve in the future, integrating the expected population dynamics, differentiating between urban and rural areas, relying on population projection by the world bank, and further assume that uniform annual income growth of 3% and no real price increases; there has been the evolution of teff demand for rural and urban areas.

4. Summary and conclusion

Ethiopia has suitable crop-producing ecological zones; such as from extremely lowland up to highland throughout all regions that enable it to produce teff all round. But there was a significant difference in teff production across the region. A country is the largest teff producing country, and the only country to have adopted teff as a staple crop and the country produces more than 90% of the teff in the world. It is Ethiopia's most important crop by area planted and value of production, and the second most important cash crop after coffee. The economic viability of *teff* is equal to the three other main kinds of cereal combined in the country (sorghum, maize, and wheat).

Despite the conducive environment, the return and incentive for growth in teff face several production and marketing challenges. Moreover, Ethiopia's significant poverty and food insecurity has been a serious problem over the decades. This is due to teff production in Ethiopia largely depends on the hands of 6.5 million resource-poor smallholder farmers. Furthermore, inefficient production, climatic factors, presence of low yield varieties are the most significant problems that affect the teff production across different agro-ecology zones. On another hand lack of transport, infrastructure and

weak market linkage decrease the profitability of teff in Ethiopia. In addition, the value chain is weak, and the market lacks large-scale processing and purchasing to capture economies of scale.

A key for improving, production and economic viability of teff in Ethiopia are to develop the value chains and strengthen mutually beneficial linkages among actors. So that they work together to take advantage of economic and market opportunities, can create and build trust among value chain participants. Investments in productivity increase higher up value chain performance, such as through marketing and transportation infrastructure, which would increase prices farmers receive for output while also putting downward pressure on urban food prices. Higher market prices would create incentives for farmers to invest in productivity through increasing technologies usage and improved input used since output increases would offer significant economic gains.

4.1. Possible suggestions

The following policy responses should be taken as a policy response. First and foremost, improving productivity and resilience; by investing in basic research and researchers. As well as selecting and scaling up new technologies that guarantee durable, multipurpose, cheap mechanized planters and harvesters. In addition, conduct rigorous and regular evaluations of outcomes and establishing fit-for-purpose distribution systems; experiment with alternative input delivery mechanisms involving different arrangements, actors, and payment modalities and managing labor demand and postharvest operations, improve monitoring and evaluation of uptake of improved technologies in various feasible means would be vital.

To meet the increasing demand for teff it is crucial to increase teff yields. This can only be done by the adoption of improved teff production technologies such as improved seeds, fertilizer, or mechanization. Inorganic fertilizer is a crucial input for teff production and most teff producers are estimated to make use of it. However, due to limited financial means and access to credits, fertilizer uses are often below-recommended rates. Access to credit and other financial services by small-scale farmers has been considered as one promising way to reducing poverty, improving farm productivity, and easing a smooth transition from subsistence farming to large-scale and agribusiness farming.

Give emphasis & advocate teff for national as well as international research and development institutions to study further for productivity increment technology. In addition, Market stabilization: a critical factor in ensuring that smallholders benefit from participating in markets is the “rule of the game”. When rules are transparent and fair, smallholders can benefit and improve their economic and social situation. Therefore, development organizations and governments tend to focus their interventions in value chains or market systems on increasing competitiveness, performance, and on providing effective technologies to smallholder producers.

Present and future analysts and investors should guarantee the coherence of long-term research combined with more successful breeding projects to open the greatest capability of this grain. With its versatility to both dry season and warmth stresses, teff could be the response to the troubling condition of food security while additionally cooking for the dietary requests of a developing populace; these points are following the sustainable global agenda for food and nutrition security.

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Notes

1. Injera is a spongy, sourdough flatbread prepared from fermented Ethiopian traditional main meal teff flour. This food is consumed by almost everyone in Ethiopia at least once a day. Injera preparation consists of numerous phases, beginning with grain preparation and ending with baking; all of which are still carried out utilizing indigenous knowledge and traditional practice. This Ethiopian national super food is gaining popularity in many western nations due to its remarkable nutritional features, particularly gluten-free and good mineral compositions (rich in iron; Neela & Fanta, 2020).
2. Food security is an increasing concern around the world; it is estimated that over a billion people would be deprived of appropriate dietary energy, with at least twice as many suffering from micronutrient deficiencies. It is highlighted on the four pillars: food availability, access to food, and use of food (Barrett, 2010). Indicators on both the supply and demand sides. Food availability is a result of developments in agricultural productivity, and access reflects the demand side of food security, and which foods are compatible with societal tastes and values. All those concepts are inherently hierarchical, with availability necessary but not sufficient to ensure access, likewise, necessary but not sufficient for effective utilization. Utilization reflects whether individuals and households make good use of the food to which they have access.
3. Despite the rising demand, Ethiopia limited the export of raw Teff and flour in 2006 as the cost of the output surged, causing buyers to panic. (Injera is not included in the boycott.) Mama Fresh is one of the firms that has been preparing and trading injera to various parts of the world since 2003..
4. Historically, teff is grown in developed nations, for example, Australia and the USA have served basically as a forage crop (Stallknecht et al., 1993).
5. Injera (staples for the majority of Ethiopians, a fermented, pancake-like, soft, sour, circular flatbread), sweet unleavened bread, local spirit, porridges and soups (Bultosa, 2007).
6. Tella is a traditional Ethiopian fermented beer-like beverage prepared from a variety of cereals (including teff) and a native herb known as gesho (*Rhamnus prinoides*). Tella is similar to commercial beer in that it is created from malted barley and other grains, but it also contains gesho, a traditional beer ingredient. It varies in alcohol content usually around 8.1–14.59 (% v/v) [Getaye et al., 2018]
7. Areki is a colorless, clear, and traditional alcoholic beverage distilled from the fermented product. It is prepared in almost the same way as Tella except that the fermentation mass, in this case, is more concentrated [mulaw et al., 2020].

Consent for publication

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