

REVIEW

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Empirical review on the use dynamics and economics of teff in Ethiopia

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Abstract

Background: Teff is a warm-season cereal crop and the tiniest grain on the planet. It is one of the underutilized crops that can contribute to food security and crop diversification. It is nutritious and well adapted to the growing conditions in Ethiopia, but little has been invested to expand its potential to the domestic or international markets.

Method: Comprehensive empirical review was carried out emphasizing the spatial, temporal production dynamics of teff in Ethiopia and its economic value. Different inclusion and exclusion criteria were applied and filtered pertinent to this study in country-wide verdicts.

Results: 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. However, 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. Instead, other countries, such as USA, are increasingly participating in the teff market and teff has a great contribution for foreign earning through Injera. Because of its appealing nutritional and functional features, the crop's popularity is fast growing over the world. Several health advantages have been associated with the grain, these conditions necessitate extensive investigation on the grain's nutritional and functional qualities.

Conclusion: This study examines the use dynamics and economics of teff in Ethiopia. Teff has received restricted consideration from the global market and mainstream researches perhaps due to its orphan crop' status. To take comparative advantage of the growing domestic and international demand of teff, intensive investment by the domestic teff industry needs to improve methods of teff producing, opening up and expanding its international market to ensuring its super global food and part of the solution to worldwide food and nutrition security gains. Ethiopia should improve to take the lead in the growing teff market and support others to engage in teff food system part.

Keywords: Economics of teff, Food system, Food and nutrition security, Teff production and value chain

Introduction and background

Teff (*Eragrostis tef*) Ethiopia's most antiquated indigenous staple food, is one of the main yields for farm income, food, and nutrition security in Ethiopia. Teff is profoundly nutritious and is a significant part of Ethiopia's cultural heritage and national identity. Being marked

as one of the most recent superfoods of the 21st century, such as the old Andean grain quinoa, its worldwide acceptance is quickly rising [24].

Even though teff has as of late picked up noticeable quality in the worldwide wellbeing food market, it has existed for over 6000 years. Ethiopia is the center of both the origin and diversification of teff and its domestication is anticipated to have happened somewhere in the range of 4000 and 1000 BC [78]. Today, teff fills in as a staple food for more than 50 million individuals in the Horn

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of Africa. It is grown by more than 6 million farmers on almost 3 million ha of land in Ethiopia [55].

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 Seimites of south Arabia during the time of food insecurity [1].

Teff is a significant staple food crop in Ethiopia, generally used to get prepare ‘*enjera*¹’, 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 [15]. 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 [7, 37, 72].

However, teff is an underutilized crop, it is inadequately recorded and frequently ignored by mainstream research because of the way that they are not economically significant in the worldwide market [58]. 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 [45].

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. The missed opportunity starts with a lack of due consideration at various stages to this crop and its economic opportunities. While adding value for

the product ensures remunerative prices to the producers and delivers maximum satisfaction to the consumers for the price they pay and it provides multiplier effects for the producers by increasing production and productivity and generating additional income and employment opportunities to their farm laborers. 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.

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 aim for the country. Increased production of teff, a calorie- and nutrient-dense but low-yielding staple, is one prospective improvement [56]

In this view, we emphasize the economics of teff and its value chain that can help familiarize with the problems associated with the products features and the preferences of producers and consumers towards a different outlet in adding value on teff for its economic significance.

Our main concern and initiative on teff is motivated by the fact that researchers have predicted that this commodity will become a new super-crop, increasing demand on a global scale [25]. Teff may be the next super-grain, and Injera may be the next super-food worldwide [8].

Teff is one of the most important crops for farm income and food security in Ethiopia, the second-most populous country in Africa. It is Ethiopia’s most important crop by area planted and value of production, and the second-most important cash crop³ (after coffee), generating almost 500 million USD income per year for local farmers. In the major agricultural season of 2011(12), teff was grown by 6.3 million farm households in Ethiopia [19]. However, the required value chain is not adequate. To this end, the profound reason behind the lagged progress in production and value addition in Ethiopia is not well recognized.

Hence, this review gives an overview of the foundation and teff supply and value chain dynamics, overall trends and gaps in local and international markets, and future research into the world’s tiniest grain, teff; an ancient grain that is right now riding on the gluten-free wave as the next super grain in the market.

¹ Injera is a fermented Ethiopian traditional staple meal made from teff flour which is spongy, sourdough flatbread. Almost everyone in Ethiopia eats this food at least once a day. Injera preparation consists of several steps, beginning with grain preparation to baking; all of these procedures are still carried out using indigenous knowledge and traditional practice. Due to its outstanding nutritional qualities, particularly gluten free and good mineral compositions (Rich of Iron), this Ethiopian national super food is gaining popularity in many western countries [59].

² Food security is basically is a growing concern in worldwide; more than a billion people are projected to be deprived of sufficient dietary energy, with at least twice that many suffering from micronutrient deficiencies. It’s noted on the four pillars: Food availability, food access, and its utilization [13]. Both supply side and demand side indicators. Food availability made possible advances by agricultural production and Access reflects the demand side of food security, and what foods are consistent with prevailing tastes and values within the society. 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 Ethiopia’s agricultural land is used to produce: primary food crops, secondary food crops and cash crops. The primary food crops are teff, sorghum, barley, maize and wheat, the secondary food crops are vegetables, fruits, and pulses; cash crops are coffee and oil seeds. The primary crops cover 70% of the total cropping area while the secondary and cash crops are accounts 20 and 10% of the total cropping area, respectively [20].

Objective

The general objective of this review is to review the use dynamics and economic prospects of teff in Ethiopia.

Specifically,

- To review spatial production dynamics of teff in Ethiopia;
- To review the missing links in the supply chain and demand for teff in Ethiopia;
- To review the use dynamics of teff in Ethiopia and estimation of future demand and market development.

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.

Search engine used

The literature searches mainly emphasized teff product use dynamics, supply and demand issues focused on Ethiopia. The information offered by Google from published documents including journal articles, books, reports, periodicals, and proceedings were included by using the main searching keywords and typing basic words, such as “teff, teff value chain, Economics of teff, teff supply chain in Ethiopia, teff demand, and use dynamics of teff” etc. More than 105 academic journals, books, proceedings and thesis work, international agencies, and national statistical reports with the topic were browsed and around 40 materials were filtered specifically to this title by using keywords fit for purpose of this review study.

Stylized descriptions of teff production and consumption

Teff production and spatial distribution

In Ethiopia, teff is a major staple food. It is the most important crop in terms of cultivation area and production value [57]. In 2017, teff accounted for about 24% of the nationwide grain-cultivated area, and nearly half of the smallholder farmers grew it between 2004 and 2014 [11, 21]. Hence, it is the most important cereal in Ethiopia in terms of agricultural land use and total value. It is adapted to a wide range of environments and is presently cultivated under diverse agro-climatic conditions. The crop is critical for income and food and nutrition security across the country and is grown by 6.5 million smallholder farmers [29].

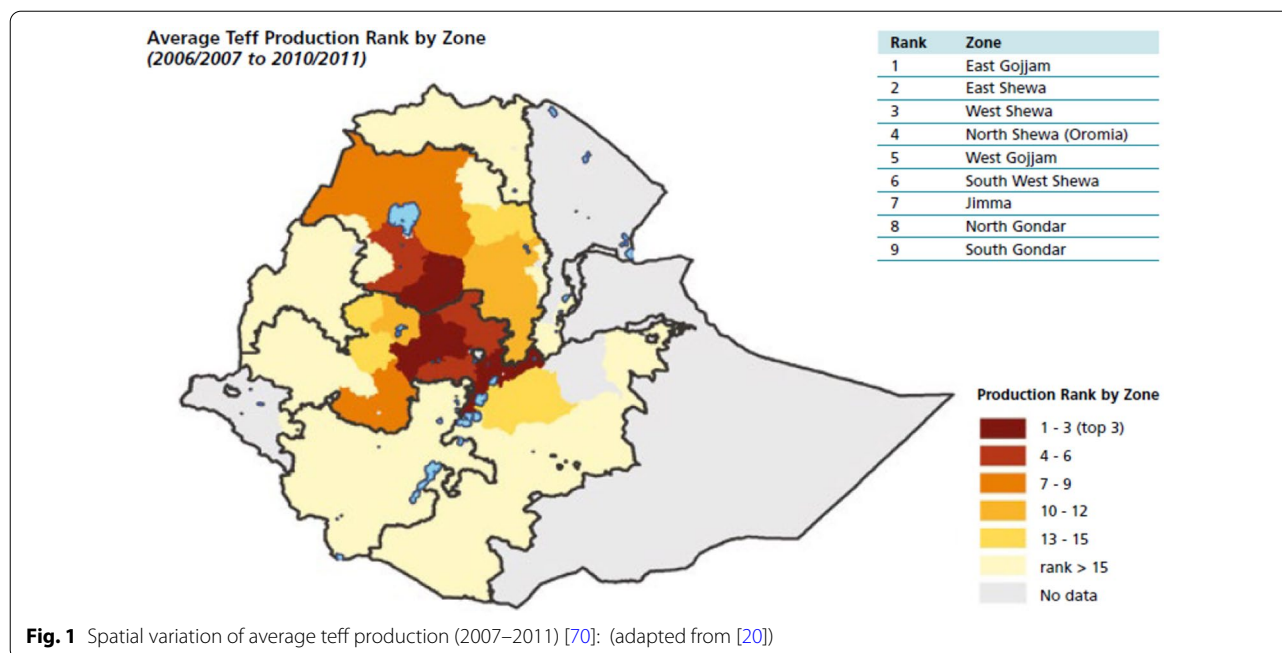
According to Food and Agricultural Organization, teff is the only cereal crop that Ethiopia has a comparative trade advantage. It can be grown in a large part of the country. Improving teff production and productivity involves different challenges; low productivity discourages using it to food security for alarming growth of population, and low yields also reveal its calorie output per hectare is limited compared with other crops. Given the increasing land fragmentation in the mid-altitude highland eco-zones, its low yields constitute a significant constraint on its expansion. The increasing cultivation of teff poses at the expense of other, higher yield crops—such as maize, sorghum, wheat, and Enset (false banana)—that brings a significant challenge to achieving food security and food self-sufficiency nationally, especially for poor families who cannot afford this crop. Keeping on mixed farming systems that combine teff and high-yield crops, as well as legumes and livestock, promoting teff production and consumption is crucial. Hence, the potential of teff to improve food security⁴ and reduce poverty deserves more recognition locally and globally in a greater scope [56].

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, such as 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 [20], more than 6.5 million resource-poor households' units were occupied with teff production in the 2014/2015 cropping season. It is, for the most part, developed in four (Fig. 1) of the nine districts in the nation: Oromia, SNNP, Amhara, and Tigray, on 3.02 million ha (30% of total cultivated land) with all-out production of 4.75 million tons (20% of total cereal grains production).

Particularly, teff is grown mainly in Amhara and Oromia, which together described up to 84% of the total cultivated area and production in 2011. East and West Gojjam of Amhara and East and West Shoa of Oromia are mainly known potential teff producing areas in the country and a smaller proportion of teff is also produced

⁴ To improve the food security concern, there has been a lot of discussion during the last few decades. A number of metrics have been presented to determine whether countries need to improve their food security situation, as well as the variability of existing indicators, has prompted international organizations to create composite indexes to synthesize the data. Hence, the heterogeneity of indicators and the process of creating composite indexes entails a number of decisions that have an impact on the final result in food security [64].



in Tigray and SNNP regions [28]. 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 [50].

In agriculture, the use of spatial analysis has begun in the 1990s with the realization of factors, such as climate; pest populations; land configurations; and soil characteristics all had spatial variability [16]. The geographical issue that is explored in agriculture is the neighborhood effect. The interaction of neighborhood change individuals' decisions, information sets; preferences; and behavioral outcomes [5]. In agriculture, neighborhood interactions have primarily been opened to investigate drivers of technology adoption [18]. The optimal growing conditions for teff corresponds about 1800–2100 m above sea level; average annual rainfall of 750 to 1000 mm; and an average annual temperature of 10 °C to 27 °C [22]. Due to this spatial heterogeneity; there is great variation in the production and productivity of teff within this growing condition area.

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. However, because of geographic heterogeneity, such as climatic unpredictability and technical inefficiency, teff productivity is still lower. Despite the Ethiopian government's efforts to disseminate improved teff varieties, fertilizer, and other modern agricultural technologies to small-holder farmers, teff remains one of the most underutilized cereal crops.

There are few comprehensive policies for large-scale teff production, as well as the adoption of farm implements at the national level. As a result, data on the role of teff in the food, agriculture, and trade sectors, as well as the pattern of teff production, challenges, and prospects, should be synthesized [8].

Teff consumption and its economic value in Ethiopia

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 [8]. According to studies, Injera exports in 2015 were estimated to be worth around ten million dollars [8, 40]. The commercial surplus of teff is equal to the commercial surplus of the three other main cereals (sorghum, maize, and wheat) combined in the country [19]. 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, thus making teff an important cash crop for producers [2].

Indeed, urban households more readily eat teff than rural households [55]. Urban consumers use 81 kg 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 crops, the urban affluent consumers

consume relatively more teff than the rural poor [81]. Teff is, therefore, an economically superior good that is relatively more consumed by richer than by the poor. According to [12], stated that the 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, such as 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 tef 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 kg out of 24 kg). In urban areas, red teff accounts for 11% of all teff consumption expenditures, compared to 27% 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 [40].

Moreover, besides home consumption, teff has been shipped to a different country abroad. According to [8], 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 prohibition⁵ is to lower the domestic price of teff to the level that people could afford and address local food security. The domestic teff prices have averaged more than 74 USD per quintal [69]. Model simulations show that if there are no limits on teff export, the price may reach 91 USD per quintal. The price of teff has risen by more than 22% as a result. Hence, it's the given domestic price that benefits local customers, particularly the underprivileged in rural and urban areas. Removing the export restrictions would very certainly raise the price of teff in the local market to a higher international level. It would be detrimental to domestic customers [2].

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, such as 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 [25].

However, 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 [8]. 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 [32]. 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.

The nutritional values of teff and its role for human health

Teff is nutritionally rich while high in complex carbohydrates. It is gluten-free and can easily be tolerated by patients suffering from celiac disease. Most notably, teff contains a higher quantity of minerals and amino acids than other cereals [2, 39]. Because millions of individuals in industrialized countries suffer from gluten-related disorders (e.g., [63]), its demand has risen rapidly in western markets [32]. Teff is very popular among ethnic Ethiopians and Ethiopian descendants in various parts of Europe and the United States. Teff grains have 357 kcal per 100 g, which is comparable to wheat and rice [23].

In addition, teff has a similar protein level to other common cereals, such as wheat, but is higher in the important amino acid lysine than other cereals. Teff is high in important fatty acids, fiber, minerals, and phytochemicals including polyphenols and phytates [14]. It is important in preventing pregnancy anemia due to its high content of fiber, calcium, and iron [27]. The crop has a longer shelf life, and slow staling of its bread products compared to that of wheat, sorghum, rice, barley, and maize. The grain is linked to several health benefits including prevention and treatment of diseases, such as celiac disease, diabetes, and anemia [34].

Thus, protein, dietary fiber, polyphenols, and certain minerals are all appealing ingredients in teff. Whole grain teff flour is becoming increasingly popular in the health food market, and it's been used to make gluten-free pasta and bread [81]. Its composition from 3.5 ounces (100 g) of teff flour provides; Protein: 12.2 g, Fat: 3.7 g, Carbs: 70.7 g, Fiber: 12.2 g, Iron: 37% of the Daily Value (DV),

⁵ Regardless of the growing demand, in 2006 Ethiopia restricted export of raw Teff and flour, after the cost of the yield skyrocketed, panicking customers. (The boycott does exclude injera.) Mama Fresh is one of the organizations that since 2003 has prepared and traded injera to different pieces of the world. Anadolu [4]. Accessed 19 dec 2020. <https://www.dailysabah.com/business/2017/10/17/ethiopias-super-grain-seeks-to-capture-global-market>.

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 [49, 65]. Moreover, teff is an adequate source of each of the nine basic amino acids, including lysine, which is regularly missing in many other cereal [14, 33].

Market structure 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 [3, 57]. 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 [57].

Along with the teff spatial prices in Ethiopia, the central market is the capital (Addis), given its large size and its central role [35, 70]. 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 [43], in which markets are all connected to Addis Ababa with the highest urban consumers and the highest volume of market size. As Antonioli and Santeramo [6], assumes that the kind of price transmission (cost-push, demand-pull, or feedback system), the degree of symmetry, and the rate at which shocks are conveyed, the price of the product may vary accordingly.

According to Urgessa [76], farming practices, favorable household characteristics, and loss management are essential to improve teff production, but not an end by itself. A functional value chain, market, and supportive policy should coexist to enhance the teff industry.

As Minten et al. [57] 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 [76] reveals that teff producers took 78.7% of the consumer price while the assemblers, wholesalers, and retailers shared the rest of the price.

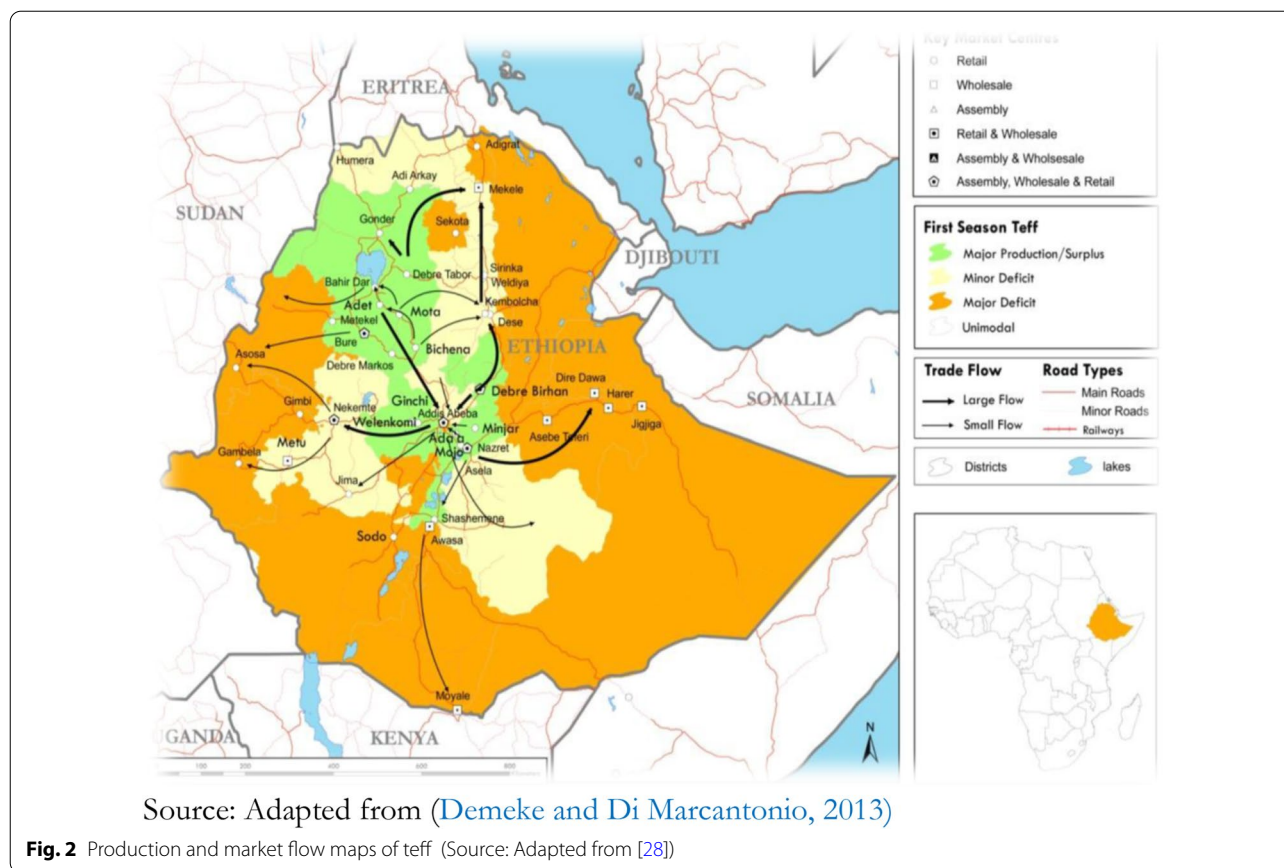
According to Tura et al. [75], teff-producing farmers in the *Becho* district added a value of 455 birr per quintal, which is 33.58% of the total value added in the district. The value added by a farmer was smaller than a value-added by an *injera* seller. The intermediate cost the farmer incurs was greater than the intermediate cost incurred by the *injera* seller. The value-adding activity performed by the rural retailer was cleaning and packaging of teff as it is appropriate to sell to urban/rural wholesalers. Rural retailers added 180–235 birr per quintal. The percentage of a value-added from the total value added is 15.46–17.34%.

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 [31, 55] 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. As Tura et al. [75] the value share of producers, rural retailers, rural wholesalers, district urban wholesalers, and district *injera* sellers in the teff value chain for *Becho* districts was 33.58%, 17.34%, 6.64%, 7.34%, and 35.06%, respectively. While for *Dawo* districts the value share from the total value added was 34.71%, 15.46%, 9.06%, 4.73%, and 36.08% for producers, rural retailers, rural wholesalers, district urban wholesalers, and district *injera* sellers in the teff value chain.

Value-added represents the contribution of payments to the primary factors of production, such as seed, fertilizer, and other inputs, the more value teff farmers can add to a product for a given primary and intermediate cost configuration, the greater its profitability. The potential for farmers to add value to their products lies in their ability to keep intermediate input costs as low as possible [66].

According to Demeke and Di Marcantonio [28], 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 subgrades within each, such as *Magna* (super white), that is grown in *East Shoa* and is being sold at a premium price. The central market, *Addis Ababa* plays an imperative role in setting the prices in the major production places. While the majority of the grain moves to *Addis Ababa*, some urban consumption centers, such as *Mekele* and *Dessie*, get their supplies directly from the production areas. Other urban centers, such as *Harar* and *Dire Dawa*, are supplied from *Nazret (Adama) (East Shoa)* (see Fig. 2).

Hence, within different regions of Ethiopia, such as *Gojam* and *Shewa* (located in the central highlands), *Gonder*, *Wello*, and *Welega* are the major teff production areas. While 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.



Use dynamics and types of teff products

The most well-known use of teff in Ethiopia is the fermented flatbread called injera [10, 71, 81]. Crymes [25] 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 [25]. Injera blended in with other flour, for example, wheat or sorghum is viewed as inferior. Different uses of teff incorporate local alcoholic beverages called tela and katikala, and porridge [2]. 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 [23, 47, 68]. 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 food⁶ [81].

As Stallknecht [67] depicts three fundamental kinds of teff grain, white, brown colored, and mixed (*brown colored and white*) as follows: white teff is the favored one but grown in the highland of Ethiopia. It requires the most thorough growing conditions, has the mildest flavor, and is the costliest type of teff. Much the same as white bread has been a superficial point of interest in the United States, white teff is normally held for the richest and most prestigious families in Ethiopia. While red(brown) teff, the most affordable structure, and the least preferred type, has the most noteworthy iron substance. According to Minten [57], changes in the types of cultivated teff are observed over time. A noticeable change is an increase in white-colored teff at the expense of red(brown) and mixed-colored teff. The white teff made up 69.6% of the teff grown in 2012, compared to 48.2% in 2002. On the other hand, the share of red teff declined from 36% to 19.7% during the same period.

Teff grain flour is widely used in Ethiopia for making injera (staples for the majority of Ethiopians, a fermented, pancake-like, soft, sour, circular flatbread), sweet unleavened bread, local spirit, porridges, and soups [17].

Nevertheless, teff has shortcomings to become an income-generating global commodity for Ethiopian

⁶ AgriFuture Australia. 2017. <http://www.agrifutures.com.au/farm-diversity/Teff/>.

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 [3, 23]. 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 [2]. However, comprehensive statistics on its production, utilization, and trade are little available in those countries.⁷

Overall, teff production in Ethiopia largely relies on the backward methods, efficiency of the value chain varies depending on the areas, and the 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. Therefore, incentives rarely exist to invest in modernizing teff production and its value chain.

Small scale, dispersed, and unorganized producers are unlikely to exploit market opportunities as they cannot attain the necessary economies of scale and lack bargaining power in negotiating prices [36].

Further in developing country farmers are not getting the right share of consumer price because of excessive margin mainly because of inefficient and costly transport. Besides transport problems, majorities of agricultural products in Ethiopia are smallholder produces, and are not producing and selling their products and agricultural inputs in an organized manner so that some of their benefits may transfer to the middlemen [52].

Furthermore, the value chains of developing country constraints to participation often are compounded by country-level challenges to competitiveness. These challenges include weak regulatory institutions, such as poorly designed and implemented sanitary and phytosanitary regulations, inadequate transportation, power, and water infrastructure, and the absence of important upstream value chain actors, such as equipment, seed and fertilizer suppliers, and firms providing supporting services [41].

Motives of integration into value chain analysis of teff

Substantial changes are happening in agricultural and food markets worldwide and particularly in developing countries (e.g., [74]). First, supermarkets are taking off quickly in a very sizable amount number [61, 73]. Second, the share of high-value crops is rapidly increasing

in the diet of consumers [38, 53, 60]. Third, quality preferences by consumers in developing countries are on the rise [54]. Fourth, the requirement of food safety for export agriculture from developing countries has vital effects on the structure of value chains [42, 51]. Fifth, food-processing corporations are increasing the degree to that they vertically integrate their operations and have become progressively concerned in the production and promoting activities [80]. Sixth, traditional value chains of food staples are characterized by a method of raised up-scaling, disintermediation, and branding [62].

Value chain is important in the enforcement of standards, with each player ensuring that the product originating from the previous stage adheres to the standards. According to Fufa et al. [31], 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.

Along with teff value chain, the adoption of modern farm inputs by farmer's increases, increasing willingness to pay for convenience in urban areas, improvement of the foodservice industry, improved marketing efficiency, quality demands rise and shifts from the cheap red varieties to the more expensive white ones [55].

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 [32]. The teff value chain has not arrived at its maximum capacity⁸ due to systematic bottlenecks at each phase of the value chain.

Teff supply chains and 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 [26, 47].

The major teff value chain in Ethiopia was relatively short. Along the value chain, there are three critical players between teff producer and Urban Retailer (UR): Farmer Traders (FT) operating at a village level, Rural

⁷ Historically, Teff is grown in developed nations, for example, Australia and the USA have served basically as a forage crop [68].

⁸ There is a considerable gap looking into this discourse in the international, national, and regional as well as locally identified gaps in the process of value addition of the most valuable crop, Teff. Despite the large potential for improvements in agricultural productivity and market performance in Africa, especially given rapid overall economic growth (which generally is linked to non-agricultural sectors of the economy), evidence on changes in domestic food value chains in Africa is still limited, possibly due to a lack of accurate and reliable data [44].

Traders (RT) at a regional level, and Urban Traders (UT) at an urban level [57].

According to Uregass [76] quantity of teff produced, access to market information, access to extension, and sex of the household head were found to have a positive and significant influence on the marketable supply of teff.

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 [9, 47]. 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.

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 [3, 23].

Teff's tiny seed additionally present several difficulties to its commercial efficiency, especially for planting [47]. At planting time, the small seed makes it hard to control population density and its appropriation [46]. Moreover, the process of threshing sifting, winnowing, and crushing the seeds can be relentless and tedious, and labor-consuming [47, 77]. 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*) [10]. These joined, along with the absence of continued innovative work endeavors and of improved strategies for research make up the fundamental variables adding to the moderately low quality and quantity of collected teff.

Moreover, according to [2], 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 farmer's 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, such as 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

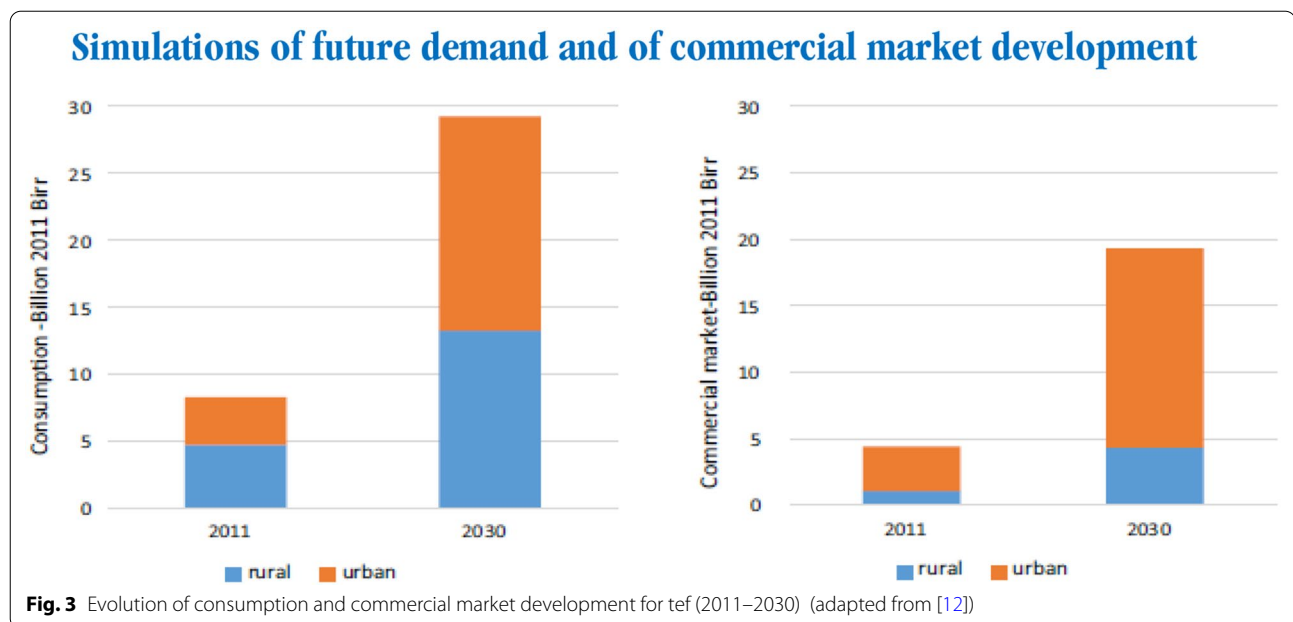
Accordingly, many problems restrict teff to maintain high quality and supply with affordable price for the consumers. Among these, (1) restricted resource for teff research and breeding; (2) low improved seed selection and costly fertilizer; (3) insufficient agronomic practices; (4) high post-harvest handling loss rates; (5) a fragmented value chain that includes numerous players; and (6) restricted value chain setups [32].

Given the socio-cultural and economic importance of teff to the people of Ethiopia, its absence elsewhere stays a conundrum that still can't seem to be clarified. It very well might be credited to the development of unique farming and domestication of this indigenous yield in the highlands of Ethiopia. Nevertheless, teff has gradually spread over the outskirts of Ethiopia, foreign families, and has the undeniable potential to be one of the world's prominent food sources. Following the current 'super-food' wave, wellbeing fans are eager to pay a premium for teff grain given its gluten-free and supplement stuffed substance, such as the main super grain quinoa [48, 79], a staple of South American good highland farmers that was previously a neglected crop [30]. 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.

Teff prospects and demand simulation

Teff has been used as a grain for thousands of years, it is a staple diet for people as well as cattle fodder; it has a variety of uses. Benefits in terms of health; animal feed; agricultural risk aversion as well as other factors teff, for example, maybe grown in moisture-stressed locations and waterlogged conditions; it is useful animal feed, because it is highly favored by animals. A dependable and low-risk crop; resistant to weevil and other storage pests; can be stored for a long time [47]. 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 [8].

Similarly, teff's popularity is rise 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 [2]. 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 Bachewe et al. [12], 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 (see Fig. 3). The demand for teff will increase by 250% between 2011 and 2030. There has been verified that rapid growth in urban demand for teff. While urban consumption of teff made up 43% of total teff consumption in 2011, this is expected to increase to 55% in 2030. Hence, the data, therefore, reassures that to what extent that the rural–urban teff value chains will raise in the future. The rural commercial markets are expected to rise by 304%. In general, a growth of 340% is expected to be by 2030. Such growth will have an enormous inference for different agents that are involved in these markets, such as traders, transporters, wholesalers, retailers.

Conclusion and recommendations

Teff production in Ethiopia largely relies on the backward methods, efficiency of the value chain varies depending on the areas, and the 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. Therefore, incentives rarely exist to invest in modernizing teff production and its value chain. The current situation draws some suggestions for teff to become more of a global commodity.

Urban households consume more teff than rural households. Teff is also characterized by high income elasticities, thus it is classified as an economically superior commodity meaning that an increase in income causes a disproportional increase in teff consumption. Teff will continue to be a product that the wealthy, mainly in metropolitan areas, consume in higher amounts than the poor. The poor's reduced consumption is explained in part by teff's high pricing compared to other crops, which are often twice as costly as the cheapest cereal, maize.

Global food security is one of the prime difficulties confronting the present reality. Broadening away from overdependence on the 'big three' cereal crops (maize, wheat, and rice) should be a fundamental piece of progress towards accomplishing sustainable food security. With its high healthful quality and versatility, teff could give a response to both the food and nutrition security requests of a growing populace. Regardless of teff's ongoing

prominence in developed nations as gluten-free specialty food, its impediments and potential remain overlooked. More extensive advancement and logical publicity should spur interest, and build up a general consciousness of the capability of teff.

Contributions through exploration and investment by global associations, combined with the current public projects in Ethiopia, present a promising future for teff and are probably going to create interest among private sector players.

With its versatility to both dry season and warmth stresses, teff could be the response to the troubling condition of food security for the dietary requests of a developing populace; these points are following the sustainable global agenda for food and nutrition security. In doing so, protecting the domestic price of teff and increase food security, its export ban seems irrational. The policy was found to be a poorly conceived restrictive measure. Rather alternate policy package for the government, which includes, among other things, multiple tax regimes, export price floors, and government-to-government transactions would bring feasible and welfare outcomes associated with it. This would likely commoditize teff. The commoditization could make enormous scope exercises important to expand efficiency and backing export volumes. In doing as such, teff should be added to the Ethiopian Commodity Exchange (ECX) for more transparent and effectively exchanging. The foundation of ECX in 2008 was to help its commodity market and transform agricultural trades and ready to serve Ethiopian farmers, processors, consumers, and different entertainers. The ECX is as of now working with the major commodities, for example, coffee, haricot bean, maize, sesame, and wheat, yet not teff.

This very tiny crop will be a superglobal food when adequate value is supplemented and highly supported by improved production technology. For significant improvement for the productivity and product, it needs continuous identification of important traits for teff improvement through strengthening national breeding programs, creating suitable and marketing strategies of teff value-added products along with

Putting in place mechanisms for teff seed standardization, packaging, labeling, and distribution that are capable of meeting farmers' demands would help to ensure a sustainable supply of high-quality improved teff seeds. Precisely, adequate public and private research, and investments are needed on teff quality seeds to boost yields and make them more drought and lodging tolerant. As well as it is necessary to develop site-specific recommendations for organic and inorganic fertilizers that are most suitable for teff production. The development of suitable specific mechanical harvesters and threshers offers the potential to

enhance efficiency, minimize produce loss, cost, and time-saving. strengthening farmers' access to price information across the place and increase the transparency of the market and would enable farmers to make better selling decisions and provide increased bargaining power to begin the value chain.

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.

For extending markets and improve market efficiencies, it needs to devote time for the study and exploration of output options and to mitigate marketing challenges and stimulating the involvement of cooperatives. Furthermore, promote the appropriate deepening of credit, insurance, and labor markets are immensely vital component to reach out the potential impact of teff products.

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Authors' contributions

ET and TH have conceived of the presented idea, reviewed the developed theory, and performed the analytical computations. ET has been encouraged to investigate the economics of teff and verified the analytical methods and reshaped the script and frameworks. Both authors read and approved the final manuscript.

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