Original Research Article

Opportunities and Constraints of Coffee Production in Southern Tigray, Ethiopia

ABSTRACT

In Ethiopia, coffee is a significant crop, but in the Tigray region, particularly southern Tigray, it receives less emphasis despite its national importance.This study investigates the status of coffee production in southern Tigray, Ethiopia, using a multistage sampling technique to gather data from 113 respondents. The goal is to identify opportunities and constraints in coffee production in the region.Data was collected using individual interviews and Focus Group Discussions, and analyzed using SPSS software and a ranking index.The study found that favorable agro ecology, fertile soils, access to water, and tolerant coffee varieties are opportunities in southern Tigray, Ethiopia. However, constraints include irrigation competition, lack of training, limited input use, and shifting to chat cultivation. Additionally, most farmers do not practice pruning and rejuvenation due to a lack of technical knowledge.This makes the coffee stand, erect, less branched and very tall which is difficult to harvest.Hence, the study suggested that an integrated coffee production intervention is important to boost coffee production and local policy instrument is prerequisite for the shifting of coffee to chat production in the study districts.

Keywords*: Coffee, Ranking index, Focus group discussions*

1. INTRODUCTION

Coffee(*Coffee arabica* L.), the world's favorite drink, is a significant commercial crop and the second most valuable international commodity after oil. It supports millions of farming families and people worldwide, with an export value of US$ 15.4 billion in 2009/10. The roasted seeds of the Coffee genus are used to make coffee, which plays a crucial role in the economies of several tropical countries. The process from plant to cup is complex, as described by Davis et al. (2011).Ethiopia is coffee producer in Africa and the fifth largest globally, after Brazil, Vietnam, Colombia, and Indonesia. It contributes about 4.2% to world coffee production (ICO, 2016).

Arabica coffee is believed to have originated in Ethiopia's humid high rain forests in the south and southwest. Ethiopia is renowned for producing high-quality coffee, known for its distinct aroma and flavor characteristics. Coffee varieties such as Sidamo, Yirga-chafe, Harar, Gimbi, Jimma, and Limmu are particularly acclaimed for their unique characteristics (Anwar,

2010).Flavor is the most crucial component of coffee quality standards, as it has a significant and direct impact. It can be used for indirect selection to enhance the overall organoleptic quality of coffee (Abdulfeta et al., 2019).Ethiopia is a significant source of genetic resources for Coffee arabica, which is cultivated in most parts of the tropics and accounts for 80% of the world coffee market. Coffee production plays a vital role in income and employment in developing countries like Africa, Asia, and Latin America (Behilu et al., 2007).In Ethiopia, coffee is a major source of foreign currency income, contributing more than 35% of total export earnings (Fayera, 2006). Coffee from certain regions, such as Harar and Yirga-chafe, is highly valued due to its fine quality and appropriate processing methods, resulting in premium prices both domestically and internationally (Workafes and Kebede, 2000).Similarly,in southern Tigray's Raya Azebo district, coffee is sold at a premium price at the local market (district level). Woreda experts and producer farmers in the area believe that their coffee is of high quality, resembling Harar type quality coffee (RWDO, 2017).

Despite the significance of coffee in Ethiopia, the average yield is generally low, at about 619 kg/ha (CSA, 2018). Several authors have identified limited use of improved technologies and best practices by most smallholder farmers, widespread prevalence of insect pests, diseases, and coffee weeds as major reasons for this low yield (Kifle et al., 2015; Tamiru et al., 2017).

Similar to the national context, coffee productivity in Tigray is also very low, falling below the national average. Despite governmental and non-governmental organizations emphasizing the production of coffee instead of chat in Tigray, particularly in the lowland areas of southern Tigray, there is a lack of integrated interventions at the grassroots level. Additionally, despite efforts by these organizations to promote coffee production, there is limited research on the existing opportunities and constraints of coffee production in the study area.Given the low productivity of coffee in Tigray and the limited research on coffee production opportunities and constraints in southern Tigray, this study was conducted to identify the major factors in this region. The findings of this study can serve as a foundation for further research and development in coffee production, as well as inform policymakers to understand the gaps in the zone and beyond in the region.

2. MATERIALS AND METHODS

2.1. Area Description of the study area

The study was conducted in the major coffee-growing districts of R/alamata and R/azebo in the southern zone of Tigray Regional State. Geographically, Raya Azebo district is situated between 12.32° - 12.95° North latitude and 39.56° - 39.98° East longitude, while Raya Alamata district is located between 12.26° - 12.57° North latitude and 39.24° - 39.76° East longitude (Fig 1; Table 1).The total annual rainfall for Raya-Alamata and Raya-Azebo is 650 mm and 600 mm, respectively. Both districts experience bimodal rainfall patterns. Raya-Azebo has light rainfall from February to April and heavy rains between July to September, while heavy rainfall for Raya-Alamata occurs between June and September. The average temperature is 25°C and 24°C for Raya-Alamata and Raya-Azebo, respectively (OoARD of each district, 2017).

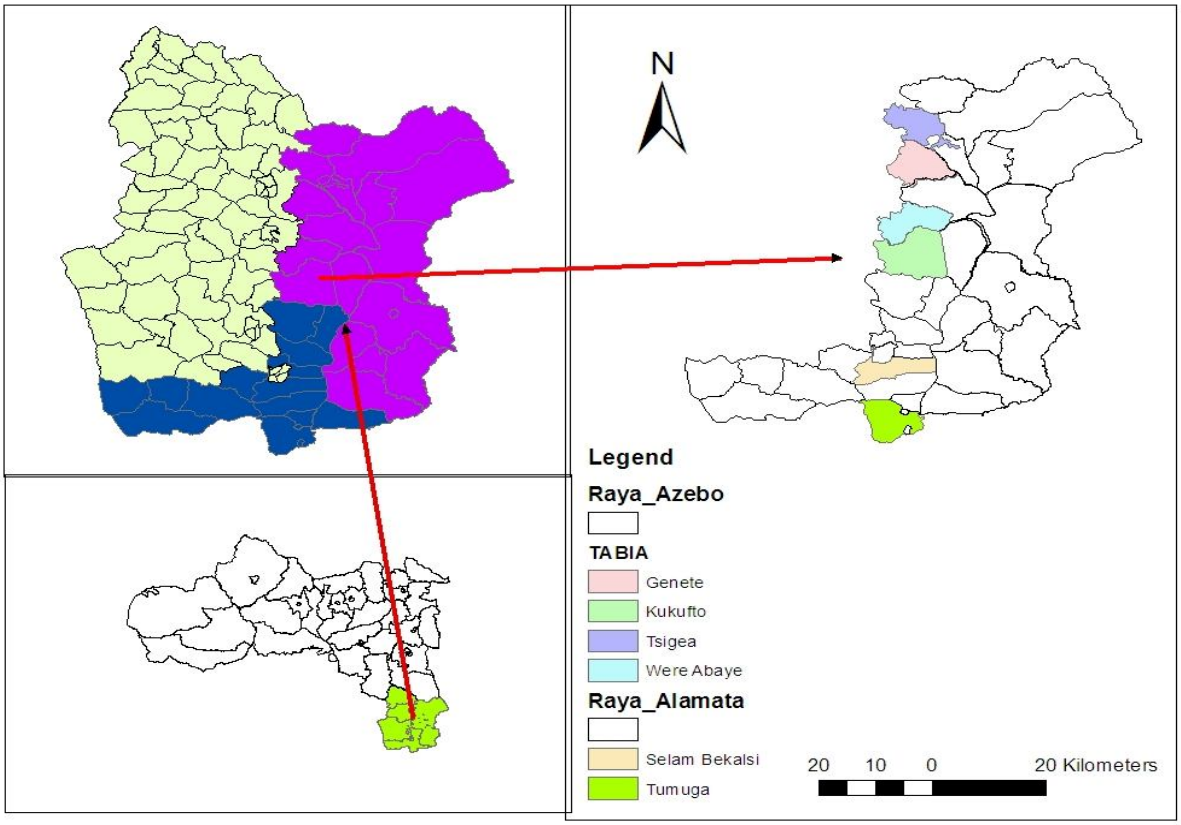

Figure 1: Map of the study area

2.2. Sampling procedure and sample size

The multistage sampling procedure was employed to select sample respondents. First, two districts, namely; Raya Alamata and Raya Azebo were selected purposively based on their experience in growing coffee. Second, six kebeles (four from Raya Azebo and two from Raya Alamata) districts were also selected purposively based on their potential in growing coffee.

Third, sample respondents were selected randomly based on their proportion to sample size from the selected six kebeles. Finally, a total of 113 respondents were drawn to conduct the study (Table 2).

Table 2. Distribution of sample respondents by Woreda and kebele

Districts	Selected kebeles	Sample taken
Raya Azebo	Hijira werabaye	43 (38.1%)
	Tsigi'a	23 (20.4%)
	Beyru kalian	7 (6.2%)
	Genete	23 (20.4%)
Raya Alamata	Tumuga	7 (6.2%)
	Selambikalsi	10 (8.8)
Total	6	113 (100)

Source: Survey data 2015

2.3. Data sources and data collection methods

In this study, both primary and secondary data sources were utilized. Primary data was primarily collected from sampled respondents through individual interviews. Additionally, focused group discussions with district experts from the agricultural office and key informants were employed to supplement the study. Secondary data sources were also used from published journals and unpublished reports and documents.

2.4. Data analysis method

The collected data were analyzed using SPSS software and the ranking index method. The ranking analysis was employed to assess the opportunities and constraints of coffee production and the economic importance of horticultural crops using the ranking index method (Musa et al., 2006). The ranking index was calculated using the following formula, which has been used by several scholars, including Mezgebo (2019), to study the opportunities and constraints of community-based seed production in southern Tigray. The results of the study were presented descriptively.

***Rank index**= Sum (number of farmers the crop rank first*8+ number of farmers the crop rank second*7+ number of farmers the crop rank third*N+…number of farmers the crop ranked*

*last *1) for individual statements economic importance, opportunity or constraint divided by Sum (number of rank first*8+ number of rank second*7+number of rank N*6+…number of ranked last*1) for all statements economic importance, opportunity or constraints.*

Value is assigned according to the ranking order, and the highest value was given for the first rank and lowest value of one for the least rank.

3. RESULTS AND DISCUSSION

3.1. Economic importance of coffee production in southern Tigray

As indicated in table 3, farmers in study districts had grown different types of fruits including stimulants like *chat* which have different levels of economic importance on their livelihood. According to ranking index, coffee, chat, and papaya respectively, are the first, second and third in that order based on their economic importance. Based on an economic importance ranking index, coffee, chat, and papaya are the top three crops, with chat being the most important (46%), followed by coffee (32.7%), and papaya (9.7%). Other crops mentioned include Gesho (6.2%), orange (1.8%), guava (3.5%), and mango (21.6%).According to a ranking index, coffee, chat, and papaya are the top three economically important crops, with chat being the most important (46%), followed by coffee (32.7%), and papaya (9.7%). Other crops mentioned include Gesho (6.2%), orange (1.8%), guava (3.5%), and mango (21.6%) (Table 3).This study is consistent with the national context of Ethiopia which states that, farmers are more likely to grow and produce stimulant crops like coffee and chat compared to fruits. These crops have a larger area and production, and their holders earn a significant amount of cash (CSA, 2018).

Table 3. The rank of major fruits based on their economic importance (N=113)

Type of fruits	Ranked 1st	Ranked 2nd	Ranked 3rd	Total	Index	Rank
Coffee	37*3	54*2	9*1	228	0.396	1st
Chat	52*3	16*2	3*1	191	0.332	2nd
Papaya	11*3	5*2	4*1	47	0.081	3rd
Gesho	7*3	7*2	3*1	38	0.066	4th
Orange	2*3	2*2	13*1	23	0.04	6th
Guava	4*3	6*2	1*1	25	0.043	5th
Mango	0*3	3*2	11*1	17	0.0295	7th

Banana	0*3	1*2	4*1	6	0.0104	8th
N	**113**	**94**	**48**	**575**	**1.00**	

Source: Survey data 2015

3.2. Management practices are done by coffee producer farmers in Southern Tigray

The most important practices for enhancing coffee productivity and quality include the use of inputs, shade, intercropping, pruning, and rejuvenation. However, the analysis shows that the use of inputs for coffee is very low, with the majority of farmers (84.5%, 98.2%, and 78.6%, respectively) not using fertilizers, pesticides, and improved seeds/seedlings (Table 4).Coffee tree pruning is a crucial pre-harvest management practice that helps reduce disease incidences, modify air movement within the plantation, reduce leaf drying time, and maintain the framework of plants in a desired shape, ultimately contributing to sustainable higher yields (Adriana *et al*., 2009 and Tadesse, 2015).However, the majority of farmers 92.7% and 89.2% respectively didn't practice pruning and rejuvenation (Table 4).The result shows that coffee farmers in the study area have low management practices, resulting in old, erect, less branched, and very tall coffee stands that are difficult to harvest and yield low quality due to their vertical branches.Contrary to this study, Birhan *et al*. (2014), reported that the majority (93.33%) of the coffee farmers in Gomma Woreda, Jimma Zoneare practicing coffee tree pruning.

The shade is important to protect coffee seedling from morning and afternoon sun injury and enhance its survival rate. As indicated in Table 3, more than 70% of respondents use shade and intercropping. Farmers explain that the use of shade could conserve moisture by reducing evaporation and yield under shade is higher than under bare land (Table 4). The result of this study is consistence with a study by (Mohammedsani, 2014), who reported that 87% of respondent were used shade for their coffee in eastern Harargae.

Table 4. Management practices applied by coffee producer farmers (N=113)

List of practices	Did you practices	Frequency	Percentage
Fertilizer application	Yes	17	15.5
	No	93	84..5
Improved seed	Yes	24	21.4
	No	88	78.6
Pesticides application	Yes	2	1.8
	No	110	98.2
Use of shade	Yes	97	77.5
	No	23	22.5
Intercropping	Yes	73	70.2
	No	31	29.8
Pruning practice	Yes	8	7.3
	No	101	92.7
Rejuvenation	Yes	11	10.8
	No	91	89.2

Source: Survey data 2015

3.3. The trend of coffee production and farmers merit to shift from coffee production to chat

The status of a coffee plantation in the study area was decreasing from time to time. The result of the study shows that about 60% of farmers did not plant coffee (no new coffee plantation takes place). However, about 20.7% of respondents were replied plantation of coffee has been increasing. In addition, more than 65% of respondents did not have any plan to increase their coffee plantation.The number of mother coffee trees owned was 103 within a maximum and minimum of 625 and 14 respectively, for coffee. However, the average number of chat per individual farmer was 754 within a maximum and minimum of 10,000 and 23 respectively. (Table 5). This indicated that there is a higher chat population than a coffee per individual farmers in the study districts. Moreover, about 65% of interviewed farmers have no plan to increase their coffee plantation. This study is consistence with Tolera and Gebermedin (2015), who reported that recently chat is competing for farmland with coffee. Some farmers are highly interested to produce *chat* instead of coffee as they are increasingly attracted by the high prices and greater yield they get from chat.

Farmers were explained their perception to shift from coffee production to chat based on merits indicated in Table 6. In terms of irrigation water consumption, coffee had higher water consumption than chat due to coffee had different growth stages which require irrigation water at

each stage to develop into the highest stage. In terms of ease of production, the chat is easy for propagation, production handling and double harvesting in a year. Additionally, producer farmers perceived that chat had higher profits than coffee (Table 6).

Table 5. Land allocated, future plan and number of tree stand of coffee production (N=113)

The trend of land allocated for coffee			Do you plan to increase your coffee		Crop	Number of stands per farmers		
						Mini	Max	Mean
Increased	Decreased	Constant	Yes	No	Coffee	14	625	103
23(20.7%)	21(18.9)	67(60.45)	39(34.5%)	74(65.5)	Chat	23	10000	754

Table 6. The main reasons for farmers to shift from coffee to chat cultivation

Parameters	Coffee	Chat
Irrigation water consumption	High	Low
Frequency of harvesting	Once/year	2-3/year
Ease of production	Hard	Easy
Biennial bearing	yes	No
Means of propagation	Time consuming	Easy
Profitability	Low	High

3.5. Post harvesting management and marketing experience of coffee in southern Tigray

Birhan *et al.* (2014) found that pre-harvest and post-harvest practices such as the age of the coffee, disease prevention, compost application, storage conditions, and storage time have a significant impact on the quality of coffee.Improper harvesting and postharvest processing are adversely affecting the quality of the coffee produced (Mohammedsani*et al.*, 2017). Similarly, Abrar and Negussie (2013) reported that coffee quality is decreased with inappropriate time of harvesting. In southern Tigray, most of the farmers about 99% and 97% respectively, were harvested through successive handpicking and they practiced dry processing. Additionally, almost all farmers in the area reported that they harvest their coffee at maturity when the cherries became red (Table 7). The actual observation of the researchers is picking of green, immature berries and red cherry is common in most farmers. This is to shorten the interval and the selective labor-intensive harvesting.

Table 7. Method of harvesting, processing, and materials used for drying

Methods of harvesting	N (%)	Stage	N (%)	Time of harvesting	N (%)
Hand picking successively	111(99.1)	Red cherries	113(100%)	soon at maturity	110(98.2%)
Hand-picking all at once	1(0.09)			Late past maturity	2(1.8%)

Coffee requires special drying materials and storage due to sensory quality nature. Quality deterioration associated with dry processing in the conventional system lowers the quality standards of coffee and is strongly discouraged (Tsegaye *et al*., 2014). The result of the study shows that the majority of respondents used the conventional way of drying, about 50% of them used bare ground and 46.4% of them were also used kenda/shara for drying their coffee (Table 8). This result is in agreement with Abrar and Negussie (2013), who reported most farmers in Raya Azebo district, used bare ground for drying and, drying coffee on the bare ground can expose the product to quality deterioration. Moreover, drying coffee on bare ground highly reduced raw, abnormal color and unpleasant odor (Mohammedsani*et al*., 2017).

The majority of respondents (88.4%) were replied that they did not ever sell unprocessed coffee. However, few respondents (11.6%) in Werabaye kebele were sold unprocessed coffee to somebody investor at some time (Table 7). Farmers were told us one investor was buying red cherries coffee products to process him in a way to exploit desired quality and to sell with a premium price. About half of the respondents (54.5%) do not grade cherries during processing. This is due to labor-intensive for grading since no special price is awarded. However, about 45% of the respondents practiced on-farm grading during processing (Table 8).

Table 8.Materials used to dry coffee, grading and have you ever sold red cherries (unprocessed) in southern Tigray (N=113)

		N	%
Using grading	Yes	51	45.5
	No	61	54.5
Sell unprocessed seed	Yes	13	11.6
	No	99	88.4
Drying materials used	N	%	
Rock	2	1.8	
Cemented ground	2	1.8	
Bare ground	56	50	
Kenda/shara	52	46.4	

Method of processing	Dry	109	97.3
	Wet	3	2.7

Opportunities and constraints of coffee production in southern Tigray

During the focus group discussion, respondents have realized the opportunities of their environment for coffee production. Some of the existing opportunities are favorable agro ecology, relatively fertile soil and presence of water (ground and spring water) and presence of already established tolerant coffee landraces in their respective order (Table 9). This study is in agreement with Duguma, (2017) and Tsegaye, (2017), who reported that having Suitable agro ecology and soilconditions of coffee production area,existence of coffee genetic diversitiesto resist different risks (Drought,disease, pest, etc.), internationally well-known brands specialty coffee, unexploited land and water resourceswith potential to produce more coffee are the main opportunities of coffee production in Ethiopia.

The group of the respondents perceived that their coffee is an attractive color for the market, big seed size physically and good aroma and flavor when roasted and tasty when drink as compared the introduced from other regions. However, intensive irrigation water competition, lack of training and knowhow on agronomic practices and use of inputs and crop replacement (shifting of a coffee farm into chat cultivation) and limited access and insect control are the main constraints for coffee production in southern Tigray (Table 9). Climate change (scarcity of rainfall, increasing temperature, the occurrence of adverse conditions), low productivity, low extension services, crop replacement by more profitable cash crops and inadequate services (credit, inputs, seeds, equipment) are also the main constraint of for coffee production in Ethiopia (Tsegaye, 2017). In addition, Degaga, *et al*. (2017), reported that in the Arsi zone substitute the land allocated for coffee by chat due to drought, diseases, pest and low price of coffee.

Table 9. Opportunities and constraints of coffee production in southern Tigray

Opportunities	Rank	Constraints	Rank
Availability suitable agroecology	1	Intense irrigation water competition	1
Availability of relatively fertile soils	2	Lack of training and know-how on agronomic practices and use of inputs	2
Availability of groundwater and	3	Shifting of a coffee farm into chat cultivation (	3

spring water		crop replacement)	
Availability of tolerant landraces coffee varieties	4	Limited access to disease and insect control	4
		Lack of access to seedlings and improved varieties	5
		Low yield and biennial bearing	6
		Difficult to process (time-consuming, labor-intensive, breaking down when pulped grinding, lack of secured drying space)	7
		The coffee is aged makes them difficult to harvest	8

N.B:1-highest opportunities/ constraint whereas 4-lowest opportunity and, 8- lowest constraint

4. CONCLUSION AND RECOMMENDATIONS

The study indicated that coffee is mainly produced at the two lowland districts of southern Tigray and it was ranked as the first economic importance crop by the producer farmers. However, coffee management (like the use of inputs and pruning) in the study area is poor. Coffee was being substituted by*chat* due to its disease resistance, drought tolerant as compared to chat.Some farmers claim the price of the coffee seedling is not fair. Important agronomic practices such as pruning and rejuvenation are not practiced due to a lack of technical know-how. Due to this reason, the coffee stand is very old (60-80 years ago), erect and less branched, very tall and difficult to harvest.This study concludes that the availability of suitable agro ecology, availability of relatively fertile soils, availability of water (ground and spring water), availability of tolerant landraces coffee varieties are the main opportunities to exploit for further coffee production, whereas intense irrigation water competition, lack of training and know-how on agronomic practices, limited use of inputs, limited disease, and insect control, shifting from coffee into chat cultivation are main constraints yet to be solved for sustainable coffee production. Hence, the study forwarded the following recommendations;

- Research institutes should be work to identify higher yielder of coffer varieties to the farming community.
- Technical training on integrated agricultural practices together with processing techniques should be given .

- Irrigation infrastructures should be constructed in order to promote efficient water. utilization and to maximize the production of coffee.

- Policymaker should give emphasis for coffee producers by promoting incentives and subsidies as well as facilitating market linkage for their produce coffee compared to chat.

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