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Scoping Study on Ethiopian Sesame Value Chain

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ACRONYMS

ATA (now ATI)	Agricultural Transformation Agency (now Agricultural Transformation Institute)
CGIAR	Consultative Group for International Agricultural Research
CSA (now ESS)	Central Statistical Agency (Ethiopian Statistical Services)
ECX	Ethiopian Commodity Exchange
FAO	Food and Agricultural Organization (of the United Nations)
GTP	Growth and Transformation Plan
MOTRI	Ministry of Trade and Regional Integration
MT	Metric ton
NGO	Non-Governmental Organization
SDG	Sustainable Development Goals
US$	United States Dollar

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1. INTRODUCTION

The Consultative Group for International Agricultural Research (CGIAR) is the largest non-profit public agricultural research group globally. Recently, it has restructured itself into One-CGIAR with the intention of integrating its capabilities, knowledge, assets, people, and global presence for a new era of interconnected and partnership-driven research towards achieving the Sustainable Development Goals (SDGs).

One-CGIAR led the development of about 30 initiatives that aimed at addressing one more of the key impact areas of SDGs. One of these initiatives is "*Rethinking Food Markets and Value Chains for Inclusion and Sustainability*," referred to as *rethinking markets* in short. Rethinking Markets Initiative aims to provide evidence on what types of bundled innovations, incentive structures, and policies are most effective for creating more equitable sharing of income and employment opportunities in growing food markets, while reducing the food sector's environmental footprint. The initiative has four work packages addressing different but interrelated issues and that are being implemented in one or more countries. Work Package 1 (WP1) is about making globally integrated value chains inclusive, efficient, and environmentally sustainable.

The focus on global value chains was a deliberate one. The characteristics of global value chains create some important opportunities to improve the livelihoods of producers, processors, and traders. Global value chains often cater to quality-sensitive consumers in other countries, creating an opportunity for farmers and other value-chain participants to benefit from improving quality, being more inclusive, and/or demonstrating sustainable production methods. Because global value chains are long, communication between consumers and producers is difficult. However, information and communication technology can help bridge this gap and facilitate coordination of supply and demand. Innovations that increase the output and quality of export commodities in a given country are unlikely to reduce the global price, so farmers and small enterprises involved in trading and processing are more likely to benefit than if the commodity were only marketed domestically.

At the same time, these chains present significant challenges. It is necessary to understand the product characteristics that affect consumer demand in destination countries, including quality, color, size, and even production methods, such as the environmental impact. Information on these requirements need to be communicated to farmers and local processors, along with a system for offering a premium for the higher quality. Coordinating harvest & transport of export agricultural products can be difficult, particularly for perishable commodities that may need to arrive within 24 hours of harvest. A major challenge

is minimizing the cost and delays in domestic and international transport, including phyto-sanitary inspection. Another challenge is ensuring the benefits of global value chains are shared among disadvantaged groups, including small farmers and women. Because of quality requirements and the advantages of scale, larger and better-connected producers are often at an advantage in producing export commodities. Global value chains are more affected by trade and exchange rate policies than domestic value chains. For example, export commodities are vulnerable to unexpected changes in export taxes and over-valuation of the exchange rate, which reduce the return on exports.

WP1 will study the impact of promising interventions that improve the livelihoods of farmers and other participants in targeted global value chains. This work package is being implemented in Bangladesh, Ethiopia, Guatemala, Honduras, and Uzbekistan.

The case study in Ethiopia focuses on oilseeds value chains. Oilseeds play an important role in the Ethiopian economy and empirical evidence have shown that there is so much potential in oilseeds that Ethiopia can exploit. A study that considered all value chains to be equally important for the economy prioritized oilseeds, fruits/tree crops, vegetables, tobacco/cotton/tea and cattle value chains in Ethiopia (Benfica & Thurlow, 2017).

The most important oilseeds in Ethiopia are sesame, soybeans, and groundnuts. Sesame is the largest exported oilseed: in 2019, sesame exports from Ethiopia were worth US$ 307 million, making it the second-largest agricultural export after coffee. Sesame is primarily an export crop. In contrast, groundnut and soybean are marketed domestically and internationally, and exports are considerably smaller (US$ 85 million combined).

About 75% of Ethiopian sesame production takes place in the regions of Amhara (particularly in Gonder) and western Tigray. Smaller amounts are grown in Oromia, Benshangul-Gumuz, SNNP, and Gambella. A large majority of sesame is grown on small-scale family farms, although larger commercial farms account for about 18% of production.

Almost all sesame is exported in the form of raw seed and converted to sesame oil, tahini, and other products in the destination countries. This is presumably because sesame oil is relatively expensive and not widely used in Ethiopian cooking. Most vegetable oil for domestic consumption is imported, and 90% of the imported quantity is palm oil. There are several hundred vegetable oil processing plants in Ethiopia. The most common types of oil produced domestically are niger seed oil (72% of processing plants), linseed oil, and groundnut oil (GAIN, 2018).

Although some Ethiopian sesame has a reputation for high quality on international markets, the sesame value chain is characterized by low productivity, fragmentation, high transaction cost, and limited infor-

mation. The Ethiopian Commodity Exchange (ECX) has a grading system for sesame, but traders often grade sesame only after it has been aggregated from multiple farmers, making it difficult to provide a premium to individual farmers. Farmers complain that the informal grading and price determination is not transparent. In addition, the ECX has established various channels for delivering market information to farmers, but access to the information remains a problem.

These constraints are undermining the performance of the value chain across all nodes of production and marketing. Addressing the key researchable constraints through bundles of innovations is what the markets initiative is planning to do in Ethiopia. The Initiative is starting its interventions in Ethiopia with a scoping study of the sesame value chain. This report summarizes the findings of the scoping study on the oilseeds value chain in Ethiopia. The overall objective of the scoping study is to identify a limited number of interventions that will be subsequently tested through some form of impact evaluation.

In order to achieve this overall objective, the scoping study has three intermediate goals:

1. To describe the structure and operation of the supply chain, from input markets to primary production, processing, and export of the commodity.
2. To diagnose problems in the supply chain, defined as obstacles or constraints which reduce the earnings of participants, limit participation of women and other disadvantaged groups, and/or exacerbate the environmental impact.
3. To explore the merits of alternative solutions that may address one or more of these problems, where the evaluation is based on an analysis of secondary data, the views of stakeholders, pilot projects, and experience in other countries.

The data and information for the scoping study were generated from literature, secondary data, and stakeholder workshops.

2. SESAME AND ITS SUPPLY CHAIN

2.1 Background information on Sesame

Sesame (*Sesamum indicum L.*), grouped under the *Pedaliaceae* family, is one of the oldest oil seed crops domesticated well over 2000 years ago (Fuller, 2003). Sesame is used for food and flavoring. The seed is rich in calories containing 50% fat, 23% carbohydrates, 18% protein, 12% dietary fiber, and 5% water (Wu et al., 2021). The sesame seed is mainly used for the production of cooking oil, cosmetics, and the manufacturing of soaps, pharmaceuticals, and lubricants (Bedigian, 2004). Sesame residue is used for bioethanol production (P. Kumar et al., 2020) and livestock feed (Kabinda et al., 2022).

Sesame is produced globally in more than 75 countries (FAOSTAT, 2020). The major sesame producing countries are in Africa and Asia with a total production of about 4.2 million tons per year. The top 10 sesame producing countries are Sudan, India, Myanmar, Tanzania, Nigeria, South Sudan, Burkina Faso, Chad, Ethiopia, and Mozambique. These countries contribute around 80% of the total global production.

Ethiopia makes around 2.64% of the global sesame production (FAOSTAT, 2020). FAO's data show that the global sesame production level is increasing at an increasing rate. Although large-scale private investors are increasingly entering into sesame production, sesame cultivation is considered a smallholder activity in Ethiopia (Kostka & Scharrer, 2011). The crop is one of the major and strategic crops for the Ethiopian government (GTP II, 2016). It contributes about 2.32% (about 29500 tons) of grain production with a total production of 20,200 tons in the 2018/2019 production season. Production and marketing of sesame is concentrated in some parts of the country. The main sesame growing areas are the lowlands of Amhara and Tigray regional states in northwest of the country. This area alone constitutes more than 80% of the country's total sesame area and production (CSA, 2020).

Marketing of sesame is highly regulated by the government. Since 2010, trading sesame seed is allowed only if it is through the Ethiopian Commodity Exchange (ECX[1]) platform with the intention of increasing the marketing efficiency of sesame and other exported crops. However, farmers' unions and commercial farmers have recently been allowed to make direct export. Sesame markets in Ethiopia are highly integrated with the international market, and price is very responsive to the changes in the supply and demand in the international trade (Abebe, 2016; Temesgen et al., 2017). According to Sirany & Tadele (2022), most of Ethiopia's sesame is exported raw without any value addition.

Recently, many new African countries have entered the international sesame market. Hence, the Ethiopian sesame business is struggling with the stiff market competition in the international market. Other countries are taking over Ethiopia's position both in terms of level of production and in terms of total supply to the international market. Ethiopia was among the top-five sesame producing countries, but currently has gone down to 9th rank (FAOSTAT, 2012). Recent estimations show that there are about 700,000 smallholder and 4,000 commercial farmers involved in sesame production in Ethiopia (Schrader et al., 2020).

The market pressure that happens due to market control interventions of the government or other sources of market inefficiency is undermining the returns of smallholder sesame producing farmers. Particularly, women headed sesame producing households are highly vulnerable to the adversities in the market (Kostka & Scharrer, 2011). Ethiopia's sesame value chain is generally characterized as long

[1] The Ethiopia Commodity Exchange (ECX) is an electronic platform or marketplace, where buyers and sellers come together to trade, assured of quality, delivery, and payment

and of high transaction cost (FAO, 2015). Otherwise, there is limited information on the details of the constraints and the power relationships along the sesame value chain.

Revisiting the existing sesame production, supply chain management, and policy environment in Ethiopia is crucial to sustaining the competitiveness of the crop as well as the comparative advantage of the country. Hence, this literature review and secondary data analysis examines the existing sesame production and supply chain features, the policy environment related to the commodity, and identifies key challenges and the interventions considered relevant to address the problems. This literature review could give insight to policymakers, producers, and market operators on how to increase the production, market efficiency, and competitiveness of the crop.

2.2 Sesame production in Ethiopia – trends and key features

Sesame is the leading oil crop produced in Ethiopia and the second most exported agricultural commodity hugely contributing to the country's export earnings. In 2019/20 production year, oil seeds covered about 5.87% (about 750,000 ha) of the total crop area and about 2.49% (about 785,000 tons) of the total crop produced in the country (CSA, 2020).

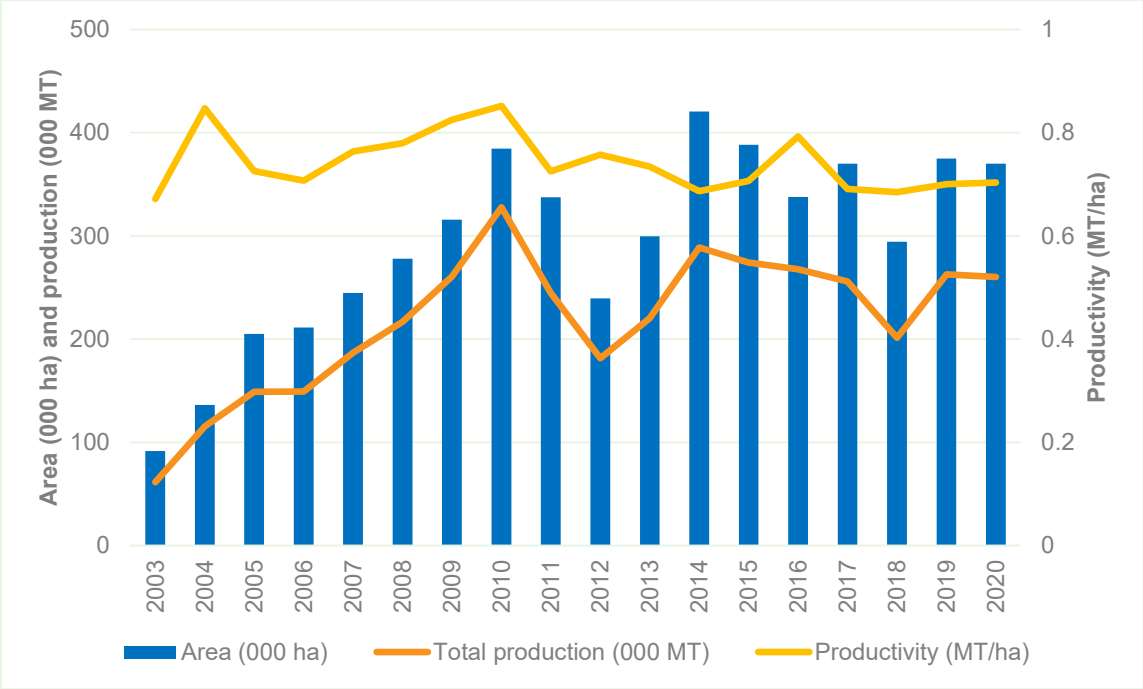
In Figure 1 we visualize the official statistics of the Ethiopian Government (Ethiopia Statistics Services (ESS, 2004)) on sesame acreage and production. The summary indicates that the area sown to sesame has increased by over 300%, from under 100 thousand hectares in the 2003/04 (2003) to nearly 370 thousand hectares in 2020/21 (2020).[2,3] Annual growth in acreage averaged at 11% during this 18-year period. Cultivated area ranged between 250 and 400 thousand hectares in most of the years while the maximum area was observed in 2014. The ESS data does not corroborate the observations made by our sesame stakeholders' workshop participants that sesame area is declining in recent years. Indeed, the data reveal that recent cultivated land figures are among the highest. For instance, the average annual sesame acreage over the last five years (2016-2020) was among the highest observed than in any other five-year period. Sesame is also important relative to other crops. The area sown to sesame in 2020/21 agricultural season was higher by 50%, 20%, and 129% than the area under vegetables, root crops, and fruits, respectively. Sesame accounted for about half of the area under oilseeds, it covered larger area than khat (locally called *tchat*) an important cash crop domestically and was grown on area equivalent to 43% of the area covered with coffee, Ethiopia's most important export crop.

[2] The data used pertains to the main agricultural season locally known as 'meher'. Depending on rainfall patterns each meher (e.g.: 2003/04) runs from around May (of 2003) to around January (of 2004). Therefore, we shorten the 2003/04 meher as 2003, 2018/19 as 2018, and so forth.

[3] The insecurity in Tigray region beginning November 2020 meant that information on agricultural production in the region was lacking for the last three years. However, ESS publications for 2020/21 meher season contain information on agricultural production in Tigray, although production, area, and output number for 2020/21 are identical to the numbers for 2019/20.

Figure 1 also shows the trend in total sesame production in metric tons (MT) and productivity in MT/ha. The figure reveals that total sesame production varies in tandem with the pattern of land allocation to the crop, while there is little variation in sesame productivity per unit area. Sesame outputs grew more than five folds from 61 thousand MT in 2003 to over 260 thousand MT in 2020 and as can be seen in Figure 1, this is mainly due to a corresponding growth in sesame area. Sesame productivity has always been under 1 MT/ha. Indeed, productivity varied under a narrow band of 0.7 MT/ha-0.85 MT/ha during the period. Productivity grew at average annual rate of 0.7% and this growth was due mainly to the rapid growth during 2006-2010. Excluding the 2006-2010 period there was an average annual decline of 0.5% in sesame yields.

Figure 1. Trends in sesame area, outputs, and yields, 2003/04-2020/21[4]



Source: Authors' compilation using ESS (2004-2021) data

The two stakeholder workshops we conducted revealed wide differences between official sesame production and productivity numbers and the numbers reported by stakeholders. Farmers and other stakeholders pointed out that sesame harvests are mostly around 0.2 MT/ha and cannot exceed 0.4 MT/ha

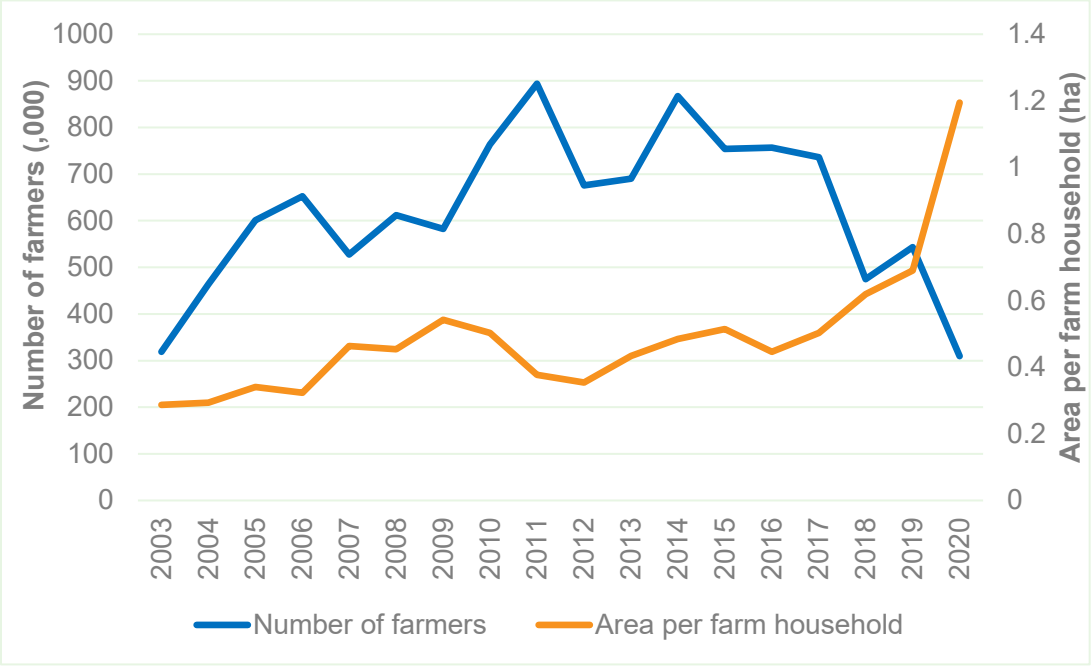
[4] In this section we mainly use data from the Ethiopian Statistics Services (ESS), formerly known as the Central Statistical Agency. The data used includes smallholder farmers and meher production. While most food crop production in Ethiopia is dominated by smallholder farmers (F. N. Bachewe et al., 2018) commercial farming plays a relatively higher role in sesame production. Therefore, the description in this section could slightly underestimate size of sesame production in Ethiopia.

even under favorable conditions.[5] To examine these differences we calculated sesame productivity using data collected in Phase 2 of the Feed the Future (FtF-II) baseline Monitoring and Evaluation Survey, described in (F. Bachewe et al., 2020). The analyses using this dataset indicate that productivity at farmers' level averaged 0.29 MT/ha in the 2018/19 meher agricultural season. That is, sesame productivity computed from the ESS dataset for the same season (0.68 MT/ha) is 140% higher than the productivity computed from the FtF-II dataset. Perhaps, what is more interesting is average productivity in the FtF-II baseline survey is at the higher end of sesame productivity indicated by workshop participants and still considerably lower than what is reported by (ESS, 2004). This important data caveat is believed to be filled with sesame-focused farm household survey that will be conducted under this Work Package in early 2023.

In Figure 2 we show the number of smallholder sesame growing farmers nationwide during the 2003-2020 period. The number of sesame growing at the end of the period (2020) was only slightly (3%) lower than the number in 2003. However, this hides the significant variation in the number of sesame growers observed during the period. Number of sesame farmers in 2011, at nearly 0.9 million was about three times the number in 2020 while the number in 2014 at 0.87 million is the highest in the recent past. The number of farmers declined at average annual rate of 13 percent during 2014-2020 and the number in 2020 is the lowest relative to any of the years in the period.

[5] Such discrepancies are not inconceivable given differences in crop harvesting and measurement methods used by ESS and smallholder farmers. The most important source of the discrepancy is that ESS uses crop-cut procedure when harvesting and uses kgs as the standard unit to measure crop outputs. Accordingly, experts trained in crop-cutting procedure carefully harvest, thresh, and measure crop outputs on sampled plots. The saving from post-harvest losses in the procedure ESS follows could be an important source of discrepancy. Furthermore, traditional measurement units used by farmers and recall data collection methods may also contribute to these differences.

Figure 2. Number of smallholder sesame farmers and average area per farmer, 2003/04-2020/21

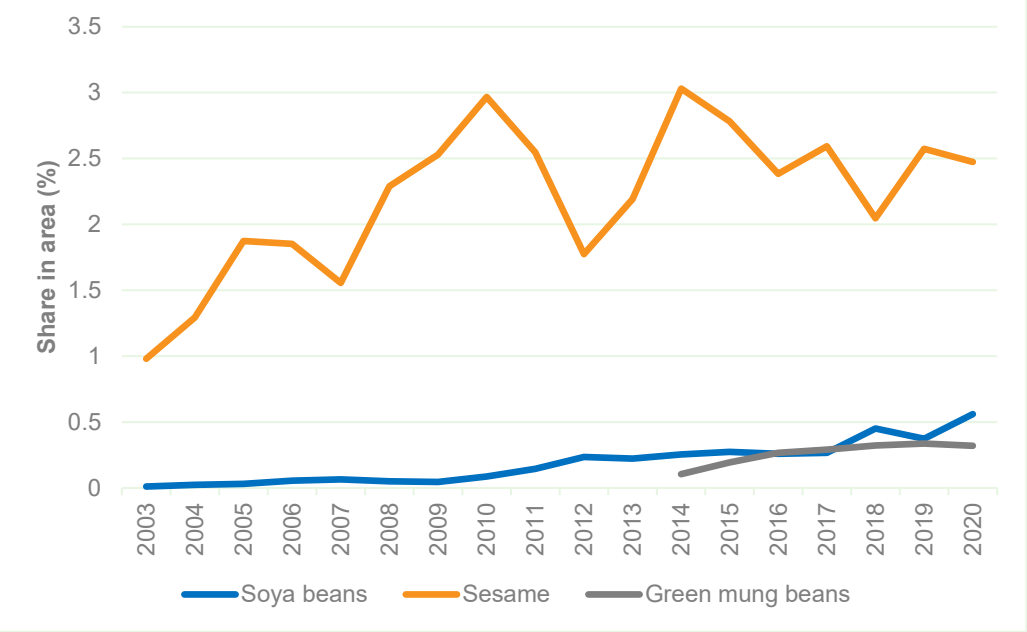


Source: Authors' compilation using (ESS, 2004) data.

Figure 2 also depicts sesame area cultivated by an average farmer, which is calculated from the aggregate numbers (=total sesame area/number of sesame farmers). The average area under sesame for 2018/19 in the ESS dataset (0.62 ha) is close to the number computed from the FtF-II baseline dataset (0.65 ha), despite differences in data collection methods followed in the two datasets (ESS, 2019; Bachewe et al., 2020). Two observations can be made about the trend in average cultivated sesame area. First, cultivated area ranged between 0.3 and 0.5 hectare per household for most of the period, excluding the last three years in which it exceeded 0.6 hectare. Sesame acreage per farm household averaged 0.4 ha in the first half of the period while it averaged about 0.6 ha in the second half. Particularly it exceeded one hectare in 2020/21, when total farm landholding per household averaged 0.8 hectare (ESS, 2021b) indicating sesame farmers are likely endowed with considerably larger landholdings relative to an average farm household nationwide. Second, there is a statistically significant negative correlation between number of farmers and average cultivated area, particularly starting from 2014. This negative relationship may perhaps have been driven by improvements in land rental markets, as farmers remaining in sesame production rent-in more land from farmers exiting sesame production. While this needs further investigation, it may have likely influenced sesame stakeholders' perception regarding trends in sesame productivity, since information on farmers exiting sesame production (decline in number of farmers) may directly be construed as decline in productivity.

In Figure 3 we visualize the data on the relative importance of sesame, soyabeans, and green mung beans in terms of land allocated to the major crops during the 2003-2020 meher seasons at national level.[6] This is to further investigate sesame stakeholders' claim that farmers are substituting sesame with soyabean and green mung beans. As indicated above, the area cultivated to sesame is higher compared to several crops and this holds also relative to the two other crops in Figure 3. The area under sesame in 2003 accounted for less than 1% of the total area under major crops, this grew to 2.5% in 2020. Although this is a 150% increase over a period of 17 years (2003-2020), land allocated to sesame in seven other years exceeded the allocation in 2020, which shows the considerable variability in the importance of sesame which in turn depends, among others, on international prices, relative profitability, weather conditions, and other factors. The importance of soyabean increased by nearly 5000% from 0.01% in 2003 to 0.56% in 2020. Considering only the period where data on green mung bean is available, the share of soyabean area increased by 120% (between 2014 and 2022), the share of green mung bean increased by 206% (from 0.1% in 2014 to 0.32% in 2020), while the share of sesame area declined by 18% (from 3.03% in 2014). This description as well as the graphs for the three items in Figure 3 seem to imply that the share of sesame area is negatively related with the acreage share of the two crops, particularly with acreage share of soyabean. However, a formal analysis whether such a relationship exists and the extent/strength of the relationship, such as the one in (F. N. Bachewe & Taffesse, 2018), might need to be considered in the forthcoming activities of the work package.

Figure 3. Importance of sesame, soyabeans, and green mung beans in terms of acreage, 2003/04-2020/21



Source: Authors' compilation using (ESS, 2021) data

[6] The area under major crops leaves out enset, which is an important crop in Oromiya and SNNP regions. Although this is a caveat with the data fortunately the comparisons across all years are uniform. Furthermore, ESS began reporting the area under and outputs of green mung beans only beginning from 2014.

We use ESS's farm level production dataset (ESS, 2021) to derive detailed information on spatial distribution of sesame production. This information is summarized in Table 1, which lists the 12 administrative zones that are most important in sesame production.[7] These areas are generally located in northwestern lowlands bordering the Sudan (western parts of Tigray and northwestern parts of Amhara regions); in northwestern Oromia, and Benishangul-Gumz regions.

North Gondar administrative zone was most important, accounting for 31.4% of the nationwide sesame area in an average year during the period. Indeed, North Gondar accounted for 50% of the sesame area in 2009. It ranked most important in almost all years, which is why it was selected as the focal area for the interventions under Work Package 1. The Western Tigray administrative zone was second important, accounting for 23.6% of the total sesame area in an average year and ranking second most important in almost all years, excluding three years in which it was the most important. The far third important Zone, East Wollega, accounted only 6% of the land allocated to sesame on an average year during the period. This zone, which has on average accounted for 17% of the area in the first three years has become less important recently. The least important zones among the 12 listed in Table 1 are Wag Hemra, Assosa, and East Gojam which respectively accounted for 1.6%, 1.5%, and 1.4% of the area under sesame in an average year during the period.

The summary in Table 1 indicates that the 12 administrative zones accounted for 80% to 96% of the nationwide sesame area in all years except 2006 in which their share was 75%. Furthermore, the two most important administrative zones (North Gondar and Western Tigray) together accounted for 55% of the nationwide area under sesame in an average year during the period. Finally, the four regions in which the administrative zones are located (Tigray, Amhara, Oromia, and Benishangul-Gumz) account for almost all the sesame production. These regions together accounted for 99.2% (with a range of 98.4% to 99.8%) of the sesame area in an average year during the period.

Table 1 also indicates that average sesame area in Western Tigray administrative zone is considerably higher, exceeding 1 ha, which is about the landholding size of an average farm household in Ethiopia during the period covered, until the recent decline in average landholding (ESS, 2021; Minten et al., 2020). Average sesame area in North Gondar is second highest, although it is considerably lower relative to that in Western Tigray. Average sesame area in Wag Hemra and Assosa are the lowest. The summary also indicates that average area in the 12 most important administrative zones is higher relative to the average in the four regions comprising the zones.

[7] We first calculate the share of each administrative zone in total area under sesame for each year. Then we use three area-share based criterion to select these zones, all of which provide a consistent list. The first criteria selects/orders administrative zones in terms of the number of years (out of the 18 years) they are included in the list of 12 most important zones. The second criterion orders administrative zones in terms of their modal ranks during the 18-year period. The third criteria orders administrative zones in terms of their average rank over the period.

Table 1. Share in area of important sesame producing administrative zones and regions (%) and average area cultivated by farmers (ha), 2003/04-2019/20

		Area shares (%) of zones in total sesame area							Sesame area (ha) cultivated by an average farmer in zone	
Region	Zone	2003	2006	2009	2012	2015	2018	2020	Mean	median
Tigray	Northwest Tigray	7.18	6.25	5.79	3.36	5.32	5.51	5.04	0.29	0.21
	Western Tigray	24.25	26.42	18.04	24.83	24.61	26.78	23.45	1.01	0.58
	North Gondar	16.13	22.36	50.22	34.23	36.80	33.11	35.37	0.64	0.40
Amhara	East Gojam	1.16	1.44	0.33	0.81	2.10	0.19	3.50	0.37	0.28
	Wag Hemra	0.03	0.13	1.17	2.63	1.33	4.00	0.95	0.20	0.15
	Awi	1.10	0.53	4.73	0.93	1.41	0.97	3.29	0.51	0.41
Oromiya	West Wollega	1.99	2.66	2.49	4.18	2.01	15.62	15.32	0.31	0.21
	East Wollega	26.11	6.32	2.77	4.01	3.38	5.30	2.50	0.36	0.29
	Bale	0.42	0.20	1.50	2.22	2.71	0.25	0.85	0.37	0.31
Benishangul-Gumz	Metekel	0.98	2.12	1.57	3.47	4.66	1.01	0.68	0.40	0.25
	Asosa	3.22	2.84	0.75	0.66	1.37	0.84	0.74	0.20	0.10
	Kemashi	9.72	3.67	1.76	2.76	2.65	2.13	0.04	0.49	0.23
Four regions	12 zones	92.27	74.94	91.11	84.10	88.36	95.72	91.74	0.43	0.28
	All zones	99.54	99.31	99.01	99.28	99.55	99.39	99.60	0.30	0.22

Source: Authors' compilation using ESS (2022) data.

2.3 Key inputs of sesame production

Annually, close to 350,000 hectares (ha) of land is covered by sesame in Ethiopia. Sesame producers are broadly categorized as smallholders, who own[8] less than 10 ha of land, and commercial farmers, who own more than 10 ha of land. Smallholder farmers who do not own land can access land either in the form of rent or share cropping[9].

Labor, finance, machinery, and certified seed are the key inputs that determine the level of production of sesame in Ethiopia (Eshetie et al., 2022; Feyisa, 2020; Gela et al., 2019; Girmay, 2018; Tadege et al., 2016). Sesame is a labor-intensive crop (Munyua et al., 2013). The crop requires at least weeding twice, and harvesting and threshing within a short period (Terefe et al., 2012). If the crop is not harvested at the right time, more than 50% of the yield could be lost due to shattering (Qureshi et al., 2022). The study done by Mezgebo et al. (2021) indicated that for a hectare of land, sesame requires around 89.33 man-days per season and 60% of smallholder farmers depend on hired labor during peak times (land cleaning, weeding, and harvesting). Commercial sesame farmers that do not have machinery also depend on hired laborers (Tadege et al., 2016). Annually, more than half million seasonal laborers move to northwest Ethiopia to work on sesame production. The extensive and manual cultivation

[8] Farmers in Ethiopia have only usufruct rights on land. Land is state owned. We use 'own' in this paper for ease of communication.

[9] Crop sharing is an arrangement in which those who have no land cover all the costs of production of the crop but share the harvest (usually one-third) with the landowners.

of the crop results in the payment for labor making it the most important component of the cost of production (50%) of the crop (E. Mekonnen et al., 2015). This has greater implications for the country to stay and be competitive in the international market arena.

Finance is another key input that is noticeably lacking in sesame production. Lack of rural finance severely hampers the productivity and production of the crop. Access to finance boosts households to choose risky-bearing and high-return enterprises (Diao et al., 2007). According to NBE (2020), only 9.3% of the total loan disbursed in the 2019/20 cropping season was for activities in the agriculture sector. This limited loan was not so accessible to smallholder farmers either, as commercial farmers received 95% of the loan (Schrader et al., 2020). The limited access to rural finance constrained farmers interest in trying/using improved technologies, machinery, and forced to fetch expensive loans from other informal sources. The lack of finance in sesame production is very critical and might remain so for the foreseeable future. This might result in slow or no transformation in the sector as farmers would not be able to access new technologies or make marketing decisions that could improve their returns (Feyisa, 2020). It is well documented that access to finance has a significant contribution in terms of increasing farmers' efficiency, and hence improving access to finance will certainly improve efficiency of sesame value actors (Desai, 1993; Havemann et al., 2022; Larder et al., 2018; Meyer, 2011; Wang et al., 2020).

Another key input that is crucial in sesame production is mechanization. Mechanization increases farmers' efficiency, reduces the cost of production, and increases the productivity of the crop through increasing water infiltration (Diao et al., 2016). Planting with machinery, in particular, reduces weeds and pests thereby increasing crop development (Qiao, 2017). Machineries for harvesting and threshing have a significant contribution towards cost reduction, and yield and quality improvement (Thompson & Blank, 2000). Most of the lowland sesame growing areas in Ethiopia are suitable for farm machinery operations. However, except for limited number of farmers, smallholders use manual labor for sesame production. In the case of commercial farmers, land preparation is commonly done with tractor-mounted plow, whereas sowing, weeding, harvesting, and trashing are conducted using manual labor and draught power (Pingali, 2007). According to Tadege et al. (2016), only 4% of the sesame production area is cultivated by tractors. The low rate of adoption of machinery is related to the low purchasing power of farmers, shortage of spare parts, and little or no governmental support to improve access (Guush et al., 2017).

Seed is also another important input that determines the productivity and quality of the agriculture production (Erenstein et al., 2011). Ethiopia is considered to be the origin of sesame (Zerihun, 2012) and, hence, it is endowed with different sesame seed varieties and rich genetic diversity (Girmay, 2018). Farmers acquire sesame varieties either from formal sources, such as research institutes and office of agriculture, or from the market and their neighbors (Alemu, 2011). In the northwest part of the country,

farmers import, or use imported, usually illegally, sesame seed from the Sudan. This is in fact the main source of seed in the area as confirmed by farmers themselves.

Though different varieties that have better yield per unit area, oil content, and marketability were released, the adoption of the varieties is extremely low. One of the key reasons why there is low adoption is unavailability of certified seed in the area (Eshetie et al., 2022). In northwest Ethiopia, for example, there is not a single seed company that supplies improved sesame seeds to the farmers. As indicated above, farmers access seed, when they do, from very limited governmental institutions. Usually, farmers hardly get enough seed from these sources. Therefore, although there is an ongoing effort to develop and make available improved sesame varieties, the seed system is not in place to provide farmers with the planting material. The varieties in production need to be replaced with new and better varieties. Without the appropriate seed system, however, this cannot happen. This will have a negative impact on quality and yield improvement and on profitability of the crop (Scoones & Thompson, 2011).

The Ethiopian sesame seed is highly preferred by high-value end markets due to its natural aroma and organic production system. However, the sustainability of the sector relies on the key inputs discussed above. Limited access to inputs, volatility of the world price, and unpredictability of the weather in sesame production areas are forcing farmers to production of other crops. Therefore, to maintain and improve the production, productivity, and competitiveness of sesame production, much more needs to be done regarding access to farm inputs both by smallholder and by commercial farmers.

2.4 Domestic marketing and processing of Sesame

The marketing of sesame is highly regulated by the government through the regional and district level instruments of the Ministry of Trade and Regional Integration (MoTRI). Marketing of sesame can only happen at specific spot markets in each Woreda/district designated by MoTRI for this purpose (Gashaw & Kibret, 2018). Government regulations seem to be stricter and rigid to smallholder farmers compared to commercial farmers. For instance, commercial farmers do not have to pass through spot markets. Licensed primary traders and cooperatives collect sesame at assigned places in the spot market. A primary trader can sell only through ECX platforms. However, cooperatives through their unions and commercial farmers could sell either through ECX or through direct exporting. Smallholders have three sesame market outlets. They can sell either through cooperatives or primary-level sesame traders, through direct selling at the nearest spot market, or through auctions at ECX sesame market platforms. Primary cooperatives are also allowed to sell directly to the spot market for primary traders or to unions. Unions and commercial farmers have the privilege to directly export their sesame produce.

Sesame grown in Ethiopia is branded and marketed in the international market as “white Humera-Gondar” and ‘’Wolega type’’ (Zerihun, 2012). Sesame grading is done by ECX platforms, and the platforms

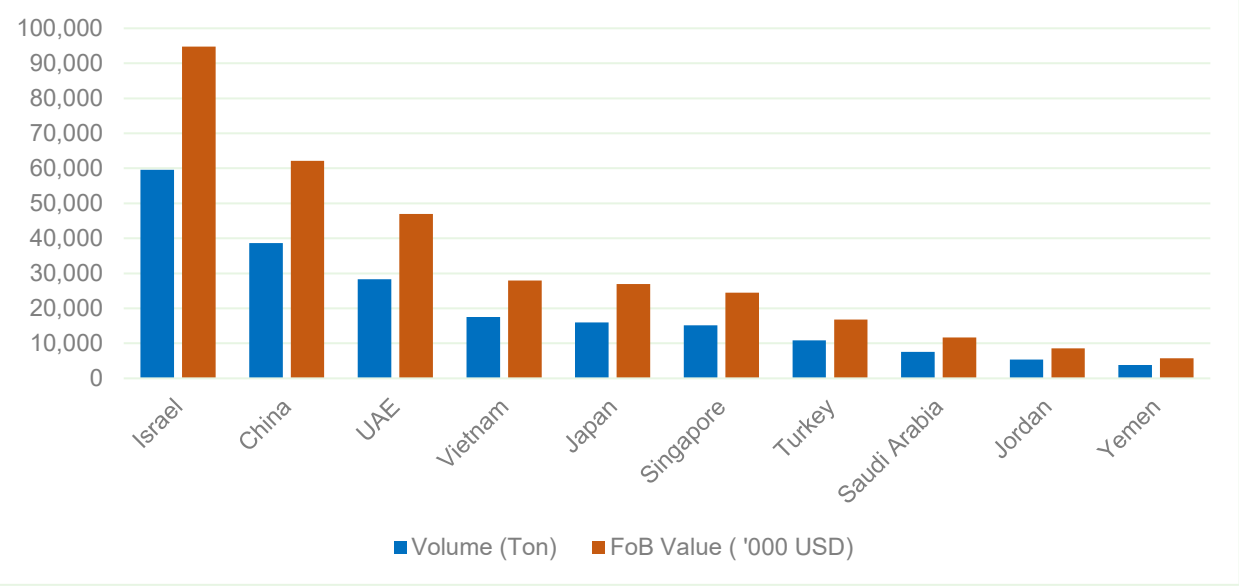
consider seed purity and color as the key criteria to set the grades. ECX has six grades for sesame that range between under grade (UG) to best quality sesame. Despite the guidelines, the grading does not usually happen at the local ECX platforms and, hence, farmers and traders may mix different qualities and adulterate the sesame before supplying it to ECX's platform.

2.5 Export markets for Sesame and their characteristics

Sesame is one of the high-value export crops which is making a significant contribution to the country's economy. Oil seeds contribute about 14.7% of the country's total export and sesame accounts for 30% of the total oil seed production in the country (NBE, 2019). Ethiopian sesame is highly appreciated in high-end markets for its color, size, sweet taste, and aroma. Sesame is predominantly organic as there is limited use of fertilizers and agrochemicals in sesame production. This could be an opportunity where niche markets could be explored and accessed. The country's proximity to the Middle East and Europe is another geographical advantage for sesame exporting. Ethiopian sesame is exported with little or no processing. Cleaning and packaging are the only value additions to keep the purity standards the international market requires.

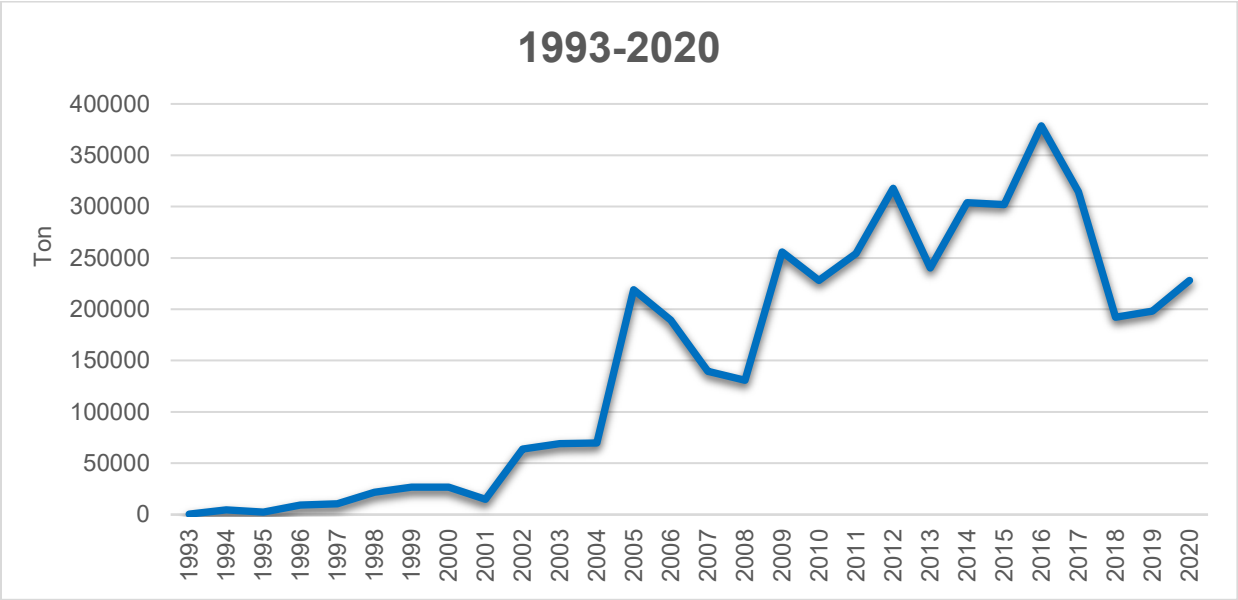
Recently, Israel has emerged as the top export destination for Ethiopian sesame seeds, followed by China and United Arab Emirates (UAE) (Fig. 2). About 98% of the total sesame export passes through ECX platform before being shipped to another country. White Humera (Gondar) sesame is demanded in the international markets much more than the Wolega type and it serves as a reference price for Ethiopian sesame in the international market. Over the past few decades, sesame export showed an increasing trend. However, the export level has been declining since 2016 (Figure 3).

Figure 4: Ethiopian sesame seed export destination countries



Source: Ethiopia Oil seeds Annual Report (USDA, 2020)

Figure 5: Ethiopia export quantity of sesame seed



Source: FAOSTAT (2020)

Internal and external factors determine the performance of the sesame export sector in Ethiopia. External factors are generic and include real gross domestic product of importing countries, the distance between Ethiopia and its importing countries, and buyers' real exchange rate (Mohammed & Ahmed, 2020). Internal factors include supply side conditions (Hailegiorgis, 2011) related to production, marketing, and the legal frameworks of the country. Another important internal factor is the overvaluation of Birr - Ethiopia's official currency.

Overvaluation of Ethiopian Birr has manifested itself in persistent and large external imbalances, foreign exchange shortages, and the overall slow pace of structural transformation (FAO, 2015). Over the past few years, the domestic sesame price has been above the international market. Lehr (2018) indicated that traders who have both export and import licensing organization are willing to accept up to 30% loss from sesame export. This is because, they can compensate the loss from access to foreign exchange and fuel their core business – imports – where these losses are recovered by high profit margins. As a result, the high price for raw domestic sesame has discouraged business organizations from participating in value-adding activities while encouraging sesame exporters with importing licenses for other commodities.

The current marketing system, which is characterized by heavy government intervention, does not encourage the different value chain actors to collaborate and co-invest to offer traceable quality products to the market. In addition to the government's heavy hand, the exportation of agricultural commodities in Ethiopia is run by unlawful and unprofessional exporters rather than fully licensed import-export companies (CBI, 2018).

2.6 Gender and inclusion in the Sesame value chain

Men and women play different roles, have different needs, and face different constraints (Ellemers, 2018). Gender inequality and women's empowerment are issues and priorities for almost all countries around the world (Tracey & Anne, 2008). Empowerment is related to helping women to make strategic decisions in their day-to-day life (Malhotra et al., 2009). Studies showed that gender disparities in development works are high in developing countries than in developed nations (Mahmud, 2019).

Historically, Ethiopia has been a country of powerful and very influential women such as Queen Sheba and Queen Tayitu. Nonetheless, the present day Ethiopia can hardly claim to have created or offered equal social, political, and economic opportunities to women (Bayeh, 2016). The Women, Business, and Law report of the World Bank (2020) indicated that Ethiopia is around the mean score in terms of women being on equal legal standing with men. In the rural parts of Ethiopia, like in other developing countries, women's participation in productive works is not well appreciated (Bari, 2005; Mabry et al., 2010; O'Reilly, 2006; Saucerman & Vasquez, 2014). Gebru & Demeke, (2014) noted that only a few projects give due emphasis to gender equality and empowerment in Ethiopia. The UN sustainable development assessment study by Georgeson & Maslin (2018) indicated that the engagement of women in development is still far from the targeted levels.

Farming in Ethiopia is a way of life than business, mainly undertaken by members of the household (Haines et al., 2016). The proportion of males and females is almost equal in the Ethiopian population. Sesame is produced largely by smallholder farmers. As in other agricultural activities, women are heavily involved in sesame production (Aregu et al., 2011). Except the physically demanding land preparation activities, such as plowing, women take part in all other activities (Ogunleye, 2017). And this is in addition to the in-house chores which they have to do day-in day-out.

2.7 Sustainability of the sesame value chain – continuity of production and marketing

According to Keeney (1990) sustainable agriculture is producing enough food without compromising our ability to do so tomorrow. It is a broad concept and encompasses environmental, economic, and social issues (Gomiero et al., 2011). In sustainable agriculture, there is a need to keep the health and resilience of the farm intact. Agricultural activities must be conducted with consideration of the needs of the future generation. To be considered sustainable, four criteria; i.e., productivity, profitability, enhancing natural resources, and improving the quality of present and future life should be satisfied (Ladha et al., 2009). Sustainable agriculture gives due emphasis to biodiversity, soil health, water conservation, and ecological pest management (Velten et al., 2015).

The sustainability of the sesame value chain in Ethiopia relies on production continuity and the marketing efficiency of actors. Worldwide, number of sesame producing countries is growing and the competition in the international market has become tougher (FAO, 2015). Sesame production in Ethiopia is heavily challenged by weather variability, low adoption of technologies, poor finance and infrastructure, and high production and transaction costs (Abebe, 2016; Gebremedhn et al., 2019; Girmay, 2018; Zerihun, 2012).

Another characteristic of sesame production in Ethiopia is lack of crop rotation. Mono-cropping in sesame production could cause ecological imbalance (Terefe et al., 2012). Depletion of the soil and reduced nutrient recycling, high pest incidence, and disease infestation are some of the problems of mono-cropping (Ehrmann & Ritz, 2014; Heggenstaller et al., 2008; Mugi-Ngenga et al., 2022). Kebede et al. (2020) & Kindeya (2018) also indicated that low crop diversity in the sesame growing areas has resulted in high disease infestation.

Soybean and mung bean have recently been introduced in the sesame production areas to serve as rotation crops and to break the mono-cropping culture (Schrader et al., 2020). Both crops can enhance production sustainability if farmers grow them consistently and happen to benefit from them. The land allocated to these crops is growing exponentially to the extent that sesame could be fully replaced by these crops and ending up in another round of monocropping (Tilahun, 2015). The growth of domestic industries that use soybean as an input, high productivity per unit of land, demand in the international market, and low production cost make soybean the preferred crop by the farmers (Fentahun, 2019). Similarly, mung bean is highly preferred to sesame due to its shorter growing period, low input requirement, and high market demand (Mohammed et al., 2017).

In addition to the competition from soybean and mung bean, sesame growing smallholder farmers are benefiting less and less from participation in high-value global markets due to competitiveness and several market failures along the value chain (Ngenoh et al., 2019). The sustainability of the Ethiopian sesame value chain is highly determined by the quality and volume of sesame supplied to the international market (Staritz et al., 2016). The high-value end market requires to keep healthy and safe crop production standards preferably with organic certification (Zewide, 2021). The rapid and growing awareness of the consumer and technological progress in the industry shifts the consumption pattern.

Value addition is also another aspect that makes the crop competitive in the international market. We have already indicated that majority (98%) of Ethiopian sesame is sold raw in the international market without any value addition (Sirany & Tadele, 2022). Evidence shows that China and other importing countries resale most of the Ethiopian sesame they import after processing it in different ways (Girmay, 2018). The profitability and sustainability of the domestic sesame supply chain relies on the supply pattern in other countries, integration among actors, and production and marketing efficiency (Ayana,

2015; Bhagwat & Maravi, 2015; Gelalcha, 2009; Munyua et al., 2013; Myint et al., 2020, 2020; Sadiq & Singh, 2020; Wijnands et al., 2007).

3. POLICY ENVIRONMENT AND PROGRAMS RELEVANT TO THE SESAME VALUE CHAIN

3.1 Key policies and strategies related to the Sesame VC

Agriculture constitutes a fair share of Ethiopia economy (NBE, 2020). Accordingly, the government has shown a growing interest in sesame production and marketing. The establishment of the ECX trading floor and the Agricultural Transformation Agency (ATA) is one of the most important steps the government has taken in relation to sesame and other cash crops of international importance. ATA, established in 2010, is mandated to improve the livelihoods of smallholder farmers across the country through comprehensive interventions that transform the agricultural sector. ATA works on improving supply of agricultural inputs such as seed, fertilizer and agrochemicals (Abebe, 2016). ATA adopted Agricultural Commercialization Clusters (ACC) approach in 2014 as a mechanism to integrate the interventions prioritized in the transformation agenda within specific geographies targeting a limited number of high-value commodities. ATA has been devising strategies and implementation plans that focus on achieving specific output, outcome (e.g., yield, marketed surplus), and impact (e.g., crops delivered to major buyers, import substitution) targets defined for each commodity value chain through analysis and consultation with key implementing partners (FAO, 2020). Sesame is among the nine crop commodity value chains that have been prioritized and focused on in growth and transformation plan (GTP) II.

ECX is arguably the most important institution in terms of determining the dynamics of sesame production and marketing. Just after two years of its establishment, ECX platforms were given full legal ownership of marketing of sesame – particularly that is produced by smallholder farmers. In 2010, the Ethiopian Government passed a proclamation (No. 178/2010) on sesame and white field pea marketing that declared trading of sesame or white field pea at the Ethiopian Commodity Exchange as compulsory. The trading was permitted only between suppliers/producers and exporters/processors based on the exchange rules at the time of the trading.

Commodity exchange trading is not a new phenomenon (Peck, 1980) and it has been in place for more than a century now (Bhagwat & Maravi, 2015). The Chicago Board of Trade established in 1848 and the Osaka rice trading center established in 1967 are among the well-known commodity exchange markets. In 2007, the Ethiopian government established the ECX trading floor through proclamation No. 550/2007 with the intention of modernizing the marketing of selected commodities (Haile et al., 2017).

ECX was given a legal mandate to undertake an efficient, transparent, and orderly marketing system for trading of agricultural commodities in a way that serves the needs of buyers, sellers, and intermediaries, and that promotes increased market participation of Ethiopian smallholder producers. All value chain actors involved in marketing, processing, and exporting of sesame are supposed to operate through ECX platform. The rules of the exchange developed by ECX provide the blueprint for all rules governing membership, management, trading, warehousing, clearing and settlement, and other operations (Gashaw & Kibret, 2018).

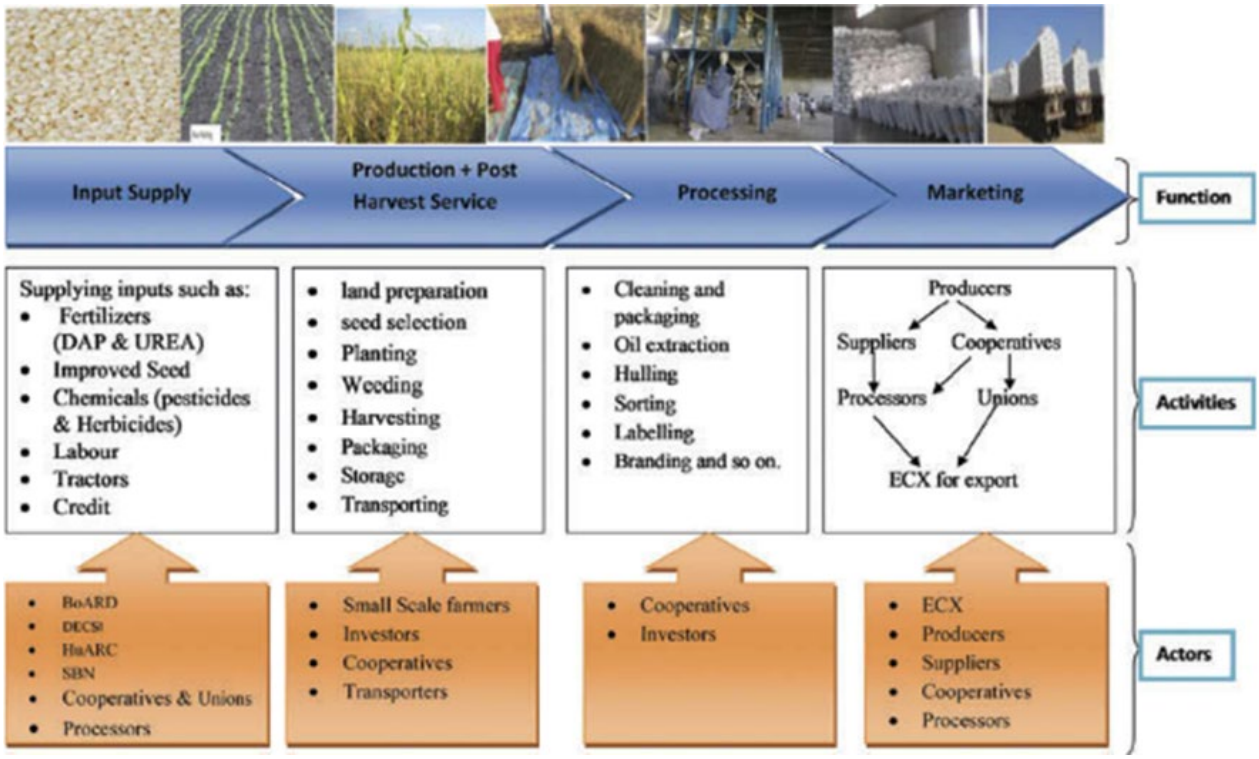
Many amendments, and proclamations have been made by the government of Ethiopia in relation to sesame marketing. In 2013, for example, product traceability procedure for all agricultural commodities traded at ECX platform was installed (Haile et al., 2017). In 2014, the government made an amendment on sesame and white field pea quality standards by incorporating the health and food safety standards of buyer countries. In 2017, the Ethiopian parliament also approved a legal framework for futures trading through proclamation number No. 1050/2017. In 2019, export products contract registration and execution directive No. 21/2019 announced the registration and execution of export product contracts. In this regulation, three major incentives were included. (1) facilitating low-interest rate loans (export loan is up to 40% cheaper than other loans) (2) allowing exporters to use their foreign currency to import goods within 28 days (3) option to retain 30% of export earnings in forex for an indefinite period.

The regulation is supposed to strictly control trading prices, product quality, and the administration of export sales contracts. Recently, a new price ceiling regulation has been set to regulate the mismatch between domestic and international sesame prices at the ECX. In this regulation, the Ministry of Trade & Regional Integration (MoTRI) has been given the mandate to regulate sesame trade, revising the threshold prices for oil seed transactions at the ECX.

3.2 Private, public, governmental, and non-governmental programs related to Sesame VC.

Private sectors such as producers, traders, processors, and financial institutes are key players along the sesame value chains in Ethiopia (Abebe, 2016; Gebremedhn et al., 2019; Gebremeskel et al., 2021). The public sector is expected to create a conducive environment that enables the sesame value chain actors benefit from the commodity fairly and efficiently. In principle, the government body should take the lead in all aspects of the sesame value chain development by keeping law and order (Linn, 2013). In addition, NGOs, donations, and programs are relevant to the value chain.

Figure 6: Sesame value chain map



Source: Adapted from Gebremedhn et al., (2019)

However, the sesame sector is empirically among the poorly financed sectors in the country. Development Bank of Ethiopia, and Amhara and Tigray Credit and Saving Institutions are the only formal sources of finance that were accessible to the few sesame producers.

As discussed above, sesame is marketed with little or no value addition. In fact, Selit Hulling PLC is the only enterprise engaged in sesame cleaning and packaging. Hulling is the process of removing the husk/skin from the sesame seed after cleaning. The company is certified organic hulled sesame exporter to food and bakery businesses globally (Abebe, 2016).

Table 2. Sesame value chain actors and their roles

Private		**Public (GOs, NGOs & Programs)**	
Actors	***Roles & Responsibilities***	***Organization***	***Roles & responsibilities***
Smallholder farmers (< 10 ha)	• Sesame producer	Ministry of Agriculture and its branch	• Advisory & training service, • Demonstration of Improved varieties & agronomy practices

Commercial/investor farmers (> 10 ha)	• Sesame producer	Ministry of Trade and regional integration	• Trade legislation, licensing traders, monitoring the market
Agro-dealers	• Seed & Agro-chemical suppliers	Ministry of Revenue	• Tax collection • Custom service
Cooperatives and unions	• Inputs such as seed, fertilizer, insecticide, cash loan suppliers • Sesame buyers	Ministry of Transport and Logistics	• Facilitate transport & logistic service • Road construction & maintenance
Primary traders	• Sesame grain buyers from producers	The ECX electronic trading floor	• Facilitate buyers and sellers to come together to trade, assured of quality, delivery, and payment • Warehouse service & quality assurance
ECX members -Intermediary	• The core actors of the exchange at the ECX trade floor (Secondary market) • Representative of sellers.	Cooperative promotion office	• Establishing & licensing farmers' cooperatives and union • Monitoring sesame marketing and other administration & financial issues of coop & Unions
Exporters	• buying at the secondary market and then cleaning, re-bagging, and exporting • Buy sesame directly through contract farming	Research institutes	• Generate, promote & recommend sesame-related technologies and information • Advisory & training service • Multiply initial seed & other technologies
Processors	• Cleaning & re-bagging	Agricultural transformation agency	• Assist research & development along the sesame value chain • Facilitate and establish an Input delivery system • Promote sesame technologies
Brokers	• Middleman on transportation & grain marketing	National Meteorological Agency of Ethiopia	• Weather information
Vehicle owners	• Transportation service		
Laborers	• Farm work, Loading, unloading		

Financial institutions (Development Bank & ACSI, insurance)	• Cash loan & savings service • Insurance service for exporters	
Ethiopian Pulses, Oil seeds, and Spices Processors_ Exporters Association (EPOSPEA)	• Providing up-to-date local and foreign market information, trends & data on the sector • Policy advocacy & capacity building	

4. KEY CHALLENGES AFFECTING THE SUPPLY CHAIN

Sesame production is susceptible to different biotic and abiotic stresses (Pathak et al., 2014). Weather and price fluctuation, and shortage of finance and poor technology adoption have great implications for sesame production and marketing in Ethiopia (Teklu et al., 2021). Studies have reported that sesame growing farmers have been heavily challenged by weather fluctuations due to the global climate change (Taffesse et al., 2012). The volatility in international price is also a big problem for producers (Abebe, 2016). Since 2016, the extent to which Ethiopia is participating in the international market is declining.

4.1 Low technology adoption

4.1.1 Evidence that this is a problem

The green revolution experience in different countries showed that use of new varieties, agronomic practices and machineries boosts agricultural productivity. Labor saving machineries played great role in terms of efficiency (Sharaby & Butovchenko, 2019). However, introduction of new technology to smallholder farmers by itself does not guarantee a widespread adoption and efficient use of technologies (Feder et al., 1985). Success in this regard depends on the fulfillment of specific economic, technical and institutional conditions (Eshetie et al., 2022; Girma, 2022; Napier et al., 1991). Firstly, from the farmer's perspective, the new technology must be more economically rewarding than the existing alternatives (Gupta et al., 1998; S. Kumar et al., 2011; Zema et al., 2016). Secondly, the new technology should be technically manageable by the smallholders and needs to be compatible to the surrounding socio-cultural circumstances (Oliveira & Martins, 2011). Finally, the availability of the new technology and all other necessary inputs to smallholders at the right time, place and quantity should be assured.

Furthermore, adoption of new technologies depends on a range of personal, social, cultural and economic factors (Workineh et al., 2020). Adoption occurs when the farmers perceive that the innovation in question will enhance the achievement of their personal goals.

Like any other crop, efficiency of sesame production depends on the use of improved seed varieties, fertilizer, mechanization, pesticides, and other agronomic practices (Schrader et al., 2020; Terefe et al., 2012). Although considerable efforts were exerted by research and development practitioners to introduce improved technologies, most famers in Ethiopia grow sesame traditionally. Farmers use local sesame cultivars and majority of them do not apply fertilizer (Gedefa, 2010; H. G. Hailu & Mezegebo, 2021; Teklu et al., 2021; Yalew et al., 2020). Research confirmed that the yield of new sesame variety can reach up to 1254 kg (or 1.3 ton)/ha^{-}under rainfed conditions (Ahmed, 2008; Habibullah et al., 2021) and 2797.6 kg (or 1.8 ton)/ha under irrigation (Hailu et al., 2018). However, farmers currently harvest less than 600 kg (or 0.6 ton)/ha from their traditional production system. The studies by Berhe et al. (2008) and Kefale et al. (2021) indicate that farmers had poor awareness about and were reluctant to use sesame pest and diseases control measures. The adoption of machinery is at low level and, when available, it is limited to ploughing or land preparation activities. Evidences show that only 2.5% of oil seed farmers ploughed with machinery (Tadege et al., 2016). Machinery reduces harvest and post-harvest loss, and improves the timeliness and efficiency of farm operations (Guush et al., 2017; Mrema et al., 2018).

4.1.2 Prevalence of the problem

The low productivity of sesame is mainly due to low adoption of recommended technologies in sesame growing areas (Dabessa et al., 2019; Gebremedhn et al., 2019; Gedefa, 2010; 2020; Teklu et al., 2021; Weyessa, 2017; Yalew et al., 2020). A meta-analysis by Feyisa (2020) showed that age of the household head, education level, farm size, livestock holding, access to extension services, access to credit services, cooperative membership, and distance from the market are the main determinants of technology adoption in Ethiopia. In addition, technological compatibility with the dynamic bio-physical condition may be the other reason for the low adoption of technologies (Chung & Snyder, 2000; Saaksjarvi, 2003; Tey & Brindal, 2012). Issues like inclusiveness, market orientation and climate change have challenged the agricultural sectors (Narver et al., 2004; Slater & Narver, 1994). The limited use of technologies have direct impact on cost of production and comparativeness of the crop (Mariyono, 2018; Rehman et al., 2016; Taye et al., 2021).

4.1.3 Policies or projects attempting to address the problem

Over the years, agricultural research centers of the country released different sesame varieties with improvements over the available ones. Different researchers tested the suitability of sesame varieties across different agroecology zones of the country (Abay, 2014; Baraki et al., 2020; Daba et al., 2015;

Fiseha et al., 2016; Z. Mekonnen & Mohammed, 2009; Teklu et al., 2014, 2022). For example Tesfaye et al. (2021) tested the environmental and genetic association of 16 high yield sesame varieties in different agro-ecologies of the country. Schrader et al (2020) indicated that high-yielding improved varieties and agronomic practices that were recommended in the country were packaged as 20 steps that improve sesame productivity (https://youtu.be/k-lgvaRGKGk). Sesame production manuals and packages are developed and introduced in sesame production areas (Rehman et al., 2016; Sharma et al., 2021; Teklu et al., 2021; Weyessa, 2017; Yalew et al., 2020).

Concerning the extension approach and stakeholders roles and responsibilities, different approaches were tested in sesame growing areas. Schrader et al. (2020) identified training and demonstration at farmer training centers (FTCs), farmer development groups, visits to the plots of so-called Model Farmers and the rollout of the sesame package Farmer Production Clusters (FPCs) as the main mechanisms being used to disseminate sesame technologies. As summarized by Berhanu & Poulton (2014) and Daniso (2017), approaches like scaling up good agricultural practices (GAP), value chain and market development, participatory extension approach, diversification and specialization, input voucher sales, and hotline advisory service have also been tried to improve productivity at farmers' level.

4.2 Weather fluctuation

4.2.1 Evidence that this is a problem

Sesame is a tropical crop that requires fairly hot conditions for its optimum growth (Meena & Rao, 2013). Studies show that the crop is susceptible to weather fluctuations (Raut et al., 2020). Climate change manifested itself in variability of key parameters such as rainfall, wind speed, humidity, and dry spell during the production period, and has become the key factor determining level of sesame production in Ethiopia (Demissie et al., 2019; Habibullah et al., 2021; Nath et al., 2000). The effects are, for example, that high rainfall causes waterlogging problems, rainfall variability affects planting and harvesting time, and the dry spell creates favorable conditions for the incidence of pests and diseases (Kostka & Scharrer, 2011).

A study by Meena & Rao (2013) indicated that variation in growing degree days highly impacted crop phenology. The growth of the plant is also highly vulnerable to terminal moisture stress that affects germination, high rainfall during flowering time creates shedding of flowers and indeterminant growth of the plant, or high temperature at the time of flowering and fruit set results in prematurity. Rainfall during harvesting creates a conducive environment for aflatoxin. This leads to low quality and has a greater implication on the market price in the international market. High wind speed after harvest creates huge post-harvest yield loss. Before threshing, farmers let the harvested sesame stalks dry on the field for a few weeks. The uneven capsule shattering that shed the seeds during maturity is a common problem (up to 50% yield loss) for the plant (Qureshi et al., 2022). The shattering nature of the plant results in

high yield loss if higher wind speed and late rainfall occurred in the season. The other weather-related factor is the incidence of pests and diseases.

4.2.2 Prevalence of the problem

Unavailability of reliable weather forecasting information has undermined sesame growing farmers' coping strategies against the unfavorable consequences of the formidable climate change (Girmay, 2018). According to Abebe (2016) weather fluctuation creates favorable conditions for the incidence of pests and diseases. The most important diseases affecting sesame production are bacterial blight (*Xanthomonas sesami*), phyllody (Phytoplasma transmitted by a vector), powdery mildew, wilt (*Fusarium exosporium f. sesami*), leaf spot (*Pseudomonas sesami*) and other viral diseases (Azanaw, 2018; Berhe et al., 2008). The major pests affecting sesame production are webworm (*Antigstra catalaunalis*), seed bug (*Elasmolomus*), gall midge (*Asphondilia sesami*), green vegetable bug (*Nezara viridula*), grasshoppers, African bollworm (*Helicoverpa armigera*) and crickets (Germew *et al.*, 2012). Insect pest and diseases which favor dry spells have tremendous effect on sesame productivity (causing up to 25% yield loss) and quality parameters (Teklu, 2022).

4.2.3 Policies or projects attempting to address the problem

Different attempts have been made to address the problem. New varieties and agronomic practices with different weather related traits were developed, tested and recommended (Schrader et al., 2020). Following the testing of technologies, a guideline entitled "**20 steps to double sesame yield**" compiled different agronomic practices and recommendations for sesame (Schrader et al., 2020). The guideline describes, for instance, that *Gondar*-1 and *Abasena* sesame varieties have a capacity to withstand high rainfall and water logging. *Humera-1, Setit-1,* and *Setit-2* perform best in moisture deficit areas. The guideline also indicates that the improved varieties listed are tolerant to common pests and diseases of sesame. Agronomic practices such as row planting and thinning were tested and proven to have improved productivity of sesame.

4.3 Market price volatility

4.3.1 Evidence that this is a problem

The Ethiopian sesame market is highly susceptible to changes in the international market price, Ethiopia's heavy regulation of its foreign currency exchange rate, and high production and transaction costs. Like other commodities, the market price of sesame is generally determined by supply and demand forces. Given the demand, the production and supply of other countries determine the international sesame price. Sudan, Myanmar, Tanzania, Nigeria, and Burkina Faso have recently started producing sesame at considerable levels increasing the raw sesame seed supply in the international market and concomitantly lowering the price.

Ethiopia's reach in the international market is also limited as the high-end western market requires high food and health safety standards to be met. For many years, China is the major destination for Ethiopia's sesame. As implied above, China resales the sesame it imports from Ethiopia to high value end markets after processing and converting the product to different forms.

Government's heavy hand on the foreign currency market has heated the Ethiopian Birr affecting the gap between domestic and international (border) prices. As indicated above, exporters with import business licenses are the main beneficiaries of the distortion due to the government's heavy intervention and the overheated Birr. They are willing to incur loss in paying higher domestic prices to export at a loss just to earn the foreign currency. The foreign currency will be used to import commodities, which are scarce in the country and can be sold with exorbitant markups compensating for the loss in exporting on top of the profit from the import business. There is an encouraging development since 2018, that started with putting in place a mechanism that ensures that the import and export business licenses are given to the same unit. As a result, the domestic market price has started to go down and stabilize. Another form intervention by the Ethiopian government is setting price ceilings. This is a biweekly exercise conducted allegedly to stabilize the domestic market and improve the country's earnings from the international market. There is little validity in the argument being made by the government and none of the private actors in sesame value chains seems to be buying the idea of price ceilings.

4.3.2 Prevalence of the problem

The domestic price has always been higher than the international price for Ethiopian sesame. This is the rationale behind the government's involvement in setting price ceilings. However, market competitiveness can sustainably be improved only through improved production and productivity. Unless the key actors are enabled to invest in enhancing the efficiency of their activities, it will be virtually impossible to increase competitiveness in the international market, no matter how stringent and widespread the price controls are. The local producers determine the price for their sesame based on the cost they incurred to produce it.

Cost of sesame production is high and increasing because of the inflationary rise in costs of farm inputs – mainly labor and chemical inputs. Records have shown that cost of labor, fuel, seed, and fertilizer has more than doubled due to the prolonged high inflation in the country. The inefficient domestic sesame market is manifesting itself through high transaction cost (Sirany & Tadele, 2022). Tax, custom fees, and loading and unloading cost also add onto Sesame's inflated domestic price. Producers are expected to pay 2% sales tax which is calculated based on yield estimation while the crop is still on the farm and the price during the yield estimation. They are also expected to pay fees levied by the municipalities

whenever they cross small towns. Traders are also expected to pay similar municipality fees, repeated transportation, loading-unloading cost, quality checking, and cost of storage at ECX.

4.3.3 Policies or projects attempting to address the problem

In addition to investing in road, telephone and railway infrastructure, the Ethiopian government made economic reforms to become a member of WTO (Wijnands et al., 2007). The GTP plan and trade reforms are some of the attempts of the government to improve the efficiency of agricultural production and marketing and that of sesame sector in particular. Several agricultural technologies are still being developed with the intention of improving the productivity of the crop as well as to reduce cost of production. The ATA are piloting the one stop agro-dealers shop to create access and reduce market transaction costs of inputs. The ECX platform and cooperative unions are also important organizations that reduce transaction costs of sesame crop marketing. Macro policies like devaluation, trade partnership agreements with potential sesame buyer countries are also the efforts made by the government. The start of organic sesame certification is also a good example to reach the high value European markets. The government also adopted various incentives for sesame exporters. Free importing of processing equipment, improving service delivery, allocating financing of loans for those engaged in export activities, creating linkages with foreign investors in marketing and production, and improving transport and transit services are some of the incentives.

4.4 Lack of Finance

4.4.1 Evidence that this is a problem

Limited access to financial capital is a key feature of the sesame production system in Ethiopia. According to Schrader et al (2020) lack of finance is the number one challenge for the sesame sector in Ethiopia. During the initial phases of the sesame production cycle, smallholder sesame producers must rely on informal sources of credit which offer loans at exorbitant interest rates. The lack of finance forces farmers to sell their produce right after harvest regardless of the price the market offers to settle the borrowed money and to meet immediate financial needs. According to Tadege et al (2016), only 4% of sesame land is plowed by tractor mounted plows. Most of the farmers depend on manual labor and draft power. The shortage in labor and draught power forces them to hire laborers and rent draught animals at extremely high prices.

4.4.2 Prevalence of the problem

In northwest Ethiopia, in 2008 only 40% of sesame growing farmers had access to credit of all types (Yehuala, 2008). Very few sesame growers have access to the formal source. Microfinance institutions and farmers' cooperatives are the formal credit source for smallholder farmers while the Development

bank of Ethiopia is the only bank that serves commercial farmers. Since formal credit sources are limited, smallholder farmers depend on informal sources, such as friends, relatives, and local money lenders. The procedure to borrow from local money lenders is locally called ‘*’Shell”*. *Shell* has two kinds of arrangements where borrowers pay back either in cash or in kind. The loan is very expensive, and borrowers are expected to pay twice the value of the loan they received, which is an interest rate of 100%.

4.4.3 Policies or projects attempting to address the problem

Farm loans in Ethiopia are mostly related to chemical fertilizer and seed inputs. However, sesame farmers face serious cash shortage during weeding and harvesting periods. The Sesame Business Network (SBN) support program studied the financial sector challenge and designed guaranty fund schemes. The idea behind guaranty fund is that the program shares the risk that financial institutions need to take in providing their services to farmers. The guaranty amount was different across the three years period. The loan was targeted to smallholder farmers through using farmers union as an entry point. The scheme is meant for smallholders to use the loan for three months for weeding and harvesting, and hence the loan matured in a year. Then, the primary farmers’ cooperatives collect the loan from the farmers and use it for trading for the next three months. Finally, before the loan is disbursed to the bank, the unions collect the loan from primary cooperatives and used it for trading purpose for about 5-6 months. As Schrader et al. (2020) noted, in this loan scheme more than 15,000 farmers benefitted and four different banks were involved. The main achievements in this scheme included that loan access was created for farmers, and cooperatives and unions were able to enter to the market. Above all, zero default rate and bankers risk sharing behavior in agriculture grew from 20% risk to 50% at the end of the third year.

Amhara and Tigray Credit and Saving Institutions have also been providing small loans using the group lending approach. These institutions targeted poor farmers and their operational philosophies hardly matched with that of the sesame growers and, hence, limiting their relevance. The Development Bank of Ethiopia is the only bank that provided loans to the commercial farmers. The bank used other non-agricultural assets as collateral to give out loans to the commercial farmers. Currently, the bank has stopped providing agricultural loans due to high debt burden in the sector.

5. POSSIBLE INTERVENTIONS TO ADDRESS THE KEY CHALLENGES

5.1 Strengthening sesame research and extension

To increase the competitiveness of Ethiopian sesame in the international market, efficiency of the production and marketing systems needs to be improved. Public investment in research and extension is

crucially important to understand the challenges, identify context specific solutions, and make the technologies available to the key actors in the sector timely and adequately. Developing high yielding sesame varieties and associated agronomic practices through the participation of the farmers is still an opportunity to exploit. Engaging private and public enterprises engaged in multiply and disseminating improved seeds and other important technologies is critically important. Technologies that improve farmers' labor efficiency should be identified, tested, and made available to the producers. Experiences of other countries show that sesame is produced mainly through use of farm machinery. Mechanization reduces not only the cost of production but also post-harvest losses.

Improving the extension delivery system is another area that should be given due emphasis. Developing, testing, and implementing new technology transfer and extension communication mechanisms is something the country must carefully work on to improve smallholder farmers' access to improved agricultural technologies. The opportunities that arise from the ever-growing ICT need to be harnessed to put in place effective information delivery mechanisms. ICT based interventions have shown to be effective in disseminating technologies (Daniso, 2017). Getahun (2020) similarly noted that mobile phones, websites, social media, and other internet/online services bring an immense prospect to farmers to create, share, store, process, interpret and preserve agricultural information and knowledge.

5.2 Climate smart sesame production technologies

Climate change adaptation using climate-smart technologies is what is being recommended for smallholders to effectively cope up with the adversities due to the variability in the weather and climate. The first step in this regard is understanding the pattern, the characteristics, and the consequence of the existing environmental fluctuations. Developing climate-smart technologies that fit different agro-ecologies and production systems should follow. Adapting to digitalizing weather information delivery methods is mandatory to take the necessary practices that enable farmers to adjust themselves in the changing environment (Abegunde et al., 2019; Karume et al., 2022; Shahzad et al., 2021). Short message information delivery system through Mobil phones is now widely used in many countries. Testing this and other information delivery practices is vital for the farmers. Possibly installing short and long-metrological season forecast systems will also be very useful for farmers to select the best enterprises, agronomic practices, and help decide the type of varieties used.

Producing sesame using irrigation is another missed opportunity in Ethiopia. Most of the sesame growing areas in Ethiopia have high potential and are appropriate for irrigation (Seleshi, 2019). Large rivers that cross the country pass through sesame growing areas. Irrigation obviously has numerous advantages over rainfed agriculture. Irrigation helps improve plant productivity by creating a conducive environment for the plant to use essential inputs than under rain fed farming. It is relatively better for testing different technologies and controlling pests and diseases (Gedefaw et al., 2019). Ethiopia as a

country has vast potential to increase sesame production and productivity through irrigation. Hence, building irrigation schemes and the infrastructure required has paramount importance.

5.3 Managing Market Price Volatility

The sesame supply chain in Ethiopia is long and is characterized by high transaction costs. The transaction costs can be reduced by shortening the supply chain and/or improving the efficiency of the ECX platforms. Looking at alternative market channels is also an important area to look into to find ways of improving sesame market efficiency.

Market information asymmetry, and the series of regulations and legislations, have made the sesame market price quite volatile. Farmers and traders do not have sufficient information on how the level of production in other countries, what the global demand is, the legislations that the government is to enact, the relative merits of Ethiopian sesame in the international market, or the price pattern in general. Recently, the government has been setting and lifting the price ceiling every two weeks confusing most of the actors along the value chain.

Studies show that selling and input utilization decisions are highly dependent on the extent to which the decision maker accesses market information (Andaregie et al., 2021). It is, therefore, important to provide reliable information and designing future markets that can reduce the risk due to price volatility. Digitalizing and providing up-to-date information will have great implications on sesame marketing efficiency. Installing crop insurance, designing, and implementing a warehouse receipt system, and improving the market infrastructure of the crop are essential in improving the marketing efficiency of the sesame sector in Ethiopia.

Value addition is another opportunity for the Ethiopia sesame sector to generate more from the sesame produce, which it is currently exporting with no value added. Market segmentation based on the needs and requirements of destination countries needs to be done as well based for instance on quality (raw seed, processed seed, etc.), color (white, black, brown, etc.) or application (bakery and confectionery products, pet food, cosmetics, medicines, etc.). The sesame sector is also being challenged by the exchange rate policy the country follows. The Ethiopia birr is overvalued and hence the domestic price does not reflect the true market value of sesame. This usually benefits only exporters who have importing licenses. Revising the existing foreign exchange policy and legislation related to sesame export is necessary to crease the marketing efficiency and competitiveness of the crop.

5.4 Rural financing

The low adoption of improved technologies and mechanization in sesame growing areas is related to shortage of financial resources. Even though sesame is the second highest earning agricultural export

commodity, there is not any Bank currently making finances available to the producers. The international competition, however, requires huge investments to improve the quality and productivity of the crop. Due attention should therefore be given to allocating public and private funds to alleviate the financial problems of the sector. One of the reasons for the poor involvement of financial sectors is loan guarantee or collateral. Crop insurance, guarantee funds, and organizing farmers could be ways around the collateral problem. Cash and asset financing strategies need to be designed to promote farm mechanization in the sector. Finally, warehouse receipt systems and future marketing need to be promoted.

6. CONCLUSION

The sesame sector in Ethiopia is currently challenged by different constraints. The low adoption of technology and lack of mechanization are serious threats to Ethiopian sesame production. The lack of seed supply system and the multi-faceted climate change are also critical challenges. Traditional production system is the main way of sesame production in the country with labor cost making up most of the production cost. Reducing cost of production and increasing the productivity could therefore save Ethiopian sesame.

Low market efficiency is another challenge the Ethiopian sesame value chain faces. Repeated taxation, lack of information system, poor infrastructure, and layers of bureaucratic procedures contribute to the high sesame market transaction cost. Segmentation of the markets and identifying and characterizing the demand in the destination countries are very crucial. Value addition at the different nodes of the value chain based on the needs of the destination country will also be particularly important.

Careful look into the efficiency of ECX as the main outlet for sesame needs to be done and creating competing market outlets seems timely and necessary. The legal and policy environment is characterized by some random decisions, e.g., exchange rate control and price ceiling related ones, and evidence-based decision making needs to replace the current precariousness.

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