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Value Chain Analysis of Sesame Evidence from Eastern Sudan.

Case Study (Kassala and El- Gedarif States)

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Abstract: Sesame is an important cash crop and plays a vital role in the livelihood of many people in Sudan. However, a few challenges hamper the development of the sesame sector along with the value chain. Therefore, this study aims at analyzing the value chain of sesame in Kassala and Algedarif States, which are, States in the Eastern part of Sudan. The results of the current study show that there are various actors across the sesame value chain in Kassala and Gedarif States in Eastern Sedan. The major ones are input suppliers, producers, traders, processors, and exporters. The results of the current study show that there are lays out a convincing case that opportunities for growth are available in the sesame key value chains covered by this paper. The econometric model results showed that; educational level, age and number of years of experience, cultivated land area / per feddan, average prices / pound per quintal, average cost of agriculture per acre, distance from farm to market / km, Fertilizer use, improved seed use, seed varieties used, harvesting method, availability of information to access local and global markets, and difficulty in obtaining agricultural financing are significantly affecting factors of sesame supply(average productivity). Thus, the government and concerned stakeholders need to give attention to yielding increasing technologies in the study area to boost production and productivity and thereby increasing the market supply of sesame (average productivity).

Keywords: Sudan; Kassalaa and Algedarif States; value chain; sesame: linear regression

Introduction

Agriculture has long been a central part of Sudan's economy. Agriculture is the foundation of livelihoods for much of the rural population in Sudan, and for many SMEs, because of its importance for food security and household welfare and as a source of export earnings. Always vital, the sector has taken on an increased importance following the secession of South Sudan in 2011. Agriculture's share of gross domestic product (GDP), which was estimated at 24 percent in 2011, increased to 31 percent in 2018. Similarly, labor's share in agriculture, which stood at 50 percent at the time of the secession of South Sudan in 2011, increased to 54 percent in 2012. Agriculture provides livelihood to approximately two-thirds of the population.

Statement ofResearch Problem

Sesame is believed to be the native oil seed to the African savanna; however, its domestic production was recorded in the Middle East and India for 4000 years ago (Ayana, 2015). Globally, the top largest producers of sesame are Myanmar, India, China, Sudan, Uganda and Ethiopia (Germany, 2018).

Sesame is economically important not only for producing edible oil but also for exporting raw and roasted seeds. The large proportion of farmers is engaged in sesame production in Eastern Sudan (Kassala and ALgadarif States). There is a lack of information regarding productivity and value chain of sesame in Eastern Sudan. Benefit sharing distribution among actors is also not clearly known. The newly elected government policy promotes sesame production in Eastern Sudan for export. The degree of vulnerable farmers integrated in the value chain of sesame production in Eastern Sudan is unclear, i.e. to what extent smallholder farmers take any stage in the value chains is not well understood. There is a lack of information on how actors of the sesame value chain coordinate and interact with each other within the horizontal and vertical chains. Therefore, this study will be carried out to analyze the value chain of sesame for improving this value chain in each segment in Eastern Sudan, (Kassala and ALgadarif States).

The main objectives of the research are as follows:

1. To map actors and analyze the value chain of sesamein Sudan.
2. To identify the issues and constraints in the value chain of sesame in Eastern Sudan, (Kassala and ALgadarif States); and
3. To look for necessary conditions in order to promote the value chain of sesame in Eastern Sudan, (Kassala and ALgadarif States).

Research Questions

1. What are the challenges and constraints at each level of the sesame's value chain in Eastern Sudan, (Kassala and ALgadarif States).?
2. What are the necessary conditions to improve the value chain to reach its potential capacity in Eastern Sudan, (Kassala and ALgadarif States).?

Scope and Limitation of the Study

This study aims at improving the various stakeholders' performance along the value chain of sesame in Eastern Sudan, (Kassala and ALgadarif States). Due to time and financial constraints, the study is limited inits depth and coverage of the study area to Eastern Sudan, (Kassala and ALgadarif States) to fully address the objectives of the study. It will emphasize only the sesame production value chain. The result of the study may have some limitations such as sample size and therefore may not be generalized and applied to the whole of Sudan. However, it will be useful for areas with a similar context to the study area.

Hypothesis and description of the variables

In the case of identifying factors affecting sesame supply to the market at farm household level in Kassala and Gedarif States, the main task was exploring which factors potentially influence and how these factors are related to the dependent variable. Therefore, the following dependent and independent variables hypothesized in Table (3.1).

Research methods of analysis and Materials in Kassala and Gedarif States in Eastern Sudan:

Study area and data collection and methods of analysis

The study was conducted in Kassala and Gedarif States, which are, States in the Eastern part of Sudan, Eastern Sudan is administratively composed of the three states of the Red Sea, Kassala and Gedarif. The Kassala and AlGedarif district were purposively selected for this study because of its highest sesame production potential in the country. The study employed structured interviews that utilized a questionnaire (survey). Since the population within each site is somewhat homogeneous, we chose to collect survey data from a fixed sample of 100 individuals in each research area. Ultimately, we collected 100 questionnaires, 25 from Kassala state and 75 from Gedarif State were interviewed to collect the required data. Alongside the survey, from each peasant association, focus group discussion (5 to 8 participants in each group) in the two states, key informant interviews, and researchers' direct observation were used to collect detailed data across the sesame chain.

The settlements covered by the survey in Gedarif are the town of Gedarif and the town of Gallabat and the locality of ALFushquh; and in Kassala,

the locality of Wad Al Helou. Data collection was undertaken from November 2021 through December 2021. All areas have differing ethnic and traditional compositions.

The survey questionnaire consisted of close-ended survey questions on (i) demographic variables for community; (ii) qualitative study variable; (iii) quantitative study variable; and (iv)the problems and obstacles faced the value chain analysis of sesame seed in study area.

additional individual interviews with employees of government agencies (such as the Kassala and Gedarif States - Ministry of Agricultural (MOA),), various government organizations, and nongovernmental organizations (NGOs) (such as the UNIDO, Eastern Sudan), the Food and Agriculture Organization (FAO), Central Statistical Organization (CSO) and other related publications.

Multiple linear regression model (OLS) was fitted to analyze factors affecting the amount of sesame supply to the market. All sampled farmers producing sesame participated in the marketing. The dependent variable is the amount of sesame supplied to the market which is a continuous variable. Hence, OLS model is the right fit to the farm household data analysis. Following Gujarati (2004), the multiple linear regression model is specified as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_i X_i + \varepsilon_i$$

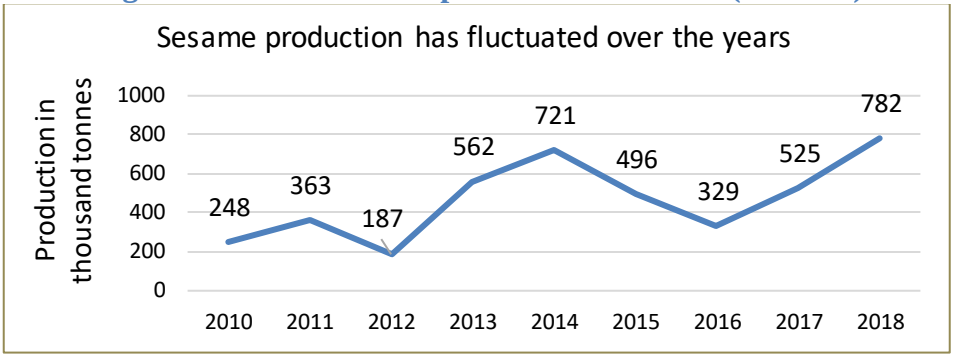
where, Yi refers the volume of sesame supplied to the market, Xi 's are the vector of explanatory variables, β0 is the intercept, βi are parameters of the ith explanatory variables, and εi is error term.

2. Review of Literature

2.1: Sesame seeds value chain in Sudan

Sesame seeds, a major cash crop in Sudan, was cultivated on over 2.77 million ha of land in 2017. In 2018, Sudan produced 782,000 tons of sesame seeds, which amounted to approximately 10.3 percent of the total sesame seeds production worldwide (Figure). Sudan is the fourth largest producer of sesame seeds worldwide after Myanmar, India, and China (United Nations Industrial Development Organization 2017). About 77 percent of the area devoted to sesame seed farming is in three states of El-Gedarif, North Kordofan, and Blue Nile. El-Gadarif state is well known for producing premium-quality sesame seeds. The state has been referred to as the country's breadbasket, producing 62,000 tons of sesame seeds in 2016–17. The majority (80 percent) of sesame fields in Sudan are relatively large and occupy around 2 ha in area. Sesame seeds production in Sennar and North Kordofan is, however, dominated by smallholder farmers (World Bank 2019d).

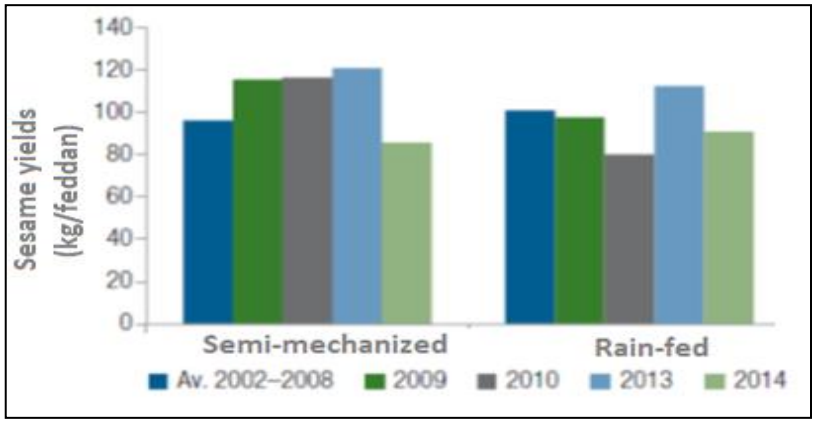
Figure 2.1: Sesame seeds production in Sudan (2010–18)



*Source:*www.ceicdata.com.

Sesame seed production in Sudan is categorized into two types of farming: semi-mechanized rain-fed farming and traditional rain-fed farming. Traditional rain-fed farming produces 38 percent of the total production. Traditional rain-fed farming of sesame seeds occupies considerable acreage and is mostly practiced by smallholder farmers. Where the system of production is rain-fed, poverty levels are high, far exceeding the national average poverty ratio. On the other hand, semi-mechanized rain-fed farming produces 62 percent of the country's sesame seeds. Semi-mechanized rain-fed farming is generally practiced by large farmers and companies with large investments.[1]

Figure 2.2:Sesame yields in mechanized and rain-fed areas



***Source:*World Bank 2019d.**

The sesame seeds produced in Sudan are classified into two types, based on physical appearance, that is, white sesame seeds and red sesame seeds. The higher-quality white sesame seeds have 40–46 percent oil content, are considered more refined, and are used for direct consumption. The lower-quality red sesame seeds contain 50–52 percent

[1] **The investments increase the operational capacity of farmers and large companies and allow them to increase the area of production.**

oil content and are processed domestically, either crushed for oil with by product sesame cake (for animal feed) or sold to processors of a sweet confectionary product 'TahniaHalwa'. Red sesame seeds make up about 50 percent of the ingredients for 'Tahnia'by volume. Production of 'Tahnia' presents good opportunities for post-harvest value addition through dry cleaning, shelling, water cleaning, roasting, grinding, mixing with other ingredients, packaging, and distribution of red sesame seeds (World Bank 2019d).

Sesame oil is produced primarily from red sesame seeds. Three types of edible oil extractors are being used in Sudan: the traditional manual (camel-driven) oil extractors, small-motorized oil extractors, and large-capacity oil extractors. Many traditional small- and medium-scale oil crushers/extractors are in Kordofan. Lack of electricity is a major concern for millers. In localities where electric power or diesel engines are available, small mechanical extractors are being used. Modern manufacturers with higher processing capacities extract oil using specialized machines. Some supplement their products by purchasing raw oil extracted through traditional methods. Large oil producers and refineries are in Khartoum, and a few are in other cities, with an overall daily processing capacity exceeding 5,000 tons. The byproduct—sesame seeds cakes—is sold to animal feed manufacturers, who blend it with other ingredients. Small quantities of seeds cakes are also exported.

Sudan's yield of sesame seeds is relatively low and fluctuates under both mechanized and traditional rain-fed production systems. This is largely due to the low availability of water and fertilizer. In 2015, average yield for sesame seeds was 259 kg/ha (283 kg/ha in mechanized systems and 253 kg/ha in traditional systems), whereas in case of Nigeria and China, respective yieldswere 500 kg/ha and 1,200 kg/ha (Table). Sudan's sesame seed productivity is estimated to be 18 percent that of China, 27 percent that of Ethiopia, and 51 percent that of Nigeria. Further, most farmers are smallholders who lack the infrastructure for storage, leading to high rates of post-harvest losses. The harvested sesame seeds are stored on ground which causes contamination with sand and other impurities.

Table 2.1: Sesame yields of various countries

Country	Yield (kg/ha)
China	1,200
Ethiopia	750
Myanmar	580
Nigeria	500
India	422
Sudan	259

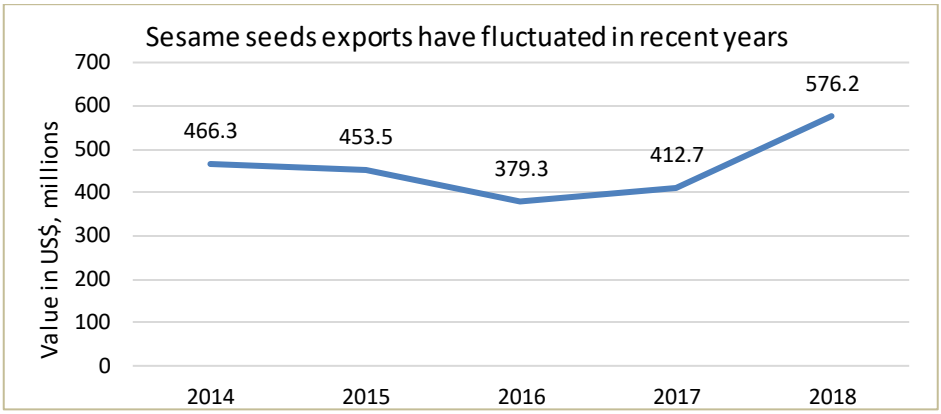
Source: Getahun Bikora, Oilseed Production and Marketing Situation in Ethiopia, Ministry of Trade, November14, 2015, U.S. Department of Agriculture; World Bank data; and FAOSTAT.

Support is required to increase productivity and reduce post-harvest losses in the sesame seeds value chain. Improved input secluding quality seed, appropriate fertilizer use, and increased access to irrigation facilities can help farmers increase productivity, which would stabilize the yearly fluctuations in production volumes of sesame seeds. Moreover, support at the postproduction level (that is, provision of proper storage infrastructure/facilities) can help minimize post-harvest losses (World Bank 2019c).

2.2.: Sesame in international and domestic markets

Sesame seed is an important export cash crop for Sudan. The country exports more than two-thirds of the production, and the remaining one-third is either processed or lost due to deficient infrastructure and poor links with the processing sector. Sudan exported 550,000 tons and 704,000 tons of sesame seeds worth US$412 million and US$576 million, respectively, in 2017 and 2018 (Bank of Sudan annual reports). White sesame is exported as grain. The lower-quality red sesame is processed domestically. The export quantities of raw sesame seeds exceed the export quantities of processed sesame seeds (oil), and Sudan, therefore, does not fully benefit from the export potential of sesame oil. In fact, Sudan became a net importer of edible oil importing annually 253,186 tons of edible oil with an import bill of US$230 million in 2017.

Figure 2.3:Sudan's sesame exports in US$, millions (2014–18)



Source:"Economic and Financial Statistical Review," CBS, 2019.

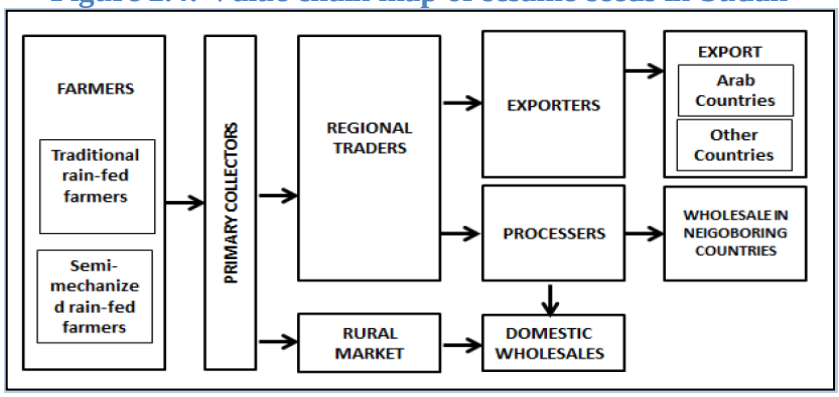
The main markets for Sudan's sesame seeds include the Middle East and China. Global demand for sesame seems to be increasing with the rapid growth of consumption in China and India. Currently, global trade of sesame seeds is valued at US$2.8 billion. The top five sesame-importing countries are China, Japan, Turkey, South Korea, and Vietnam, with China accounting for 30 percent of global imports. Sudan has exported sesame seeds to over 75 total destinations since 1990. In 2013, the Middle East accounted for 51 percent of all sesame exports, and China for 27 percent. The major markets for white sesame seeds export include Algeria, Greece, Morocco, Poland, Tunisia, and Turkey. China is a major importer of red sesame seeds produced in Sudan, for oil extraction, which provides a stable market for the Sudanese exporters. There exist, however, major markets of sesame seeds such as Japan, Malaysia and the United States that have not been penetrated yet, due to the low quality of the sesame seeds and Sudan's inability to comply with SPS standards.

2.3: Sesame marketing chain

There exist several small-scale actors in the sesame seeds value chain, including farmers, traders at different administrative levels (village, district, state, and national), transporters, small-scale and large-scale processors, and exporters. Growers typically sell their seeds within two or three weeks after harvest to a village collector or trader. Village traders take and sell the purchased sesame seeds to intermediate traders in the regional markets, who in turn collect larger quantities and sell them to the wholesaler, processor, or exporter. In several cases, processors and exporters have direct agents to purchase sesame seeds at the local or intermediate markets. Large commercial farmers usually have direct purchase agreements with the wholesalers, processors, and exporters. Only

a small percentage of sesame growers (large commercial farmers) have storage facilities to store their produce and wait to fetch better prices. Additionally, there exist some institutions that play an important role in sesame seeds marketing. These institutions include the Ministry of Agriculture and Forestry (MOAF), the Ministry of Industry (MOI), ARC (Agricultural Research Corporation), and Sudanese Standards and Metrology Organization (SSMO), industry stakeholder associations, and international organizations and NGOs (United Nations Industrial Development Organization 2017).

Figure 2.4: Value chain map of sesame seeds in Sudan



Source: United Nations Industrial Development Organization 2017.

Most exporters and processers are in the capital city Khartoum and Port Sudan. In these cities, exporters screen, clean, and bag sesame seeds into 50 kg sacks. The bagged sesame seed is then packed into 20 MT and 40 MT containers which are transported to the shipping lines for transport to the export destinations (United Nations Industrial Development Organization 2017).

The sesame seed processing sector is dominated by 2–3 large corporations operating in the capital Khartoum, while SMEs (Small and Medium Enterprises) serve rural areas. The two large 'Tahnia' manufacturing companies are based in Khartoum and have their own distribution networks. The SMEs manufacturing 'Tahnia' serve the rural and small urban markets. There is a growing demand of 'Tahniahalwa'in rural areas and small towns. 'Tahnia' produced by SMEsis distributed through wholesalers in large plastic buckets, mostly unbranded because quality packaging is expensive for SMEs and import restrictions limit their ability to access better packaging. Despite the product being highly desired by domestic consumers, price sensitivity and high operational costs limit the scalability of local markets, resulting in mostly subsistence-level entrepreneurship by the SMEs (World Bank 2019d).

2.4: Constraints along the sesame seeds value chain

1. The sesame value chain faces several constraints beginning with production and extended through exports. Besides the issues common to all value chains, the specific key challenges identified by the stakeholders are summarized as follows:

- **Inappropriate use of pesticides.** Sudanese farmers have limited pesticide knowledge, and unsuitable use of pesticides lowers the quality of sesame seeds. According to an ARC analysis on the pesticides used by sesame farmers in the field, 5 out of 10 commonly used pesticides were not suitable for sesame cultivation.

- **Lack of quality seeds and poor agricultural practices.** Farmers have limited knowledge about the value of improved seeds and Good Agricultural Practices (GAPs). Most farmers still use traditional seed varieties, which result in low productivity. There are hardly any active input providers for oil seeds in the rain-fed areas and smallholder farmers have limited opportunities to access improved seeds, fertilizers, pesticides, and so on. Improved varieties of sesame seeds are mostly imported and are expensive for smallholder farmers to buy. The growers lack Gaps, that is, efficient crop management methods, pest control measures, and pre- and post-harvesting practices. The situation in the irrigation sector is relatively better as private suppliers provide the required inputs to a certain extent.

2.5: Investment opportunities along the sesame seed value chain

2.5.1: Productivity enhancement, value addition, and employment generation

The competitiveness of raw sesame seeds in terms of quality and consistency of supply to the domestic market is positive, while the competitiveness of sesame seed processing in terms of quality is low. There is a regular supply of sesame seeds in the local market, and there are no major constraints aside from the usual seasonal limitations. More than 90 percent of sesame seeds enter the local market for consumption and export. The competitiveness of sesame seeds processing in terms of quality is low. The sesame seeds processing is mostly carried out on a small-scale by SMEs (Small and Medium Enterprise. Uneven supplies of sesame seeds, poor infrastructure, limited access to the latest processing equipment, and a lack of quality packaging material reduces the quality and output of sesame seed processing in Sudan.

Investment opportunities exist in sesame seeds productivity and quality enhancement through provision of quality seeds; timely supply of appropriate fertilizer and pesticide; advisory and extension services; and post-harvest handling including collection, sorting, safe packing, warehousing, and safe transportation to markets.

Investments in sesame seed productivity enhancement and value addition (processing and oil extraction) will create employment and increase household income, food security, and entrepreneurship opportunities along the entire value chain including agri inputs supply chain, road and transport network improvement, processing, oil extraction, sorting, grading, packaging, and marketing

2.5.2: Quality enhancement, certification, and export earning

1.**Sudanese sesame seeds are not competitive in the premium global markets in terms of cost and quality.** The high-quality sesame seeds are often sold at discounted prices to markets (with less-stringent quality standards) like China, as the sesame seeds exporters face several challenges in accessing the premium markets, that is, the EU, Japan, and Korea, in part due to noncompliance with SPS standards and regulations. The key limitations are (a) producers' limited knowledge regarding SPS standards of importing countries; (b) poor agronomic practices for harvesting, post-harvesting, transporting, and storage that lead to contamination with my cotoxin-producing fungi (in particular aflatoxins), pests, and rodent infestations; and (c) limited or no vertical connection along the value chain to monitor product safety at each stage of the value chain (United Nations Industrial Development Organization 2017).

2. **Investment opportunities lie in strengthening the sesame value chain to fulfill the required quality standards for global markets.** Weak SPS measures, inadequate post-harvest handling, lack of laboratory facilities, and inadequate regulatory control impede the export of sesame seeds export. Investment opportunities exist in developing forward and backward links to improve SPS compliance along the value chain and building the capacity of value chain actors to meet SPS requirements, especially for premium markets, is critical for increasing export revenues.

3. **Sesame seed processing for oil extraction presents medium- to long-term investment opportunities.** The medium- to long-term investment opportunities exist in upgrading/increasing the output capacity of existing processing plants and setting up new sesame seed processing plants with the latest equipment and technology. Further, medium-term investments could also be targeted toward value addition for bakery and confectionary

items that will improve the quality of these items and increase the income for the sesame seeds processors (World Bank 2019c).

4. **Organic certification and branding of sesame value chain present long-term investment opportunities.** Organic certification, traceability, and branding of sesame seeds will result in higher income for the value chain actors due to certified export quality of sesame seeds, and ability to tap into the premium markets like the EU and the United States. It would also contribute toward the Transitional Government's agenda of 'establishing the bases of sustainable development.

5. **The investments will enable Sudan to market high-quality sesame seeds and sesame oil to the premium markets,** generate skilled jobs and higher incomes in the sesame export supply chain, and enhance export earnings manifold by tapping into new markets in the Middle East, Arab countries, and Africa.

3.Results and discussion

3.1: Sesame value chain map of the Kassala and Gedarif States

Value chain map is a potential starting point for the including farmers, traders at different administrative levels (village, district, state, and national), transporters, small-scale and large-scale processors, and exporters. Growers typically sell their seeds within two or three weeks after harvest to a village collector or trader. Village traders take and sell the purchased sesame seeds to intermediate traders in the regional markets, who in turn collect larger quantities and sell them to the wholesaler, processor, or exporter. NGOs (United Nations Industrial Development Organization 2017). Hence, we start presenting our results by mapping of the sesame value chain in the study area (Figure2. 4). The chain map described in Figure (2.4) can also be applied for the nation because sesame production, processing, and marketing situations are almost similar in all regions. The map involves functions, actors and other service providers in the whole value chain. (Lundy et al., 2014). The main actors in the sesame value chain are an individual or institution directly involved in sesame value chain activities from the points of production to consumption. The main actors of the sesame value chain in **Kassala and Gedarif States** are faces several constraints beginning with production and extended through exports. Besides the issues common to all value chains, the specific key challenges identified by the stakeholders are summarized as follows:

1. **Inappropriate use of pesticides.** Sudanese farmers have limited pesticide knowledge, and unsuitable use of pesticides lowers the quality of

sesame seeds. According to an ARC analysis on the pesticides used by sesame farmers in the field, 5 out of 10 commonly used pesticides were not suitable for sesame cultivation.

2. **Lack of quality seeds and poor agricultural practices.** Farmers have limited knowledge about the value of improved seeds and Good Agricultural Practices (GAPs). Most farmers still use traditional seed varieties, which result in low productivity. There are hardly any active input providers for oil seeds in the rain-fed areas and smallholder farmers have limited opportunities to access improved seeds, fertilizers, pesticides, and so on. Improved varieties of sesame seeds are mostly imported and are expensive for smallholder farmers to buy. The growers lack Gaps, that is, efficient crop management methods, pest control measures, and pre- and post-harvesting practices. The situation in the irrigation sector is relatively better as private suppliers provide the required inputs to a certain extent.
3. **The competitiveness of raw sesame seeds** in terms of quality and consistency of supply to the domestic market is **positive,** while the competitiveness of sesame seed processing in terms of quality is **low.**
4. **Sesame seed is an important export cash crop for Sudan.** The country exports more than two-thirds of the production, and the remaining one-third is either processed or lost due to deficient infrastructure and poor links with the processing sector.
5.limited or no vertical connection along the value chain to monitor product safety at each stage of the value chain (United Nations Industrial Development Organization 2017).

3.2: Factors affecting sesame supply to the market (average yield per acre (Faddan)

Table (3.1) Description of the variables included in the model estimation and its hypothesis

Variable description	Variable type	Unit of measurement	Expected sign
Dependent variable			
Quantity of sesame seed supplied to market (average Yield per acre(Faddan)	Continuous	Quintal(100kg)	
Independent Variables			
Educational Level	Continuous	Number of years	+
Number of family members aged 15 to 69 years	Continuous	Number of productive ages in the households	+
Farmer's experience on sesame production	Continuous	Number of years	+
Membership in an agricultural cooperative	Dummy	1 if yes, otherwise, 0	+
Area of sesame	Continuous	Acre (Faddan)	+
Market Price in 2021	Continuous	Pound for Quintal (Sudanese currency)	+
Averge cost of agriculture per acre	Continuous	Pound for Acre (Faddan) (Sudanese currency)	+
Use of Fertilizer D	Dummy	1 if yes, otherwise, 0	+
Use of improved Seed	Dummy	1 if yes, otherwise, 0	+
Varieties of seeds used	Dummy	1 if yes, otherwise, 0	+
Harvest method	Dummy	1 if yes, otherwise, 0	+
Distance to central market	Continuous	km	-
Provides information for access to local markets	Dummy	1 if yes, otherwise, 0	+
Provides information to access global markets	Dummy	1 if yes, otherwise, 0	+
Providing logistics services from government and organization	Dummy	1 if yes, otherwise, 0	+
Access to credit	Dummy	1 if yes, otherwise, 0	+

Table (3.2) Description analysis of demographic variables:

Variable	Statement	Frequency	Percent
Local	Rural Wad Helou	32	35.6
	ALGedaref	42	46.7
	Gallabat	15	16.7
	ALFushquh	1	1.1
	Total	90	100.0
Gender	Male	87	96.7
	Female	3	3.3
	Total	90	100.0
Educational Level	Unlettered	5	5.6
	Reads and Writes	7	7.8
	Basic	10	11.1
	Secondary	31	34.4
	University	33	36.7
	Above University	4	4.4
	Total	90	100.0

Age	Less than 20years old	2	2.2
	20 less than 30years old	16	17.8
	30less than 40years old	31	34.4
	40less than 50years old	21	23.3
	50 and over	20	22.2
	Total	90	100.0
Farmer's experience on sesame production	Less than 5years	18	20.0
	5 Less than 10years	31	34.4
	10 Less than 15years	5	5.6
	15 Less than 20years	12	13.3
	20years and above	24	26.7
	Total	90	100.0

Source: Authors computation from the own survey data (2021) using the program SPSS.

Table No. (3.2) show the descriptive analysis of the demographic variables (local, gender, educational level, age and number of years of experience) and from the results according to the distribution of sample members according to the locality variable, we find that most of the individuals are from Gedaref locality with a percentage of (46.7%) Then the locality of Wad Al-Helio in the state of Kassala with a percentage of (35.6%), then the locality of Qalabat of the state of Gedaref with a percentage of (16.7%), and the lowest percentage was (1.1%) only for the locality of Al-Fashqa.We also note that most of the sample members according to the gender variable are males, where their percentage reached (96.7%), while only 3.3% for women. As for the educational level variable, we find that it is distributed among all qualifications in varying proportions and that most of them are at the university level with a percentage of (36.7%), followed by the secondary level with a percentage of (34.4%), then the basic level with a percentage of 11.1% and the lowest percentage was for the post-university level by only 4.4% due to the high illiteracy rate in eastern Sudan. According to the age group variable, it becomes clear that most of the sample members are between the ages of 30 and less than 40 years, with a percentage of (34.4%), that is, most of the sample members are young people, and the lowest percentage was (2.2) for the age group less than 20 years. According to the variable number of years of experience, we note that most of the sample members have years of experience ranging from 5 to less than 10 years (34.4%), then 20 years or more with (26.7%), and the lowest percentage was (5.6%) for the number of years of

experience 15 and less than 20years. In a group interview, that most of the individuals are from Gedaref locality with a percentage of (46.7%) noted that Investments in sesame seed productivity enhancement and value addition (processing and oil extraction) will create employment and increase household income, food security, and entrepreneurship opportunities along the entire value chain including Agri inputs supply chain, road and transport network improvement, processing, oil extraction, sorting, grading, packaging, and marketing.

Table No. (3.3) Descriptive analysis of the qualitative study variables

Variable	Statement	Frequency	Percent
Membership in an agricultural cooperative	**Yes**	**12**	**13.3**
	No	**78**	**86.7**
	Total	**90**	**100.0**
Fertilizer use	**Yes**	**28**	**31.1**
	No	**62**	**68.9**
	Total	**90**	**100.0**
Use of improved seeds	**Yes**	**51**	**56.7**
	No	**39**	**43.3**
	Total	**90**	**100.0**
Varieties of seeds used	**White**	**42**	**93.3**
	Red	**3**	**6.7**
	Total	**45**	**100.0**
Harvest method	**manual**	**77**	**85.6**
	machine	**13**	**14.4**
	Total	**90**	**100.0**
Provides information for access to local markets	**Yes**	**71**	**78.9**
	No	**19**	**21.1**
	Total	**90**	**100.0**
Provides information to access global markets	**Yes**	**33**	**36.7**
	No	**57**	**63.3**
	Total	**90**	**100.0**
Providing logistics services from government and organizations	**Yes**	**4**	**4.4**
	No	**86**	**95.6**
	Total	**90**	**100.0**
Difficulty obtaining agricultural finance	**Yes**	**69**	**76.7**
	No	**21**	**23.3**
	Total	**90**	**100.0**

Source: Authors computation from the own survey data (2021) using the program SPSS

Table No. (3.3) illustrate the descriptive analysis of the qualitative study variables (organism in an agricultural cooperative, use of fertilizers, use of improved seeds, types of seeds used, method of harvesting, availability of information to reach local and global markets, and difficulty in obtaining financing agricultural) From the results, we find that most individuals are

not members of agricultural societies at a rate of (86.7%), while only (13.3%) of the sample members participate in agricultural cooperative societies, which confirms the weakness of the value-added chain link and that there are problems and obstacles facing farmers to join agricultural societies. Regarding the use variable Fertilizers, we note that only (31.1%) use fertilizers, which confirms the weak awareness among farmers of the importance of using fertilizers, in addition to the weakness of agricultural extension services by the government to support the value chain of sesame crops. We also note that most individuals use improved seeds at a rate of (56.7%), mostly of the white variety by (93.3%) With regard to the method of harvesting, we find that most individuals follow the (traditional) manual harvest method at a rate of (85.6%), which confirms the weakness of agricultural mechanization services and innovation on the part of the government and agricultural organizations to support the value chain of the sesame crop. As for the availability of information to reach local and global markets, we note that most of the sample members are available They have sufficient information to reach the local markets by (78.9%) and they do not have sufficient information to reach the global markets by (63.3%), and this confirms the absence of agricultural commodity markets in Sudan compared to the Ethiopian Commodity Exchange, We also note that (95.5%) of the sample members do not provide them with logistical services from the government or organizations, which confirms the weakness of logistical support for the value-added chain of the sesame crop in Sudan compared to other countries, while (76.7%) of the sample members do not find it difficult to obtain agricultural financing. This is consistent with the research questions that there are problems and obstacles facing the development of the value chain of the sesame crop in Sudan. In a group interview. Noted that most farmers still use traditional seed varieties, which result in low productivity. There are hardly any active input providers for oil seeds in the rain-fed areas and smallholder farmers have limited opportunities to access improved seeds, fertilizers, pesticides, and so on. Improved varieties of sesame seeds are mostly imported and are expensive for smallholder farmers to buy.

Table No. (3.4) Descriptive analysis of the quantitative study variable

Descriptive Statistics					
Variable	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Cultivated land area/acres	90	2.00	8000.00	1206.1667	8470.41461
Average productivity / quintals / acre	90	.25	6.00	2.0104	1.22925
Average price/pound per quintal	90	15000.00	40000.00	21918.8889	3353.34461
Average cost of agriculture per acre	90	50000.00	150000.00	47784.9444	33352.56651
Total production / quin	90	4.00	10000.00	457.8889	1318.96104
The distance from the farm to the market / km	90	5.00	600.00	62.8778	76.13085

Source: Authors computation from the own survey data(2021)using the program SPSS

The above table shows some descriptive statistical measures (the lowest value, largest value, average and standard deviation) for the quantitative study variables (cultivated land area / acres, average productivity / quintals / per acre, average prices / pounds per quintal, average planting cost per acre, total production / quintals and distance from farm to market / km) from which we note that less .The cultivated area was 2 acres, the largest cultivated area was 80,000 acres, and the average cultivated area was 1206.1667 with a standard deviation of 8470.41, meaning that there is a discrepancy in the cultivated areas. As for the average productivity variable per acre, the lowest was 0.25 and the highest was 6 quintals/feddan with an average of 2.01 quintals per acre and with a standard deviation of 1.22. As for the average prices, the lowest was 15000 Sudanese pounds and the highest was 40000 Sudanese pounds with an average21918.89 and a standard deviation of 3353.34. As for the average cost of an acre cultivation, it was the lowest average of 5000 Sudanese pounds and the highest was 150,000 Sudanese pounds with an average of 47784.9444 pounds and a standard deviation of 33352.56651. As for the total production, we note that the lowest amount was 4 quintals and the largest amount was 10,000 quintals, and the closest distance from the farm to the market was 5 km and the farthest distance was 600 km on average 62,877 km and a standard deviation of 76.136. In a group interview, noted that Sudanese sesame seeds are not competitive in the premium global markets in terms of cost and quality.

Table No. (3.5) Multiple regression analysis of the study model (. OLS results of factors affecting farm-level marketable supply of sesame (average yield per acre (Faddan) in Kassala and Gedarif States)

Variable	B	Std. Error	t	Sig.
(Constant)	3.861	1.898	*2.035	.051
Educational Level	.148	.181	**.820	410.
Number of family members aged 15 to 69 years	-.034	.185	*-.184	850.
Farmer's experience on sesame production	.014	.148	*.096	920.
Membership in an agricultural cooperative	.446	.535	**.834	410.
Area of sesame	-2.006E-5	01.000	**-1.096	280.
Market Price in 2021	12.000-	04.000	***-2.580	.015
Average cost of agriculture per acre	8.005E-6	400.00	*1.834	.077
Use of Fertilizer D	.232	.361	**.643	520.
Use of improved Seed	.136	1.073	*.127	900.
Varieties of seeds used	-2.571	.726	***-3.540	.001
Harvest method	1.995	.546	***3.655	.001
Distance to central market	-.001	.002	*-.502	620.
Provides information for access to local markets	1.064	.461	**2.306	.029
Provides information to access global markets	.161	.345	*.467	640.
Providing logistics services from government and organization	.868	1.052	**.825	410.
Access to credit	.988	.470	**2.103	.045

Model Summary	R	R Square	Std. Error	F value	F Sig.
	.798[a]	.636	.89764	***3.062	.005[b]

Source: Own survey result. Dependent variable: Quantity of sesame supplied to market(average yield per acre(Faddan) in Kassala and Gedarif States) in the 2021 production year

***** There is a significant effect at the level of significance 1%.**

**** There is a significant effect at the 5% level of significance.**

*** There is a significant effect at the level of significance of 10%.**

The above table(3.5) shows the results of the multiple linear regression analysis of the study model to determine the impact of the independent variables (educational level, age and number of years of experience, cultivated land area / per feddan, average prices / pound per quintal, average cost of agriculture per acre, distance from farm to market / km, Fertilizer use, improved seed use, seed varieties used, harvesting method, availability of information to access local and global markets, and difficulty in obtaining agricultural financing) on the dependent variable (average productivity) ,from the results of the table, it is clear that there is

a positive significant effect of the educational level at the level of morale of 5% and the presence of a negative moral effect of the variable of age, availability of family members between ages of 15 to 69 years negative affected the amount of sesame supply(average yield) to the market in the study area. The result implies that as productive family members increase by one person, sesame supplied to market decreases by **-.034**quintals keeping other factors constant. This result is inconsistent with the assumption. The previous study by Gebremedhn et al., Cogent Food & Agriculture (2019). reported positive relationship between the two variables, this is because the productive age persons strive to produce and sell more sesame either by renting land or doing effectively on their own land. In the study area context, this result is mainly relevant to the larger family members who may provide labor for sesame planting, weeding, and harvesting to maximize production and productivity. And a positive significant effect of the variable number of years of experience on the average productivity at the level of morality 10%, while the effect of participation in agricultural cooperative societies was positive and moral at the level of morality 5 While the effect of the cultivated area and average prices were negative and significant at the level of significance of 5% and 1%, respectively, **Why this result?** The negative relationship implies that an increase in **land area cultivate** to sesame production decreases marketable supply of sesame (average yield). Increasing the size of 1 acre of land cultivated results in decreases in marketable supply of sesame by -2.006E-5 quintals, keeping other factors constant. This result is inconsistent with findings of Goshme, Tegegne, and Zemedu (2018) in Malokoza districts of the southern Ethiopia, who stated that an increase in the size of 1 ha of land allocated under sesame resulted in an increase in farm-level market supply of sesame by 6.80quintals and Gebremedhn et al., Cogent Food & Agriculture (2019).This negative relationship due to Sudanese farmers have limited pesticide knowledge, and unsuitable use of pesticides lowers the quality of sesame seeds and Farmers have limited knowledge about the value of improved seeds and Good Agricultural Practices (GAPs). Most farmers still use traditional seed varieties, which result in low productivity. **The market price of sesame**, in 2021, was positive and significantly related to its supply to market (average yield). In economic concept, quantity supplied increases as selling price increases which is supported by this result. However, the previous study by Gelalcha (2009) and Hagose (2017) indicated that sesame farmers in Humera district sell immediately after harvest when the price is the lowest. The single most important reason for selling immediately after harvest was farmers' liquidity constraints related to their credit balance, family need,

government tax, and other obligations. The previous study by Gebremedhn et al., Cogent Food & Agriculture (2019). reported negative relationship between the two variables your result might be related to the season of the sesame selling and the effect of **the average cost of cultivation** per acre was positive and significant at the level of significance of 10%, and **the effect of the variable fertilizer use was also positive** and significant at the level of significance of 5%Also, the effect of using improved seeds is positive and moral at the level of morale 10%, **and the improved seed varieties its effect was negative** because farmers have limited knowledge about the value of improved seeds and Good Agricultural Practices (GAPs). Most farmers still use traditional seed varieties, which result in low productivity, and significant at the level of morale 1%. And the effect of the harvest method was positive on the average productivity at the level of morale 1%, and **the effect of the distance from farm to market was negative** and significant at the level of morale 10%,Similar results were also reported by (Gebremedhn et al., Cogent Food & Agriculture (2019), 5: 1705741) ,**while The effect of providing the necessary information to reach the local and global markets was positive** at the 10% level of significance, as well as the effect of providing logistic services from the government or organizations and obtaining agricultural financing, both morally and positively, on the average productivity at the 5% level of significance. And the indicators of the quality of the fit of the model at the end of the table refer to the quality of the model used in estimating the effect of independent variables on the dependent variable, where the value of the correlation coefficient (R) (0.79) indicates a strong relationship between the combined independent variables and the dependent variable (average productivity) and the value of the coefficient of determination ((R2 was 64%, which indicates that the independent variables in the model explain 64% of the change in the dependent variable and the rest 36% are explained by other non-inclusive variables in the model. The standard error in the estimate was 0.8976 and the F-statistical value was 3.062 with a significant level of 0.005 indicating the significance of the model. The user is at a level of significance of 1%.

4.Conclusions

The results of the current study show that there are various actors across the sesame value chain in Kassala and Gedarif States in Eastern asaudan. The major ones are input suppliers, producers, traders, processors,and exporters. The results of the current study show that there are lays out a convincing case that opportunities for growth are available in the sesame key value chains covered by this paper. Hurdles to growth are present as well, which leave the value chains characterized by low crop(sesame) and productivity and supply chains plagued by poor information flows, high transaction costs, and inadequate investments in storage and transport that reduce the quality, safety, and value of commodities as they move from farm to domestic consumers and export markets. There is a need for increased production and productivity of sesame in the study area. This could be enhanced through extensive use of modern agricultural practices and technologies such as improved quality seed, combine harvester, and improved postharvest management practices. These practices can enhance quality as well as the increased supply of sesame products to the export market. Fully incorporating smallholder producers will remain a challenge. Working with existing producer associations and supporting the formation of new ones can help. Innovative digital technologies, which link farmers to input providers and buyers, show promise as ways to overcome well-known hurdles to productivity and better-integrated and more efficient supply chains. The Government and donors should consider finding ways to support similar innovation efforts in Sudan. Moreover, the estimates of linear regression model showed that area of land allocated to the sesame production, yield per hectare, distance to market, average market price, use of the improved seed, and the number of family members under productive age group significantly affects the amount of sesame supply to the market. The government and other relevant stakeholders who aim to improve the functioning of sesame market to the export level need to address these factors. They should give more emphasis to the availability and use of improved seeds and other yield enhancing technologies, improved post-harvest practices and handling, options access to credit, possibilities to consolidate land for technology use and economics of scale, and further support value addition through processing.

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