WERABE UNIVERSITY

COLLEGE OF AGRICULTURE AND NATURAL RESOURCE,

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DEPARTMENT OF ARGICULTURAL ECONOMICS

FACTORS AFFECTING ROSEMARY (ROSEMARINUS OFFICINALIS) PRODUCTION AND MARKET PARTICIPATION IN THE SILTE ZONE, CENTRAL ETHIOPIA REGION, ETHIOPIA

MSc THESIS

BY:

ABDULSHUKUR BUSSER AMAN

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WERABE, ETHIOPIA

FACTORS AFFECTING ROSEMARY (ROSEMARINUS OFFICINALIS) PRODUCTION AND MARKET PARTICIPATION IN THE SILTE DISTRICT, CENTRAL ETHIOPIA REGION, ETHIOPIA

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A THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ECONOMICS, COLLEGE OF AGRICULTURE AND NATURAL RESOURCE, POSTGRADUATE PROGRAM DIRECTORATE, WERABE UNIVERSITY IN PARTIAL FULFILLMENTS OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS

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DECLARATION

I hereby declared that this MSc. thesis is my original work and has not been presented for a degree in any other university, and all sources of materials used for this thesis were accordingly acknowledged.

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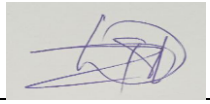
This is to certify that the thesis entitled "Factors Affecting Rosemary Production and Market Participation: the Case of Silte Zone, Central Ethiopia Region, Ethiopia" submitted in partial fulfillment of the requirements for the degree of Master's with specialization in Agricultural Economics, the Graduate Program of the Department of Agricultural Economics, and has been carried out by Abdulshukur Busser Aman Id.no AgEc/MSc/W/002/14, under our supervision. Therefore we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

Debela Gelete (PhD)		Jan.16/2024
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DEDICATION

I dedicated this thesis manuscript to my wife Mrs. SAMIRA ESUBALEW for her sacrificing her mother without asking for about 20 years up to die, love and care, and to all smallholder farmers who are feeding the mass.

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LIST OF ABBREVIATIONS AND ACRONYMS

BiMAAP	Bishoftu Medicinal Aromatic Agricultural Project
BoA	Buero of Agriculture
CC	Contingency Coefficient
CER	Central Ethiopia Region
CSA	Central Statistical Agency
DAs	Development Agents
DH	Double Hurdle
ETB	Ethiopian Birr
EU	European Union
EXIM	Export Import Market
FGDs	Focus Group Discussion
GDP	Gross Domestic Product
HVLV	High Value Low Volume
KII	Key Informant Interview
NBE	Nationa Bank Of Ethiopia
OLS	Ordinary Least Square
PLC	Private Limited Company
STATA	South Texas Art Therapy Association
SZAD	Silte Zone Agriculture Department
SZPD	Silte Zone Plan Department
TLU	Tropical Livestock Unit
UAE	United Arab Emirates
URAP	Universal Road Access Program
USA	United States of America
VIF	Variance Inflation Factor

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ABSTRACT

Rosemary production and marketing had not given due attention compared to other spices, which has potential production and marketability. Therefore, this study was designed to identify factors affecting production and market participation among smallholder rosemary producer farmers in Silte zone. For this purpose Level of rosemary production, determinants of rosemary production, stage of rosemary market participation and factors affecting rosemary market participation were focused. The study was followed cross-sectional survey research design and the primary data was from rosemary producer household survey using a pre-tested semi-structured questionnaire. Stratification, purposive and random sampling techniques were used to draw an appropriate sample of 385 rosemary producer householders from 10211 total farm householders. The data were analyzed using descriptive statistics and cobb-Douglass production function and double-hurdle econometric model. The descriptive statistics result indicates that smallholder farmers' input use is very low for the production of rosemary (HPI=21.3%) and their participation in output marketing is medium (HPI=66%). In addition the output market participation of the rosemary producers in the area was high (59.2%). The Cobb Douglass production function output revealed that 14 checked independent variables of gender, contact of extension service, rosemary seedling, rosemary farming experience fertilizer use, number of oxen, rosemary farm land size and total farm land size were found to be affect positively the gross rosemary production. Based on double hurdle model results, out of 15 checked independent variables 3 variables (gender, number of oxen and gross rosemary yield) were significantly affect rosemary market participation decision. From those gender was negative factor and the rest were positive factors. And also 6 variables (education, lagged price, rosemary farm land size, market distance and storage) were significantly affect level rosemary market participation. Out of them education, market distance and storage were negative factors and the rest lagged price and rosemary farm land size were positive factors. Therefore the government should improve road facilities, give trainings and awareness creation *to improve production and market participation of smallholder farmers.*

Key words: Rosemary, Production factor, Marketing factor, Double-hurdle, cobb-Douglass production function**,**

1. INTRODUCTION

1.1. Background of the Study

Agriculture remains the backbone of Ethiopian economy with traditional practices that have been handed down through generations still practiced in many parts of the country. It forms one of the largest components of the Ethiopian economy, contributing 32.4% of the country's gross domestic product (GDP)(NBE, 2022), 79% of total export earnings and 71% of employment (Diriba, 2018). Ethiopia is a source of different spices with 18 major agro-ecological zones and various agro-ecological sub-zones. So that having a suitable climate the country produces as many as 50 type of spices, out of which 23 are trading as export items (Goshme & Ayele, 2019). A spice is a dried seed, fruit, root, bark or vegetative substance used in nutritionally insignificant quantities as a food additive for the purpose of flavoring, and sometimes as a preservative by killing or preventing the growth of harmful bacteria (Yimer, 2019). Spices, being a cash crop, have an immense potential for developing countries economy through enhancing the purchasing power of the smallholder farmers job creation and expansion of employment opportunities and distribution of income and foreign exchange earnings and thus helping in poverty reduction and ensuring food security in Ethiopia (Hordofa & Tolossa, 2020). Due to the fact of these spices plays a major role in poverty reduction and livelihoods for smallholder farmers, which is estimated to contribute about 1.2 percent of Ethiopians gross domestic product (GDP) and 5.6 percent of the Agriculture GDP (Jemal *et. al.*, 2021).

Ethiopia is a source country for many spice exports, with a long history of spices. The average land covered by spices is approximately 222,700 ha with production reaching 244,000 tons per year (Goshme & Ayele, 2019). According to (BoA, 2022), spices cover 109,000 ha of land and 1,241,200 quintal of yield in the Central Ethiopia Region (CER) While in Silte zone 9,895.4 ha of spices are cultivated and 168,637.4 quintal of yield was produced (SZAD, 2022).

The start of production and development activities on aromatic plants was started around 50 years back at Wondo Genet College by French investors. At that time, geranium, citronella grass, lemon grass and citrodora are the major spices cultivated and processed. Essential oils used to be exported to European countries until the owners left the country *(Nigussi et. al., 2020).*

Rosemary (*Rosmarinusofficinalis*) is a woody, perennial herb with fragrant evergreen needle-like leaves. It is a member of the mint family Lamiaceae. Rosemary is resistant to water stress and

can continue to grow under drought conditions (Degu, Leulseged, Fikadu, & Melka). Rosemary will remain in the site for 5 years or more, depending on crop performance. One harvest is made per year, with first harvest made in the year after planting and well drained sandy loam soil with pH of 4.5 to 8.7 is ideal for rosemary production (Banjaw *et. al.,* 2016).

According to (Xylia *et. al.,* 2022), Rosemary grows for its leaves and essential oil obtained from stems, leaves, and flower twigs. Both fresh and dried rosemary leaves are used for their characteristic aroma in food cooking or in small amounts as herbal teas, while rosemary extracts are commonly used as natural antioxidants to improve shelf life *(Himed-Idir et al., 2021)*. Rosemary oil is one of rosemary product which used for all variety respiratory problems colds, sinusitis, lung congestion and asthma. The oil is used as perfume in ointments, shampoos and soaps. The leading countries in production of essential oil of rosemary are Morocco, Spain, USA, and Tunisia ((Zigene *et. al.,* 2018); (WOLDEMICHAEL, 2020)). Currently, the commercial cultivation of rosemary contributed a lot in supplying the perfume and pharmaceutical industries which use the essential oils as raw materials (Zigene et al., 2018). Import of rosemary oil by the USA, it has shown a general growth (Gezehagn, 2021).

traditional way of farming, absence of seeds and planting materials, high frequency of weeding, high input requirement, high input cost, lack of drying facility, taking long time to dry, shortage of access to credit and extension, different disease and pests, wild animal competition, poor-quality of output, absence of proper post-harvest handling practices and others are factors affecting production of spices in Ethiopia. While Low output price, poor market access and imperfect market information, capital constraints, limited processing of spices, adulteration, mismatch between demand and spices, transportation problems, unlicensed traders, theft, low government support, lack of value addition, price volatility, weak market research and promotion, poor market infrastructure, lack of effective linkage of stakeholders, lack of capacity building, low bargaining power of producers, limited ability of producers to enter in market due to limited time, skill, and resources are some of the factors that affect spices marketing in Ethiopia (Goshme & Ayele, 2019).

According to (Kifelew *et al.,* 2017), Russian Federation, United Kingdom and Ireland were the leading Importers of Product Rosemary from Ethiopia with a market share of 92.33% with an exports value of US$ 357,500. Russian Federation has a market share with 41.28%, followed by

United Kingdom with 39.34% and Ireland with 11.71%. According to (BoA, 2022), rosemary covers 6,911 ha of land and 124,398 quintal of yield in the region (CER) and while in Silte zone 2,067.9 ha of land was cultivated and 48,039 quintal of yield was produced (SZAD, 2022).

According to (Geyo, 2023), improvements in market participation are necessary to link smallholder farmers to markets in order to ensure sustainable supply and expand demand for these products as well as improve the opportunities for better income generation. Even if it is easy to market fetching good value, the items observed in the homestead rosemary is use for domestic consumption, cultural practice and occasionally for marketing purpose. These herbal items were more available in the fresh state and were also cheaper in the wet than in the dry season. Due to long distance from the markets, some rural women also buy these items in the villages from the small producers and bring them in bulk to the town market, but there were retailers too (Gezehagn, 2021).

In general rosemary is important in terms of job creation, soil and water conservation purpose, for the purpose of income generation (from both local and export), medical purpose, industrial purpose even to make cosmetics and perfume. In addition there are no enough research investigations about rosemary production and marketing factors in Ethiopia as well as in Silte zone while there is high potential production rather than spices (SZAD, 2022). Thus, in order to fill this gap, the title which was factors affecting rosemary production and marketing in Silte Zone was preferred.

1.2. Statement of the Problem

Rosemary is a part of spices and it is produced extensively and used for meal for the human being. Recently, it has been devoted for its producing nearly the same as any other rural smallholder's cash crops. However while reviewing factors affecting rosemary production and marketing, there are no enough materials and studies rather than in spices. Even though some researchers and institutions such as Nigussie, Shabbara and Guta Bukero Geyo, and also wendo genet agriculture research center were tried to investigate and address the issue.

Based on these, Nigussie investigated about rosemary production in intercropping, and their effects on yield and as supplementary income generation. Shabbara also investigated the comparative economic part of the plant, even though in Egypt and India, in terms of cash

(monitory calculation with respect to cost and profit). Guta Bukero Geyo (2023) examined the value-chain of rosemary production. Wondo genet agricultural research center have done many researches for the rosemary plant such as its variety and its successfulness of intercropping with different vegetables, and some of them are still in the process. However these are not enough to enhance the production of rosemary due to having highly demanded in the market and its usefulness.

So knowing the factors those hinder production and distribution of the rosemary product is important and gives clue to overcome the problems with possible solutions. Nevertheless tries were made to examine the problems of production and marketing of spices in general, and korerima and Ginger particularly, but almost all nothing were done to investigate the factors that affect production and marketing of rosemary specifically. More over these researches are conducted in other areas; as a result, little information is available on rosemary production and marketing without such knowledge in Silte zone.

Knowing factors affecting production and marketing of rosemary product and its participants in the study area are important to reduce poverty and susceptibility. There is large number of smallholder farmers producing output for home consumption and local market rather than in competitive market and the levels of marketing are very low compared to the potential in study area. Thus, the marketable output is generally small, because a vast majority of smallholder farmers in the area were dependent on traditional farming and marketing activity. As far as investigated, no sufficient problem solving researches were done to verify the major factors those affect production and market participation of rosemary smallholder farmers in Ethiopia.

In other way, as earlier silte zone farmers were planting rosemary spice for the purpose of home consumption, gardening and amenity value. Since 2020 farmers start to plant rosemary as a farm for the purpose of local market with diversification and this gradually leads the farmers to produce rosemary not only for local market but also export commodity based on the recommendation of different governmental structures' for example agriculture, cooperative, trade and other concerned bodies collaboration extension service mobilization. According to Silte zone agriculture department with starting two years back, the farmers' attention to produce rosemary is declining because of declining rosemary market price and other different problems. Therefore, to fill this gap and to recommend solutions for the current problem, the researcher

was preferred to study the factors affecting rosemary production and marketing in Silte Zone, Central Ethiopia Region (CER), Ethiopia.

1.3. Objectives of the Study

1.3.1. General objective of the study

The general objective of this study was to examine factors affecting smallholder farmers' rosemary production and marketing in Silte Zone, Central Ethiopia.

1.3.2. Specific objectives of the study

- To assess the level of rosemary production in the study area;
- To identify determinants affecting rosemary production in the study area;
- To examine the stage of rosemary market participation in the study area;
- To determine factors affecting rosemary market participation in the study area.

1.4. Research Questions

- What is the level of rosemary production in the study area;
- What are determinants affecting rosemary production in the study area;
- What is the stage of rosemary market participation in the study area;
- What are factors affecting rosemary market participation in the study area.

1.5. Significance of the Study

Based on this thesis a significant number of authorities, institutions, researchers, students and the wider academia are expected to be benefit from the findings. And also it can contribute a lot in helping the nation achieve its development embarked projects of both governmental and non-governmental organizations. Development and technology diffusion programs, and also farm output enhancing initiations can be informed about factors those affect either production or marketing of rosemary to increase the income and living standard of farmers. This is confirmed by research outputs especially for those smallholder farmers farming and marketing surplus product for local or central/export/ market beyond the home consumption.

In identifying the factors that affect production, marketing and participation with special emphasis on the study areas using several and yet complementary econometric tools right from the simple descriptive statistics to econometric analytical (cobb-Douglass production function

and double hurdle) model (Quagrainie & Chu, 2019). By so the study had shed lighted the factors that affect the production, marketing and participation by comparing the results of the different econometric tools and the study most plausibly had come up with a credible solution of the research question. Researchers and theoreticians in field and different stake holders of agricultural development can also benefit a lot from the study for a very wide discussion on the need of and their application in factor identification.

1.6. Scope of the Study

All smallholder rosemary producer farmers need effective information about production and market strategy and mechanisms. However, this study was focused only in Central Ethiopia Region (CER), Silte district small-holder rosemary producer farmers which comprised analysis of factors affecting production and market participation. Based on these, in order to find out the factors affecting rosemary production and marketing, the study covered two districts of Silte district with four kebeles having two from each district with a total of 385 rosemary producer small-holder farmers. This study was carried out for one year of educational calendar of Werabe University. As it was outlined from the introduction part this study revolved around the factors which affect production and marketing with special emphasis on the small holder farmers in Silte district of Central Ethiopia Region by so employing cross sectional data on a sample of farm householders.

1.7. Limitations of the study

According to the second-stage of double-hurdle (selection) model output, Lnsigma MP or selectivity bias correction factor had a positive impact on farm households' rosemary product market participation at a 1% significance level. And, the positive sign shows that the existence of unobserved factors that positively influenced both participation decision and level of rosemary output marketed. This indicated that sample selection bias and the existence of some unobservable household characteristics determining livelihood to participate in rosemary market.

In addition while testing whither omitted variable was occurred or not the Ramsey reset test value was insignificant meaning that omitted variables were observed during econometric model application (cobb-Douglass production function and double hurdle model).

1.8. Organization of the Study

The thesis consisted of five chapters. The first chapter was the Introductions, back ground, statement of the problem, objectives, research questions, significance of the study, scope and organization. Chapter two reviewed literature related to the research topic, which deals about theoretical, empirical studies and conceptual frame work. Chapter three was about research methodological issues including area description, research approach, design, procedure and methods. Chapter four referred to result and discussion and the last chapter five was about conclusion and recommendation. The final one was references including different appendices.

2. LITERATURE REVIEWS

2.1. Theoretical Review

2.1.1. Operational definition of the main terms

Rosemary (Rosmarinus officinalis):- is a woody, perennial herb with fragrant evergreen needle-like leaves. It is a member of the mint family Lamiaceae spices. Forms range from upright to trailing; the upright forms can reach 1.5 m tall, rarely 2 m. The leaves are evergreen, 2-4 cm long and 2-5 mm broad, green above, and white below with dense short woolly hairs. The flowers are variable in color, being white, pink, purple, or blue (Banjaw et al., 2016).

Agricultural production factors: - the factors which govern the usage of productive inputs (land, labour, fertilizer, seed, machinery, practice etc.) and influences the production of agricultural product (Tamsah & Yusriadi, 2022).

Market participation: refers to any market related activity which promotes sale of produce.

Socio-economic factors: are the factors that influence both the social and economic wellbeing of an individual (Haile *et al.*, 2022).

Institutional factors: are formal and informal rules that govern transaction activities between individuals or among groups of people (Haile et al., 2022)..

Market factors: any external factors that affect the demand for or the price of a good or service (Haile *et al.*, 2022).

Smallholder farmers: Farmers characterized by land holding less than 3 hectares (Girma, 2022).

Theoretical Framework of production and Market participation

Networking Theory According to (Mathewos, 2016) networking in a small firm context is an activity in which the entrepreneurially oriented producers build and manage personal relationships with particular individuals in their surroundings. According to (Mengesha, 2018), strategic cooperation and networks are the means that allow producers to compete and innovate in dynamic business environments. Therefore, the success of a firm depends on its collaboration with other organizations that influence the creation and delivery of its products

or services (Momanyi, 2016). Networks play an important role in business due its value creation, in terms of gathering information and provision of the infrastructure to communicate, purchase, sell products and 19 services and collaborate with others (Mathewos, 2016). Moreover, networks offer interactive, personal relationships with individual consumers, and offer an opportunity to understand individual preferences and needs (Mpombo, 2022). Therefore, networks and relationships are important for smallholder farmers because they enable these farmers to link activities and tie available resources together, to identify new market opportunities and contribute to building market knowledge and the absence of networks hinders the producers' efforts to expand into multiple markets (Mpombo, 2022). This theory is of importance in this study as it underpins the presence of intermediaries in the networking channels from farmers' or middlemen's consolidation centers that link spice farmers and spice traders in activities such as transporting the products between these two nodes, insurances, consolidating and packaging (Mugera, 2022).

Power-Dependency Theory Power-dependence theory is the name commonly given to the social exchange theory originally formulated by Richard Emerson (Cook, 2015). As the name suggests, the dynamics of the theory revolve around power, power use, and power-balancing operations, and rest on the central concept of dependence. Mutual dependence brings people together; that is, to the extent that people are mutually dependent, they are more likely to form exchange relations and groups and to continue in them. Inequalities in dependence create power imbalances that can lead to conflict and social change. Power and dependency are generally considered as important concepts in understanding buyer-seller relationship (Osmani *et. al.,* 2015). A high level of interdependence is an indicator for a strong, cooperative and 20 long-term relationship characterized by mutual trust and mutual commitment (Opata *et. al.*, 2020). A close and lasting cooperation between supplier and buyer leads to improvements in quality, delivery reliability and cost reduction (Osmani *et. al.*, 2015). Power is the major means available to achieve coordination and cooperation among channel members (Özyazici, 2021). This could be in the form of high level of commitment, cooperation and trust. This theory is helpful in this study as it asserts that the level of power and dependence is a critical determinant of business partnership existence between the spice farmers and traders. It is, therefore, necessary to assess Power- Dependency relationships in order to find out how power distribution influences spice market participation.

2.1.2. Global production and marketing of rosemary

Internationally, India, China and Mediterranean countries like Spain, Turkey, etc. are major producers of rosemary; whereas America, Japan and European countries reported to be major importers of rosemary. Both the leaves and essential oils of rosemary are greatly demanded worldwide (Sharangi & Acharya, 2018).

The trade in spices is one of the oldest and has been one of the most important forms of commerce. Like the trade of silver and gold, spice trade connected many different civilizations and helped the growth of global contact (Sustainable spices initiative India, 2018; (Pradhan, 2018)). The trade was developed throughout Asia and the Middle East in around 2000 BCE. There are around 40 to 50 spices of global economic and culinary importance. Global consumption of spices is expanding steadily with growth rates of between 2% and 5% per annum and total production of spices was estimated at 7.8 million MT per annum and global trade in spices was estimated at 1.5 million MT per annum in 2013, of which exports to developed economies in the EU, USA and Japan accounted for 700,000 MT. Domestic consumption of the spices was high and there is a shortage in supply for most spices. The gap between increased demand, insufficient supply and speculation results in a steady increase of prices. For example, prices for spices imported to the EU from developing countries increased by 6.8% per year on average between 2010 and 2014 (Hibst, 2020; (Pradhan, 2018)).

The majority of this volume is consumed locally. India being one of the largest producers of spices (800,000 MT), followed by Indonesia, with a production of 400,000 MT. Total volume of spices exported in the world is estimated at 600,000 MT. Black and white pepper account for nearly one-third of the spices and of which 100,000 MT is exported from Vietnam alone. The EU is a major importer of tropical spices with an annual volume of 220,000 MT. North America imports 130,000 MT(Momin *et. al.*,2018; Wako, 2020).

Global demand for fresh and dry leaves of rosemary has increasing trend in both price and quantity (Industry, 2021). Besides, global demands for rosemary essential oil have increasing trend Population growth, growing knowledge of the advantages of rosemary products, rising popularity of organic foods and substances, increase in health problems, increased consumers interest for organic natural products, and growth in industries thought to be the major reasons

behind the increment of rosemary products (Opata *et. al.,* 2020). Due to the high demand for it as a food additive and a food/drink ingredient, the rosemary extracts market was estimated at USD 215 million in 2019 and is anticipated to grow at an annual rate of 3.7 percent between 2020 and 2025 (Industry, 2021).

2.1.3. Rosemary production and marketing in Africa

African spice producers mainly focus on domestic and regional market. Spices trade between African countries and between Africa and the Middle East and India is estimated at 300,000 MT per annum. It mostly comprises of exports from Nigeria, Ethiopia, Tanzania and Côte d'Ivoire to Uganda, Kenya, North Africa, Middle East and India. Ethiopia is one of the largest consumers of spices in Africa and grows many spices, used not only to flavor bread, butter, meat, soups and vegetables, but also to produce medicines and perfumes. Most of the spices produced (>90%) are consumed domestically. So far Ethiopia is not recognized as a major exporter of spices, and the contribution of spices to the national economy is low and it represented 0.8% of the total export value in 2013(Mengesha *et al.,*2018). However, looking at the export of spices by destination, in 2009/10, Sudan is the leading importer of spices from Ethiopia (with a 38.4% share of value of total spices export from Ethiopia), followed by India (10.4%), and Yemen (8.6%). Other important importers of spices from Ethiopia are: UAE (8.3%), Saudi Arabia (6.7%), Morocco (5.8%), while Singapore and Jordan have a share of 3.2% and 3.1% respectively. Spice exports in 2013 and 2014 amounted to 15,000 MT per annum, representing a value of US$26 million in Ethiopia (Woldetsadik *et al.,* 2023).

2.1.4. Smallholder farmers, production and marketing of rosemary in Ethiopia

At the farm-level, key production constraints faced by farmers are the shortage of land, limited knowledge on the production knows how and diseases and pest attacks in their order of importance (Woldetsadik *et al.,* 2023). Concerning market constraints low price followed by cost of marketing. This will fear producers to not expand Aromatic and medicinal plants production and marketing (Mengesha *et al.,*2018). Rosemary farmers suffer from poor post-harvest handling techniques, leading to significant losses, which affect returns to the farmer and traders. Furthermore, farmers do not have good drying and storage facilities available at the farm level, and this forces them to sell their fresh product immediately after harvest. On the other hand

disease and pest attacks as the major problems most of the time farmers are not well trained on pest and diseases control measure on their rosemary cultivation (Geyo, 2023).

According to Ethiopian Institute of Agricultural Research (Kifelew et al., 2017), the standard set by the International Standard Organization (Lagiso *et. al.,* 2020) known by its identification number (ISO 11164:1995), states the quality requirements for dried rosemary. According to the ISO standard the dried leaves of rosemary should contain a minimum of 1.2% volatile oil, maximum of 10% foreign matter, maximum of 2% woody stems, and a maximum of 7% ash. In Ethiopian export product value share the first one is coffee, Tea and Spices (including Rosemary) (Mengesha *et al*.,2018). Russian Federation, United Kingdom and Ireland were the leading Importers of Product Rosemary from Ethiopia with a market share of 92.33% with an exports value of US$ 357,500. Russian Federation has a market share with 41.28%, followed by United Kingdom with 39.34% and Ireland with 11.71% (Jemal *et al.,* 2021).

In Ethiopia, a considerable amount of plant-derived chemicals and their derivatives are imported by an alcohol, soft drink, soap, detergent, cosmetic, pharmaceutical, food, textile, paint, pulp and leather industry. An average of 1,736.5 tons of essential oils and related products are imported per year with an average of about 37 million Birr. Although there is no data about the amount of essence imported by private liquor factories, based on the pure alcohol amount they buy from National Alcohol and Liquor Factory, it is estimated that they import half of the amount. This makes the total amount of imported essence 21,750 kg and the total money spent by liquor factory is estimated at about 6 million birr (Melanie & Michael, 2011).

From 2001 to 2004 Ethiopia spend more than 50 million birr by importing more than 200,000 kg of essential oils during four years. This huge amount of money is an indicator that the demand oil is very high in the country. Despite the sector is lucrative, the number of participants in production and processing of essential oils in the country to fill up this demand good. This might be due to lack of information and technologies about the production and processing of essential oils or awareness about this sector. Therefore, much is expected from technology generating bodies and government officials in such a way that local and international producers and processors of aromatic plants to be involved in the sector and save huge amount of money (Gebreyesus, 2016).

So far, local production of essential oils and other related plant extracts has hardly established. Few years ago, the pilot scale production of essential oils by the Essential Oils Factory with a capacity of 1 tone/year, which had changed itself to the only research center engaged on aromatic and other oil bearing plants. Recently, new investors on such sector are involving. Tabor herbs Private Company, Ariti Essential Oil Company, Bishoftu Medicinal Aromatic Agricultural Project (BiMAAP), and Abyssinia Essential Oils plc are some of them (Kholif *et al.*, 2017).

According to (Dessie *et al.* 2020) as plant spices have a wide possibility of being cultivated in different agro ecological zones of the country. Except pepper (capsicum annum) spice cultivation is traditional, no improved seed or planting material. The cultivation practice and technique are highly based on knowledge that passed from generation to generation and production level is low. Spices are used as flavoring material, source of essential oil, source of color and cash crop of many smallholders. The cultivation practice in smallholders' farm is fragmented and planted as mixed crop within their main crop land and rain fed. High frequency of weeding and high input requirements including seed and fertilizers, high cost of production could result in loss of market prices are below the expected level as there are irregularities (Goshme & Ayele, 2019).

In addition, due to lack of facilities for drying, long time is required to dry by using traditional practices that lead to development of fungi during wet weather condition contributing to low market price (Geta & Kifle, 2011). Inadequate fertilizer supply, inadequate planting materials, shortage of access to credit and wild animal competition were some factors affecting spices production (Gebreyesus, 2016).

According to (Yimer, 2019), lack of high yielding verities, need for improved spice agricultural research in existing and new and locally adaptable varieties that offer opportunities for increased yield, poor quality of final output ,weak role of private commercial investors in spices production, irregular supply and variable quality of spices produced from forest and agricultural landscape, lack of proper post-harvest handling practices, post-harvest wastage/spillage and product quality deterioration, lack of use of appropriate modern technologies in farm management, drying, storage, etc… and lack of appropriate spices development strategic interventions were some of factors affecting production of spices (Dessie *et al.* 2020).

According to (Kifelew et al., 2017) limited production technologies developed so far have yet not multiplied and popularized to farmers. Disease like Fusarium wilt, blight, Powdery mildew, Downy mildew, Leaf spot, Root rot, damping off, Rust, Stem gal, Grain mold, and Pest such as Aphids, Mites, Stick-bugs, leaf-eating caterpillars are constraints that leads to overall reduction in productivity and quality of production system. According to (Melanie & Michael, 2011), states that often small-scale farmers cannot get good seed adapted to their conditions; poor seed can affect productivity and encourage the spread of disease. Fake seed sold by unscrupulous traders is a major problem in many areas of Africa, access to finance, equipment and processing expertise are also difficult (Dessie *et al.* 2020).

Smallholders are limited in their abilities to enter supply chains and become active players of fostering business relationships and linkages. Limited time, skills and resources may be a constraint on small-scale farmers' ability to become active players in supply chains (Matthews & Jack, 2011). Low average output price was found negatively influence marketable supply of spices (Dessie *et al.* 2018). Most common constraints are capital issues, imperfect market information and poor market access (Rutgers, 2010). There is a limited business activity in production, processing and marketing of spices and spice products (Dessie *et al.,* 2020). Adulteration problems, quality problems, capital shortage, demand problem, lack of government support, supply shortage, problem of transport, theft problem and absence of government control on unlicensed traders were determinant factors of spices marketing (Gebreyesus, 2016).

According to (Hibistu, 2020), challenges demanding strategic and routine tasks which call for concerted efforts of all stakeholders from federal to regional levels were limitation of extension services to build the capacity of spices producers and value chain players, lack of improved technologies and research services to ensure efficient production and supply of quality spices, lack of modern marketing system to properly guide the production, processing and marketing of spices, lack of effective and efficient spiced value chain service delivery mechanism and challenges to channel the spices products to the international market through market promotion and creation of market links (Matthews & Jack, 2011).

Keeping spices in store for long in expectation of higher prices, adulteration of inferior varieties with better ones for marketing, poor quality of spices traded due to highly traditional pre and post-harvest handling practices; adding water to increase weight and also color/appearance,

increasing role of unlicensed brokers in the trading of spices in the market, weak marketing system not stimulating production and marketing based on enforceable quality standards, lack of value addition in terms of major agro processing activities in spices, weak organizational capacity of cooperatives/unions, price volatility due to changes in demand and supply in local and overseas markets, lack of organized market information service to the different actors in the spices farm-to-market chain, weak market research and promotion in potential overseas markets for natural and processed spices products were marketing constraints of spices (Yimer, 2019).

According to (Negera, 2015), lack of use of appropriate modern technologies, unlicensed traders and brokers in the trading of spices, poor training program, lack of organized market information service, lack of proper post-harvest handling practices, irregular supply and quality deterioration due to limited commercial investors in spices production, poor access to credit facilities, absence of effective linkage among stakeholders, adulteration of inferior varieties with better ones for marketing, keeping spices in store for long in expectation of higher prices, inadequate processing facilities, price volatility due to changes in demand and supply in local and overseas markets, lack of organized market information service to the different actors in the spices farm to market chain, absence of capacity building like training program, inadequate transport in remote markets specially during wet seasons and challenges from unlicensed traders in spices markets are constraints. Price setting, weighting and demand are the major factors affecting spices production negatively (Gebreyesus, 2016). Spices farmers and traders face low prices, difficulty finding markets, lack of capital for transport and extending production, lack of market information and small volumes to sell (Agize & Zouwen, 2016).

According to (Vijayalaxmi & Sreepada, 2014), the presence of inadequate innovate technologies, post-harvest handling, spice agricultural research, irregular supply and variable quality of spices produced from forest and agricultural landscape, weak role of private commercial investors in spices production, weak business linkage among stakeholders, absence production and marketing based on enforceable quality standards, lack of value addition in terms of major agro processing activities in spices, price volatility due to changes in demand and supply in local and overseas markets and lack of organized market information service to the different actors in the spices are some of the marketing constraints (Matthews & Jack, 2011).

Lack of marketing skills and ability prevents access to potential markets and customers may be lost where there is inability to efficiently deliver the required volumes and quality. Lack of availability of clean potable water and suitable waste disposal facilities may compromise sanitation and hence product safety (Melanie & Michael, 2011). Low access to improved inputs, collateral problem to get credit, poor storage facilities and low price of produce (Abay, 2010). Spices marketing is also affected by poor market information system, limited bargaining power of farmers, oligopolistic market structure in the market and also adulteration, natural quality, capital shortage, demand, government support, supply shortage, access to credit, farmers' reluctance to sell, administrative problems, competition with licensed traders, road, theft, competition with licensed and unlicensed traders, storage, telephone services, information flow, health, unstable prices, packaging, broker, bank service and journey (Dessie *et. al.*, 2017).

According to (Gil *et. al.*, 2010), **t**he price of rosemary either as fresh and dry herb or essential oil forms depends on various factors that include the quality of the product, the cost of production, and the balance between supply and demand. In the local markets of Ethiopia, the fresh leaves of rosemary are sold with a price of up to 50 Birr/kg. Whereas, the dried leaves are sold about 45 Birr/kg. With regard to the international market, the up to date prices of rosemary oils from various origins can be found on giant online marking sites (Mengesha *et. al.*, 2010).

The production essential oil is simple and relatively cheaper than other agro based industries. Large or medium-scale distillation units can be run by farmer groups, cooperatives, or other local institutions and involve a number of small scale farmers as a supplier of raw material. In addition to this, as it requires low capital and technology and agricultural based investment, many countries have involved in production from the cultivation of selected (market oriented) aromatic plant species including Rosemary, as an alternative approaches of integrated rural development projects (Banjaw *et al.*, 2016).

According to (Adafre, 2019), intercropping onion with rosemary in different cropping systems and planting patterns might affect yield due to competition between the two crops compared to sole cropping. The inclusion of onion with 80% a rosemary population density raised yield advantage and competitiveness over sole planting crop per unit area. and also intercropping carrot with rosemary at 25% population density revealed less actual yield loss and maximum intercropping advantageous in terms of yield and income.

2.2. Empirical Literature Review

2.2.1. Level of rosemary production

In Ethiopia, medicinal plants are a fundament in the traditional healthcare system, play a major role in maintaining rural livelihoods as a non-timber forest product, and be an incentive to conserve forests ((Tuasha *et. al.,* 2018); (Guchale *et. al.,* 2021)). It is estimated that 80% of the Ethiopian population depend on traditional medicines for the healthcare of not only humans, but also livestock animals (Tuasha et al 2018; Tegen et al. 2021). Due to the economic affordability, efficacy against certain diseases, and the trust communities have in the medicinal values of traditional medicines, medicinal plants are constantly in demand in Ethiopia (Tegen et al. 2021).

In Ethiopia, the homestead production system to the livelihoods of the rural populations is very important. The number of small-scale producers engaged in homestead plant production is estimated at around 6.0 million (CSA, 2008/09), and is an important source of income for smallholder farmers. The demand for the homestead-based products are rising in both domestic and international markets thus the increase of smallholder farmers' participation in the market becoming more important ((Melese *et. al.,*, 2021); Bezabih & Hadera, 2007; Yilma, 2009). The Highlands of Ethiopia have a good potential in homestead based production for which smallholder farming have diversified from staple food subsistence giving better access to market and higher value commodities.

Many of aromatic plants were available in nature and are grown in the homesteads' villages as they require no inputs and regular planting, being semi-wild they grow and regenerate naturally (Taye *et. al.,* 2024).

According to on average the overall daily demand of fresh aromatic plant biomass of the established distillers averaged to be 1 to 1.5 tones, which requires about 6 ha of farming land. For successful implementation, synchronized planting is required which depends on the location, water availability, area of farmland allocated and the number of farmers involved.

According to Solomon and Beemnet (2011), locally large number of high standard hotels is being opened in various parts of the country with various services like spa and massaging. In addition cosmetic industries, soap factories and detergent making companies are many. Medicinal factories are also found in good numbers. Essential oils being ingredient of many

products of these hotels and factories have high local potential, thereby substituting the current imports (Shilpa, 2022).

2.2.2. Factors affecting rosemary production

Goshme and Ayele, (2019), with title of "Factors Affecting Production and Marketing of Spices in Ethiopia: A Review", showed that, traditional way of farming, absence of seeds and planting materials, high frequency of weeding, high input requirement, high input cost, lack of drying facility, taking long time to dry, shortage of access to credit and extension, different disease and pests, wild animal competition, poor-quality of output, absence of proper post-harvest handling practices and others are factors affecting production of spices in Ethiopia.

Dejene Tadesse Banjaw, Tigist German Wolde, Aynalem Gebre and Bemnet Mengesha (2016) investigated with the title of "Rosemary (Rosmarinus officinalis L.) Variety Verification Trial at Wondo genet, South Ethiopia" suggested the three (WG-rosemary-I, WG-rosemary-II, and WG-rosemary-III) rosemary varieties can easily cultivated in Ethiopia; so that, local producers, investors, research organizations, universities can use them for production and further research purposes.

Ashenafi Nigussie, Muleta Gadissa, Nibret Tadesse (2020), with their in titled project of "Competitiveness and Yield Advantage of Carrot-Rosemary Intercropping over Solitary at Wondo Genet, Southern Ethiopia" find out that intercropping of carrot with rosemary at 100% population density enhanced yield advantage and Competitiveness as indicated by higher land equivalent ratio and relative crowding coefficient. The experimental design was randomized complete block design was used.

Ashenafi Nigussie (2020), on his in titled project "Estimation of Yield Advantage and Competitiveness of Onion-Rosemary Intercropping over Sole Cropping at Wondo Genet, Southern Ethiopia" by using experimental research find out that intercropping of onion with different population densities of rosemary significantly affected dry bulb yield.

Guta Bukero Geyo (2023) investigated on his project title of "Value Chain Analysis of Medicinal and Aromatic Plants: The Case of Rosemary (Rosemarinus Officinalis L.) in Ethiopia" using Descriptive statistics and Inferential statistics such as t-test, chi-square, value chain mapping and

profit margin methods. In this study he suggested that Key production constraints faced by farmers are the shortage of land, limited knowledge on the production knows how and diseases and pest attacks in their order of importance.

Francisco José González-Minero, Luis Bravo-Díaz and Antonio Ayala-Gómez (2020), reviewed on the title of "Rosmarinus officinalis L. (Opata, Ezeibe, & Arua): An Ancient Plant with Uses in Personal Healthcare and Cosmetics" and find that The applications of rosemary in cosmetics, considering its preservative power, the kinds of products in which it is used, and its toxicological safety, as well as its current uses or future applications in topical preparations, according to recent and ongoing studies.

Katarzyna Pawłowska, Katarzyna Janda and Karolina Jakubczyk (2020) on the title of "Properties and use of rosemary (*Rosmarinus officinalis* L.)", find that it deserves special attention, not only because of its unique taste and smell, but also due to a composition that provides health benefits. Its antimicrobial activity has been proven in relation to bacteria, fungi (including yeast) and viruses. Positive effects on the metabolism of carbohydrates and lipids, and the function of the nervous system, as well as hepatoprotective properties have been demonstrated. The plant itself and the extracts and essential oils obtained from it are used in home cooking, and the cosmetic and food industries. It also finds applications in agriculture as an animal feed additive.

2.2.3. Stage of rosemary market participation

Global demand for fresh and dry leaves of rosemary has increasing trend in both price and quantity (Industry ARC, 2021). Besides, global demands for rosemary essential oil have increasing trend. Population growth, growing knowledge of the advantages of rosemary products, rising popularity of organic foods and substances, increase in health problems, increased consumers interest for organic natural products, and growth in industries thought to be the major reasons behind the increment of rosemary products (Kaur *et al*, 2021; Tzimaet al., 2015). Due to the high demand for it as a food additive and a food/drink ingredient, the rosemary extracts market was estimated at USD 215 million in 2019 and is anticipated to grow at an annual rate of 3.7 percent between 2020 and 2025.

In Ethiopia smallholder rosemary farmer's access to markets for higher-value agricultural products is recognized as a vital opportunity to enhance and diversify the livelihoods of lower-income farm households and reduce rural poverty (World Bank, 2008), there is poor attention in this sub-sector by the researchers and policy makers. The species of plants in and around the Ethiopian village homes are traditionally used in providing food, fodder, spices and flavors, medicine, energy, construction material, contribute significantly to the local economy.

The demand for the homestead-based products are rising in both domestic and international markets thus the increase of smallholder farmers' participation in the market becoming more important (Dawit *et al.,* 2004; Bezabih & Hadera, 2007; Yilma, 2009). The Highlands of Ethiopia have a good potential in homestead based production for which smallholder farming have diversified from staple food subsistence giving better access to market and higher value commodities. Most of small holder rosemary farmers being very poor and land scarce, also due to difficult travel, the likelihood of household participation in rosemary market as a seller is strongly influenced by available land (for enough production) and distance to the nearest market (Yilma, 2009).

According to (M.I.Zuberi, 2013), improvements in market participation are necessary to link smallholder farmers to markets in order to ensure sustainable supply and expand demand for these products as well as improve the opportunities for better income generation. Even if it is easy to market fetching good value, the items observed in the homestead rosemary is use for domestic consumption, cultural practice and occasionally for marketing purpose. These herbal items were more available in the fresh state and were also cheaper in the wet than in the dry season. Due to long distance from the markets, some rural women also buy these items in the villages from the small producers and bring them in bulk to the town market, but there were retailers too.

A significant share of rural households may in fact participate in commercialization of what are traditionally considered subsistence food staple crops. This suggests that the distinction of cash versus food crops, as concerns own-consumed goods produced on the farm, is a false dichotomy. In addition rural households participate significantly in the market as buyers rather than as sellers of food grains, negating the long held assumption that smallholders participate in the market to dispose of surpluses following subsistence consumption (Jayne, Snapp, Place, & Sitko, 2019).

And also buying an important aspect of smallholder behavior, but that smallholders may be buying back the same product they have sold at a later date, even resulting in what might be considered “inverse arbitrage” in which producers sell early in the harvest at a low price and buy back the same good in a later period at a higher price. Thus, a key challenge is to understand the dynamic behavior of households as both buyers and sellers of agricultural product, alongside the complex factors underlying their production and market participation decisions.

According to Beemnet *et al.,* (2016), India, China and medetranian countries are major producers of rosemary; whereas America, Japan and European countries reported to be major importers of rosemary. There is a great need to be able to supply high quality product with minimum price in order to enter to aromatic herb market; which is highly competitive and a sort of monopolized by large scale and efficient producers. Currently, on international online marking sites like amazon; depending on its quality; 30ml of pure essential oil of rosemary excluding shipping cost is available at the price starting from 10.6 USD (around 196 birr).

The price of rosemary either as fresh and dry herb or essential oil forms depends on various factors that include the quality of the product, the cost of production, and the balance between supply and demand. The quality and cost of production intern depends on many factors; oil extraction efficiency can highly influence cost of production. In addition, rosemary fresh and dry leaf yield, oil content and yield largely vary depending on many factors including the variety of rosemary used, harvesting age, spacing, crop management and environmental conditions. As the sector is almost new in case of Ethiopia; intense cost benefit analysis and crop management studies are under way.

2.2.4. Determinants influencing rosemary market participation

According to many researches, the production and marketing of spices cultivators and traders is affected by several problems. In the side of producers’ climate changes, High Labor cost, Lack of skilled labors, lack of financial support from the Government, diseases to the spices plants are identified. While in the side of traders Price fluctuations in the market, inadequate storage facilities, Lack of monetary support from the Government, Implementation of Gov’t rules related EXIM policies and inadequate financial facility are identified. In addition to these the price of rosemary either as fresh and dry herb or essential oil forms depends on various factors that

include the quality of the product, the cost of production, and the balance between supply and demand. In the local markets of Ethiopia, the fresh leaves of rosemary are sold with a price of up to 50Birr/kg. Whereas, the dried leaves are sold about 45Birr/kg. With regard to the international market (Elazab et al., (2022)). Both the leaves and essential oils of rosemary are greatly demanded worldwide. In order to benefit from this huge potential market; Ethiopian producers are expected to supply rosemary with good quality and competitive price using modern internet based marketing and advertising tools (Elazab et al., (2022); Tigist et al., (2016)). In order to compare and contrast, with my specific objectives some important and related research findings are discussed below.

Goshme and Ayele, (2019), with title of "Factors Affecting Production and Marketing of Spices in Ethiopia: A Review", suggests empirical evidences showed that, Low output price, poor market access and imperfect market information, capital constraints, limited processing of spices, adulteration, mismatch between demand and spices, transportation problems, unlicensed traders, theft, low government support, lack of value addition, price volatility, weak market research and promotion, poor market infrastructure, lack of effective linkage of stakeholders, lack of capacity building, low bargaining power of producers, limited ability of producers to enter in market due to limited time, skill, and resources are some of the factors that affect spices marketing in Ethiopia.

W. Vibin Hershon and Dr. S. Memukhan Gnanamoni (2018), his entitled project of "A Study on Production of Spices and the Problems Faced by the Cultivators and Traders" using Garrett's ranking technique he find out that he producers problems high labor cost ranks first by the cultivators as the major problem. Lack of skilled labors ranks second, diseases to the spices plants ranks third, lack of financial support from the government ranks fourth and climate change ranks fifth. The traders in spices marketing reveals price fluctuations in the market ranks first by the spices traders as it is the major problem for marketing. Inadequate financial facility ranks second, lack of monetary support from the Government ranks third, implementation of Government rules related to EXIM policy ranks fourth and in adequate storage facilities rank fifth.

Guta Bukero Geyo (2023) investigated on his project title of "Value Chain Analysis of Medicinal and Aromatic Plants: The Case of Rosemary (Rosemarinus Officinalis L.) in Ethiopia" using

Descriptive statistics and Inferential statistics such as t-test, chi-square, value chain mapping and profit margin methods. In this study he suggested that the value chains for Rosemary herbal products have some unique characteristics, which seem to have had little impact on the discussion about value chains in the socioeconomic i.e., it is a market often dominated by small and medium sized enterprises, and one which is governed by diverse regulations relating to the products quality and health claims, which vary widely throughout the world. And also low price followed by cost of marketing are another market problems.

Abdullah Ijaz Hussain, Farooq Anwar, Shahzad Ali Shahid Chatha, Abdul Jabbar, Shahid Mahboob, Poonam Singh Nigam (2009), using experimental research with the title of "rosmarinus officinalis essential oil: ANTIPROLIFERATIVE, ANTIOXIDANT AND ANTIBACTERIAL ACTIVITIES" find out that Rosmarinus officinalis essential oil exhibited antiproliferative, antioxidant and antibacterial activities.

However most of the above and other related researchers try to investigates mostly medicinal, physiological and comparative advantages of the rosemary production. Except Dagnaygebaw Goshme and Tariku Ayele (2019); W. Vibin Hershon and Dr. S. Memukhan Gnanamoni (2018) and othe researchers tries to find the factors those related to spices production and marketing. In addition Guta Bukero Geyo (2023) tries to study the value-chain of rosemary product. Even though the findings of the above researchers are very important, they are not enough to enhance the production of rosemary due to having highly demanded in the market and its usefulness. So knowing the factors those hinder production and distribution of the rosemary product is important and gives clue to overcome the problems with possible solutions.

2.3. Conceptual Framework

The conceptual framework in Figure 1 was illustrated the interrelationships in the study, the key variables involved and how they are interrelated. Socio-economic characteristics are the background factors like (age, education level, gender, household income, family size and marital status), institutional factors like (total livestock unit(without oxen) and storage facility), farmers related factors (farming experience, land holding size (without rosemary land), rosemary farm land size, ownership of oxen, use of improved seedling, contact of extension service deliverers and land preparation mechanism) and market factors like (lagged

prices of output, price information, marketing experience and distance to the market) will be an influential factors on rosemary production and market participation.

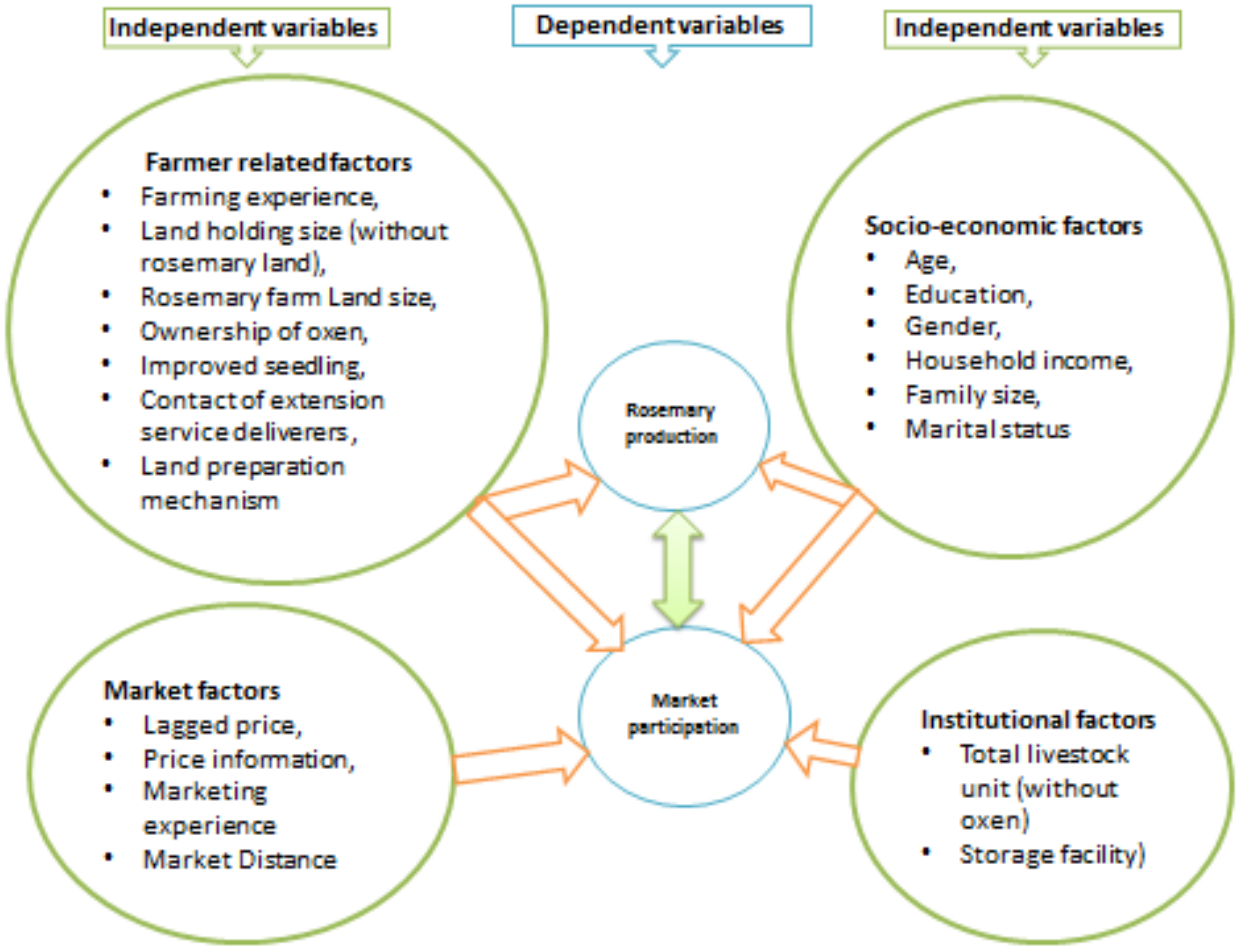

Figure 1:- conceptual frame work of production and market participation of rosemary
Source: own conceptualization, (2023)

In the production side rosemary production is affected by socio-economic factors and farmers related factors directly, and institutional and market factors affect rosemary production indirectly because they affect market participation and as a result participation in a rosemary market will affect the production negatively or positively. In the market side, the four factors (farmers' related factors, market factors, socio-economic factors and institutional factors) affect market participation directly. In addition rosemary production also affects market participation directly.

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

Silte zone is among one of the 7 zones and 3 special districts that forms Central Ethiopian Region (CER) covering an area of 2670.06 square kilometer. Astronomically, it is roughly lie between $70^{0}43^{1}$-$80^{0}10^{1}$ N latitude and $37^{0}86^{1}$-$38^{0}53^{1}$ E longitude. It is bordered with Hadiya zone in south, East Gurage zone in north and North Gurage zone in the North West, in East Oromiya region, in south east Halaba zone. It contains 10 woreda (Dalocha, Silti, Misraq silti, Lanfuro, Mito, Sankura, Misraq azernet berbere, Mirab azerenet berbere, Hulbarag) and 5 city administration (Werabe, Kibet, Tora, Dalocha town and Alemgebeya) districts with a total of 31 urban and 200 rural kebeles.

The capital city is werabe locating on the main road from Addis Ababa to Arbaminch just 172 km apart from Addis Ababa. According to 2007 G.C population and housing census of Ethiopia the population in 2022G.C were about 1,200,762 with 587,762(48.9%) male and 613,609(51.1%) female concerning the settlement 82.17% and 17.83% of the population lives in rural and urban areas respectively. The adjusted household size is 265,967 (Rural 209,455 & urban 56,512) revealing family size of 4.2 in the zone.

Regarding to the climate of the zone it has two main different agro climatic conditions, high land (Taye T.) in the northern parts and temperate (weyna dega) in the eastern parts. The annual rainfall ranges from 780-1818 mm. and the temperature ranges from 12-26C^{0}. The altitude of the zone ranges from 1500 - 3277 mm above sea level. The land use of the zone is 167,288.96 ha cultivated, 21,884.93 ha of grazing land, 33,677.48 ha of forest coverage, 7725.73 ha of water bodies, 16487.95 ha potential cultivable land and 20,882.92 ha is covered by others.

The zone mainly uses multiple cropping systems to maximize production per unit area. According to Silte Zone (Zonal Statically Abstract 2022), the major crops grown in the study area are maize, Teff, Enset (false banana), potato, wheat, barley, pulse, fruits, vegetables, spices, chat and coffee (SZPD, 2022).

Silte zone had covered more than 50 percent of the Central Ethiopian Region (CER) rosemary production coverage with 2,067.9 ha of land was cultivated and 48,039 quintal of yield was

produced (SZAD, 2022). As earlier Silte zone farmers were planting rosemary spice for the purpose of home consumption, gardening and amenity value. Since 2012 EC farmers start to plant rosemary as a farm for the purpose of local market with diversification and this gradually leads the farmers to produce rosemary not only for local market but also export commodity based on the recommendation of different governmental structures' for example agriculture, cooperative, trade and other concerned bodies collaboration extension service mobilization. As a result of this, Silti, Werabe administration, Hulbarag, Alicho and Misraq azernet woredas with specialization rosemary production land coverage were placed in the first up to fifth rank respectively.

The livestock population was estimated about 1,366,828 Cattle, 767,250 Sheep, 483,400 Goats, 2,053,311 Poultry, 72,453 Horse, 312,798 Donkey and 23,877 Mule. The commonly feed sources used for livestock include natural grazing and crop residues.

Now day's digital and automatic telephone service is expanding throughout the zone. The 8 districts have access of asphalt road while the rest 7 districts are URAP road to be connected with in the zone. Mostly electricity is one of modern source of energy used as source of power in industries and residents, while in some areas solar energy is used.

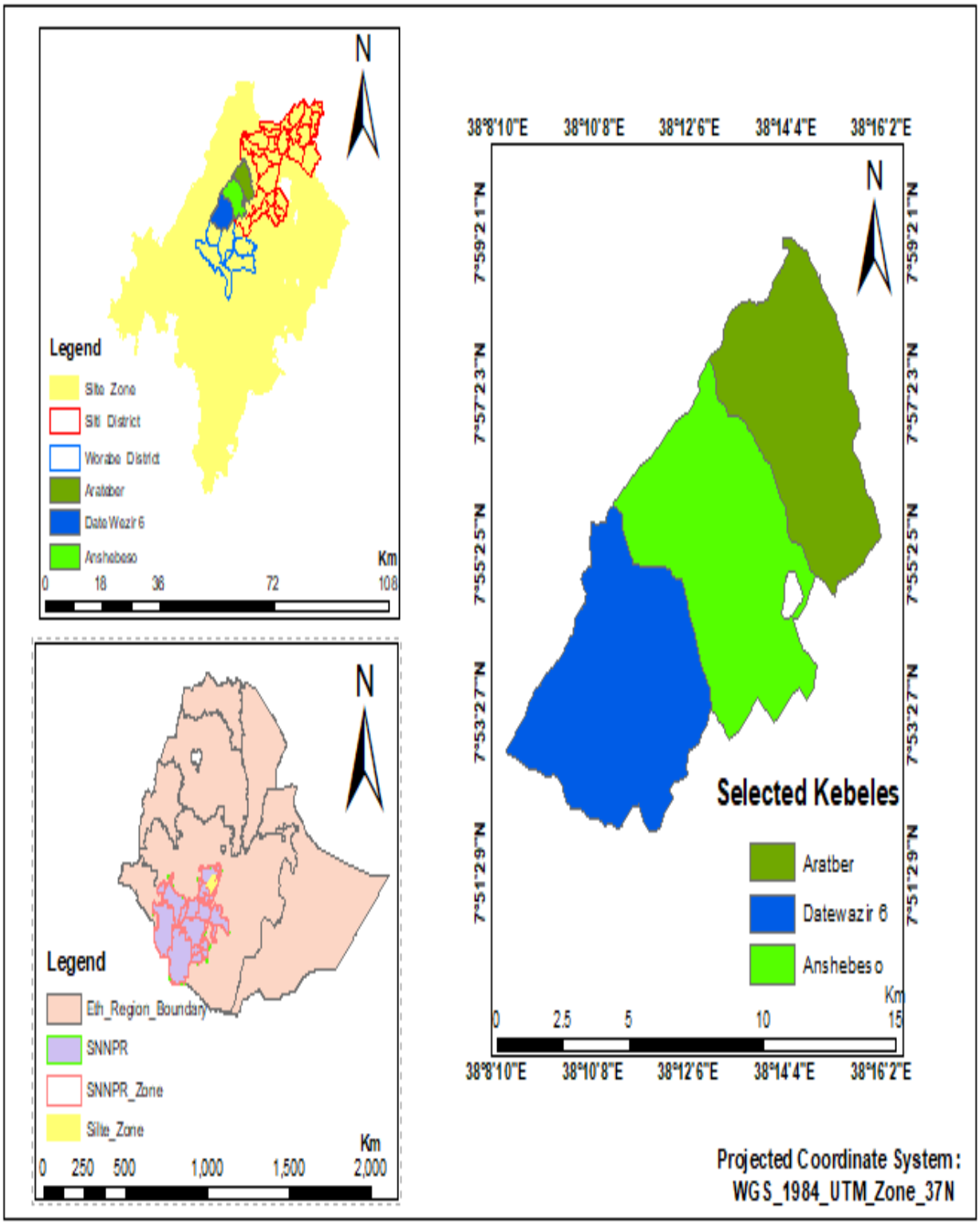

Figure 2:- geographical location map of study area

Source: Silte Zone Plan Department (SZPD, 2023)

3.2. Research Design

The research design for this study was cross sectional survey. This is due to the fact that, cross-sectional design is relatively affordable and less time-consuming to conduct because it includes collecting data at a single point in time. Both quantitative and qualitative methods were used to collect data. The use of the two types of data was believed to provide adequate information that may not be obtained through the use of either quantitative or qualitative approach. As noted Red in our and Newman (2008) the application of multiple methods, triangulating qualitative and quantitative approach methodologies was the most appropriate method of study to reach a level of truth and it enables the researcher to come up with complementary and convergence of facts. In addition, data gathered through various means using multiple instruments was helped to overcome the weakness that could be observed in one instrument (Sedgwick, 2014). Thus, the selected design was used to explain and describe the factors influencing of smallholder farmers in Rosemary production and marketing participation in the study area.

3.3. Sampling Method and Sample Size Determination

3.3.1. Sampling technique

Probability multi-stage sampling techniques were employed. In the first stage from 15 structures were clustered in to two (rosemary producers and non-producers). In the Second stage from the rosemary producers 2 (Silti woreda and Werabe city administration) structures were selected through random sampling method. In the third stage, two (02) kebele (aratber and lay anshebeso) from Silti woreda and two (02) kebeles (tach anshebeso and date wezir 6) from Werabe city administration totally four (04) kebeles were selected purposively, this was due to extent of production and experience in rosemary marketing (SZAD, 2022). Finally in the fourth stage smallholder farm householders were selected using probability systematic random sampling from each rosemary producer Woreda and city administration.

3.3.2. Sample size determination

The primary concern of the study was to include representative and adequate number of sample size. According to Silte Zone plan department (2022), the number of smallholder farmer householders was living 1,916 in Aratber, 734 in lay anshebeso, 5,110 in Tach

anshebeso and 2,451 Date wezir and hence the population size (N) was 10,211 households. The Samples for this study were determined according to the formula for sample size determination for finite and homogenous population was given by (Yamane, 1973).

$$n = \frac{N}{1+N(e^2)} = \frac{10211}{1+10211(0.05^2)} = \frac{10211}{1+10211(0.0025)} = \frac{10211}{1+25.53} = \frac{10211}{26.53} = 384.88 \sim 385$$

Where: - n- The sample size, N -The population size (total household size) in the sampled kebeles and e-Level of precision (for this study 5% precision level was used). Thus, the sample sizes (n) of 385 respondents determined. So, the distribution of representative producers for each kebeles in proportion was as follows.

Table 1:- Number of sample size for selected sample areas

Name of district	Name of the Kebele	Number of household	Proportion	Sample size
Silti	Aratber	1,916	1,916/10,211= 0.19	0.19 * 385 = 73
	Lay anshebeso	734	734/10,211= 0.07	0.07 * 385 = 27
Werabe	TachAnshebeso	5,110	5,110/10,211= 0.5	0.5 * 385 = 193
	Date wezir	2,451	2,451/10,211= 0.24	0.24 * 385 = 92
Total		10,211	1	385

3.4. Types, Sources and Method of Data Collection

3.4.1. Types of data

According to (Creswell, Plano Clark, Gutmann, & Hanson, 2003; Hanson, Creswell, Clark, Petska, & Creswell, 2005), the researcher was applied both the qualitative as well as quantitative research approaches, in order to collect two different types of data; qualitative (for example market participation, price information etc.) and quantitative (for example, rosemary yield, income from rosemary sell, household income, total farm land size, rosemary planted farm land size, tropical livestock unit, oxen, amount of labor used, market distance), simultaneously. Quantitative data type was used for the generation of data in quantitative form, which may be subjected to rigorous quantitative analysis in formal and rigid conditions. While qualitative data type was concerned with subjective assessment of attitudes, opinions and behavior. It was essentially involved to mention the research feelings, opinions, emotions, etc. that cannot easily be quantified and triangulating the quantitative data.

3.4.2. Sources of data

The primary sources of data for this study were 385 small-holder farmer households. In addition agriculture department and office heads, and Directorate directors (Zone in addition to these 5 key informants were interviewed. The researcher had collected secondary data from annual statistics, proceeding government performance reports and documentation related to production and marketing of rosemary by smallholder farmers from kebele, woreda and zone agricultural development. Also other information was gathered in electronic databases that can be assessed and analyzed by the concerned bodies. Additionally, electronic Source, census data, economic data and different official statistics was used.

3.4.3. Method of data collection

The data for the study were collected from 385 respondents. The semi-structured questionnaire solicited information on the major activities and services of rosemary production, marketing and associated with their activities like farmers related and demographic factors. The subjects were selected randomly and surveyed at each producer.

The data were collected through questionnaires, focus group discussions, key informant interview and document analysis. Since, clearly understanding what method/technique of data collection was appropriate for what kind of data is very crucial (Kothari, (2004)). To carry out this research the researcher had carried on documents, household survey (both questionnaire and personal interview), Key Informant Interview (KII) and Focus Group Discussion (FGD) were used. Since the planed sampled size was large and difficult to collect them with in scheduled period of time with the help of enumerators & collaboration of DAs in each kebeles to collect the data.

Semi-structured questionnaire was prepared, revised and dispatched based on the objectives of the study. This questionnaire was administered among selected members. The researcher DAs asked questions by preparing both open-ended and close-ended questionnaires to collect data from the population of selected sample size (385). Hence, this enabled the researcher to describe what factors influencing participation of smallholder farmers in rosemary production and marketing in study area. The questionnaires were prepared to collect information that comprises on main topic; factors affecting production, marketing and participation of small holder farmers

of rosemary market. The questionnaires were prepared in English and for ease of understanding by the researcher and respondents; it was translated in to local languages of Siltigna.

One of the methods used for collecting information was key informant interview. As explained by (Amini *et al.*, 2022), interviews were important to gather information that may not be secured through questionnaire, because they give an opportunity to listen respondents. Therefore, interviews was included Silte zone Agricultural department, Silti woreda and Werabe city administration Agricultural office, and 2 kebeles totally 5 key informants were included from the study area by selecting purposively based on their work experience, rosemary production and marketing experience.

The FGD was used to gather data relating to feelings, opinions and reaction of the sampled members on challenges and determinants on participation in small holder especially in rosemary market. A guideline was prepared and used to facilitate the discussions groups having 10 respondents from each kebeles individually totally 4 FGDs were implemented.

3.5. Method of Data Analysis and Model Specification

3.5.1. Descriptive Statistics

In order to analyze the quantitative data, descriptive and inferential statistics, and econometric model analysis were employed. STATA software version 16 was used for data analysis.

Descriptive analysis:- Descriptive statistics such as minimum, maximum, mean, standard deviation, frequency distribution and percentage were used to describe the status of demographic and socio-economic characteristics of the respondents. Chi-square test was used to see the percentage difference between participants and non-participants of rosemary market for categorical variables. Similarly, t-test was used to see the mean difference between rosemary market participants and non-participants for continuous variables. Moreover, household production index (HCI) was used to identify the level of rosemary production of households. The index was calculated from both input and output sides of production. Tables were used as data presentation tools. Narration, interpretation and conceptual generalization were used to give meaningful information for the qualitative data.

Household production Index (HCI): Household production level was measured from input and output side separately. To measure stallholder's production level (HPL) was used. HPL on input side was measured as the ratio of the value of total inputs acquired from market for rosemary production to the gross value of total annual rosemary produced multiplied by 100. Similarly, HPL from output side was measured as the ratio of the value of total annual Rosemary sold to the value of total quantity of the annual rosemary produced by households, multiplied by 100. Past studies by Kusse *et al.* (2022); Addisu and Gadisa (2022) and Mulualem (2022) used this index to measure smallholder farmers' level of agricultural commercialization. Hence, the HPL formula is mathematically expressed as:

$$\text{HPLi (input side)} = \frac{\text{The sum of the value of input acquired from market x 100}}{\text{The sum of Gross value of rosemary Produced}} \text{----------2}$$

$$\text{HCIi (output side)} = \frac{\text{The sum of Gross Value of rosemary Sold x 100}}{\text{The sum of Gross value of rosemary Produced}} \text{----------3}$$

Where, HPLi= Household Production index of ith household in a given year and expressed as a percentage. HPL has a value between zero and one hundred, inclusive.

3.5.2. Econometric Analysis

Two econometric analyzing models (Cobb-Douglass production function and Double Hurdle model) were used.

Cobb-Douglass production function:- The objective of applying cobb-Douglas production function was to estimate the coefficient of inputs, their marginal productivities, factor shares in total output and degree of returns to scale. This production function was widely applied in empirical studies. Cobb-Douglas production function still today is the most abundant form in theoretical and empirical analyses of growth and productivity. The estimation of the parameters of aggregate production functions is central too much of today's work on growth, technological change, productivity, and labor. Empirical estimates of aggregate production functions were a tool of analysis essential in macroeconomics, and important theoretical constructs, such as potential output, technical change, or the demand for labor were based on them (Chowdhury & Islam, 2015; Hasan *et al.*, 2023).

In order to determine factors affecting rosemary production regression analysis techniques were used. The Cobb-Douglas production function model was used to estimate the coefficients for factors affecting the gross rosemary production. Cobb Douglass production function to analyze the functional relationship between gross production and selected variables, and it was a commonly used model in similar studies ((Temesgen & Tufa, 2017); (Miyamoto *et al.,* 2023)). It was important to analyze the contribution and magnitude of the effect of the several factors that affect rosemary production. The model for rosemary production was specified as following to estimate the degree of influence of various explanatory variables on dependent variable. The matrix form of the equation was given as:-

$$Y = a\, X_n^{bn}\, e^{u} \text{ ----------4}$$

Above equation was linearized into logarithmic form, which was expressed as,

$$\text{Log } Y = \text{Log } a + b_n \text{ Log } X_n + u \text{ ----------5}$$

Where Y= Gross rosemary product in quintal, a = Constant, bn are the coefficients for factor variables, X_n= factor variables, e= Base of natural logarithm, u = Error term.

Double Hurdle model:- Double Hurdle(DH) model is commonly applied to market participation studies ((Amevenku & Asravor, 2023); (Abobi, 2023), (Mather *et al.*,2013); (Komarek *et al.*,2020); (Aristei & Perugini, 2022)). It is adopted to examine the rosemary marketing factors in terms of decision to sell and level of participation. The decision process was assumed to involve two hurdles: the first hurdle relates to whether or not the farmer will sell their product to the market (y^{*}_{1i}), and the second relates to the level/quantity/ of rosemary sold (y^{*}_{2i}). The hurdles involve zeros because some farmers do not sell their product to the market at all. The DH model addresses the zero outcomes arising from the farmers' deliberate decisions, and it is a more general and flexible model than other models such as the Tobit model (Tesfay, 2018) by allowing separate stochastic processes for the incidence and intensity of sales (Jones, 2014).

The DH model allows the decision to sell to buyers and the percentage of sales to be determined by two different stochastic processes. Thus, the model permits the possibility of estimating the first and the second decision processes using a different set of explanatory variables (Jones, 2014). In the first hurdle, the latent variable underlying the producer's decision to sell to the market is represented as a binary process:

$y^{*}_{1i}=\gamma'_1 X_{1i}+\pi_i \qquad \pi_i \sim N(0, 1)$ ----------6

Where $\boldsymbol{X}_{1i}$ is a vector of explanatory/independent/ variables, and π_i is the error term.

The observed decision of the producer is then modeled as:

$$y^{*}_{1i} = \begin{cases} 1, \text{ if } y^{*}_{1i}>0 \\ 0 \text{ otherwise} \end{cases} \text{----------7}$$

In the second hurdle, the latent variable describing the quantity of rosemary product sold to the market is represented as:

$y^{*}_{2i}=\gamma'_2 X_{2i}+u_i \qquad u_i \sim N(0, \sigma^2)$ ----------8

Where u_i is the error term, and the observed quantity is represented as:

$$y_i = \begin{cases} \gamma'_2 X_{2i}+u_i 0, \text{ if } y^{*}_{1i}>0 \text{ and } y^{*}_{2i}>0 \\ 0 \text{ otherwise} \end{cases} \text{----------9}$$

And the $\boldsymbol{\gamma s}$ are coefficients to be estimated.

3.6. Definitions of Variables and Working Hypotheses

3.6.1. Definitions of variables

Decision to rosemary market participation: it was a dichotomous dependent variable that represents the probability of market participation of the household in marketing of rosemary that was regressed in the first step of two stages estimation procedure of double hurdle models (Mpombo *et al., 2022*). In the first stage of double hurdle model, examined the decision to sell the product. Therefore the farmers who participate in the rosemary market take the values of 1, otherwise it taken the values of 0 for the farmers who do not participate in the market.

Amount of rosemary sales (SRP): It was a continuous dependent variable in the second step of the double hurdle model and it was measured in quintal implying the quantity of rosemary product sold to the market and represented the actual supply by rosemary farm household to the market in the survey year. The variable was used as a dependent variable to analyze the factors that influenced the extent to which farmers had decided to sell (the amount of sales, based on the decision to participate in the market) by using ordinary least square method (OLS) estimators.

Amount of rosemary produced (Y): It was a continuous dependent variable in the cobb-Douglass production function model and it was measured in quintal implying the gross rosemary produce in the survey year. The variable was used as a dependent variable to analyze the factors that

influenced the farmers' rosemary production by using multiple log linear regression function estimators.

Age of household heads: It was a continuous variable measured in number of years. A study conducted by (WOLDEMICHAEL, 2020) confirmed better experience and wise resource use of older household heads and he revealed positive effect of age on market participation and marketable surplus. Thus, if the self-sufficiency preference or attitude towards risk of households would change as the household grows older, it would be expected a U-shape or an inverted U-shape relationship between age of the household and volume of output sold(Haile *et al*.2020). Most probably there would be positive relationship in the production and negative relationship in the marketing.

Sex of the household head (GEN): This was a dummy variable that takes a value of one if the household head was male and zero, otherwise. Male headed households, due to their potential rosemary production efficiency advantaged over female headed households, were expected to be more market oriented, and to sell more produce (Serkalem *et al.,* 2014). Similarly, in this study sex of the household head was expected to affect volume of rosemary produced/sold positively.

Educational status of the household headed (EDU): It was categorical variable that represented 0 for uneducated, 1 for primary attended, 2 for secondary attended and 4 for diploma and above attended years of schooling of the household head. This variable reflected the ability to retrieve and interpret information. A study conducted by (Mehraban *et al.,*2022) revealed that the education had key role to promote commercialization of agriculture. Literate or households with higher grade education are expected to have better skills, and better access to information and ability to process information. This helps them to produce efficiently and thus positively associated with a volume of produce sold. And it is also possible that education could increase the chances of the household head earning non-farm income. This could reduce the household dependency on agriculture and thus market participation. Therefore, the direction of the effect was ambiguous (controversial). Even though most probably positive relationship in both production and marketing.

Lagged price of rosemary (P): It was a continuous variable and measured by Ethiopian Birr. Farmers that received a high market price for rosemary produced more and increased market surplus. (Musumba *et al.,* 2022) found that output price positively influenced both the probability

and intensity of market participation. In addition, (Kalawa *et al.,* 2022) found that output price had a positive impact on the intensity of market participation. The same was true for this research for marketing participation.

Uses of fertilizer (F): Uses of fertilizer was a continuous variable which was measured in quintal. Fertilizer was increased the productivity especially to Depreciated Land and it was expected to positive influences on both production and market participation (Getachew, 2021; Sarkar *et al.*, 2020). It was expected a positive relationship with rosemary production.

Improved seedling (SDL):- It was a discrete variable which was measured in pack/bundle. Uses of improved seedling by smallholder farmers enhance market participation by ways of its contribution to surplus production (Getachew, 2021; Sarkar *et al.*, 2020) So it was affected positively in both production.

Ownership of oxen (OXN): It was a discrete variable and measured as the number of oxen owned by the household heads. The aim of this variable was to know impact of number of oxen on households' volume of production and sale through their impact on the volume of product (Fufa & Hassan, 2003). Similarly, in this study, the researcher was hypothesized that farmers who own more number of oxen would have more output production and market participant than others. This was because; oxen ownership would help farmers to carryout agricultural operations like plowing, sowing and others on time that would improve productivity.

Distance to the market center (MDC): it was a continuous variable measured as average distance to market center in kilometers. Near road accessibility can had important influence on markets from both the supply and demand side because it reduces the imperfect information and transaction costs. (Binswanger-Mkhize & Savastano, 2017) identified that the lack of roads is a significant barrier to the ability to respond to agricultural supply. Similarly in Ethiopia, (Abebaw *et al.,* 2023) and (Tegegne *et al.,* 2022) and other authors also examined that marketing costs is completely hindering or limiting the level of smallholder market participation. Hence, in the present study was hypothesized to affect market participation negatively.

Income from on farm/off farm/non-farm activities other than rosemary (HHI): It was a continuous variable measured as the total income earned from wage employment, self-employment activities, farm activities and remittances in Ethiopian Birr. Income from off farm /non-farm activities was expected to supply the cash requirement of the household. A study

conducted by (Bekele & Georgis, 2023) found less commercialized group of farmers following income diversification, share cropping and off-farm and non-farm employment strategies more than the highly commercialized group during his surveyed year. The same authors revealed that, off farm /non-farm income had significant negative effect on the level of crops market participation. In this study, the impact of this variable was expected to affect quantity of sale negatively.

Family size (HHS): it was a discrete variable and represented the number of potential active family members participating in agricultural activities which was measured in man/woman equivalent in general rosemary production and marketing in particular for the proper management of farm operation. Thus, households with higher endowment with labor were expected to participate in market participation of their produce. Thus, a positive relationship was expected for market participation and negative relationship with production (Mefekir, 2019). The same expectations were for this study.

Amount of land allocated to rosemary (RFLS): This variable was a continuous variable measured by number of hectares allocated and it was expected to affect the household market participation and level of rosemary marketed surplus positively. (Helfand & Levine, 2004; Mugera & Langemeier, 2011; Qiao *et al.*, 2022) Argued that producers who own large area holding could produce more than a producers who own less area and thus to supply more to the market. So it was expected to affect production positively.

Total farm land landholding other than rosemary land (TFLS): it was continuous variable and measured in hectare. It is the total land owned by a household. According to Geremew (2012), households who have larger land size more participate in production of cash crops than those who have smaller land size. Thus, landholding was hypothesized to affect production and market decision positively. The finding of Quy and Payuabon (2016) showed that land size positively and significantly affected level of marketing. The study by Ouedraogo *et al.* (2018) also indicated as land holding increase the level of market among household increases. Larger farm size may enable farmers to produce and sell more cash crops. Therefore, it was expected to determine production positively.

Market price information (MPI): it was dummy variable that takes values 1 if the household have access to market information and 0 otherwise. Farmers market decision were based on market

price information, poorly integrated markets may convey inaccurate price information, and leading to inefficient product movement. It was hypothesized to positively influence the volume of Rosemary marketed of small farmer households. Because, producers that have access to market information were likely to supply surplus product to the market. (Mushi *et al.,* 2022) found that if producer gets more market information, the amount of supplied to the market increases. Hence the effect of this variable in this study was similar expectation.

Experience of Farmer's (FEP/SEP): it was discrete variable and measured by number of years of participation in rosemary production or in selling rosemary produce. It could help to produce more marketable production. Those who were risk taker were willing to transport their farm produces to distant places while risk averse, always alternative to sell at farm-gate. (Onuwa & Folorunsho, 2022) stated that the farm gate sale tends to reduce farmers‟ revenue since the prices are relatively low. So the expectation for this variable in this study was the same thing. So it affected both positively.

Extension Service (EXT): it was frequency of gaining extension service delivers and a categorical variable having daily, weekly, monthly and quarterly. This was affected production and market participation positively (Tamsah & Yusriadi, 2022). And the expectation for this study was the same.

Livestock holding (TLU): it was continuous variable measured in the Tropical Livestock Unit (TLU). It represented a total number of livestock owned by household. The study by Chala and Chalchisa (2017) indicated positive relationship between number of livestock owned and level of market participation. Asfaw (2020) found that positive relationship between livestock ownership and level of output market. On the other hand, as the households‟ have more livestock endowment, their market participation and degree of output market decreases (Anuto, 2021; Kusse *et al.,* 2022). And households who have larger livestock size allocate less land to production because they may use larger land for grazing (Chala and Fikiru, 2021). As a result, livestock owing was hypothesized to affect rosemary marketing positively.

3.6.2. Hypotheses of variables

Table 2:- summary of rosemary marketing explanatory variables

Variables	Symbol	Description	Variable type	Expected sign on marketing
Surplus rosemary product	SRP	Marketable quantity of rosemary product in quintal		
Age	AGE	Age of household heads	Continuous.	-
Sex	GEN	1 for Male, 0 for Female	Dummy	+
Education Level	EDU	Educational status of household	categorical	+
Ownership of oxen	OXN	Number of oxen	Discrete	+
Market Distance	MDC	Distance	Continuous	-
Extension service	EXT	Frequency of gaining extension service delivers	Discrete	+
Household Income	HHI	Income from non- farm	Continuous	-
Family size	HHS	Number of family	Discrete	+
Amount of land allocated for rosemary	RFLS	cultivated land by Rosemary	Continuous	+
Market price information	MPI	1 for have info. 0 otherwise	Dummy	+
Price of rosemary	P	Price of sell rosemary	Continuous	+
Livestock holding	TLU	Total livestock unit	Continuous	-
Labor	LAB	Number of family/hired labor	Discrete	-
Selling experience	SEP	selling experience of rosemary production year	Continuous	+
Store	ST	1 for having store otherwise 0	Dummy	-

Source: own computation (2023)

Table 3:- summary of rosemary production explanatory variables

Variable	Symbol	Description	Variables	Expected sign on production
Gross production	Y	Gross rosemary production in quintal	Dependent variable	
Age	AGE	Age of household heads	Continuous	+
Sex	GEN	1 for Male, 0 for Female	Dummy	+
Marital status	MST	0 for single, 2 for married, 3 for divorce/widowed, 4 for polygamy	categorical	+
Education Level	EDU	Educational status of household	categorical	+
Seedling	SDL	rosemary seedling in bundle	Discrete	+
Fertilizer	OIF	Amount of organic fertilizer in quintal	Continuous	+
Labor	LAB	Number of family/hired labor	Discrete	-
Amount of land allocated for rosemary	RFLS	cultivated land by Rosemary in hectare	Continuous	+
Ownership of oxen	OXN	Number of oxen	Discrete	+
Extension service	EXT	Frequency of gaining extension service delivers per week	Discrete	+
Family size	HHS	Number of family	Discrete	-
Land holding size	TFLS	Total farm Land size owned	Continuous	+
Land preparation mechanism	LPM	1 for hand digging, 2 for oxen otherwise 3	Categorical	+
Farming experience	SEP	selling experience of rosemary production in year	Continuous	+

Source: own computation (2023)

4. RESULTS AND DISCUSSIONS

4.1. Respondents' Demographic and Socio-Economic Characteristics

Under this section the demographic and socio-economic characteristics of sample respondents were presented in relation to rosemary production and market participation.

4.1.1. Socio-Economic Characteristics of respondents'

Resource ownership is characterized in terms of livestock and land owned (Table 4). The livestock species found in the study area are cattle, goat, sheep, donkey, mule, horse and poultry. Livestock is kept both for generating income and traction power. To assess the livestock holding of each household, the Tropical Livestock unit (TLU) per household was calculated. In terms of tropical livestock unit (TLU), respondents had an average of 5.46 TLU.

Table 4 :- Descriptive result of continuous variables

Continuous Variables	Mean	Std. dev.	Min.	Max.
Total farm land size (TFLS)	1.477597	.635162	0.125	3
Rosemary farm land size (RFLS)	.6592727	.2332283	0.125	1.25
Tropical livestock unit (TLU)	5.462909	2.107276	0.52	10.49
Market distance (MDC)	8.890909	3.112231	1	17
Gross Rosemary yield in quintal	22.25714	5.679721	9	36
Surplus Rosemary yield in quintal	16.19481	8.888544	0	36

Source: survey data and own computation (2023)

The result showed that average land holding size of the overall sampled household was 1.48 ha with minimum of 0.125 and maximum of 3 hectare. Results showed that rosemary producers on averagely get 22.3 quintal with maximum of 36 and minimum of 9 quintal and average sale of rosemary producer in a year 2022 was 16.2 quintal with maximum of 36 and minimum of 0

quintal (Table 4). Respondents traveled 8.89 km on average to reach nearest market for farm output marketing with maximum distance of 17 km and minimum distance of 1 km. (table 4)

4.1.2. Socio-demographic characteristics of respondents'

As indicated in table 5, the sample respondents were composed of both male and female-headed households. From the total sample, 87.79 percent were male headed households and 12.21 percent were female headed households (table 5). Marital status of respondents was 9.8 percent unmarried, 81.04 percent married; 3.64 percent divorce/widowed and 5.45 percent polygamy.

As indicated in the table 5, More than one third of rosemary producers practiced land preparation with hand digging without oxen plough (39.48 percent). On the other hand, 37.14 percent of producers used both hand digging and oxen plough, and few farmers (23.38%) used oxen plough. Since the culture of rosemary cultivation is intermixed with degraded and sloped, land under such situation is difficult for oxen plough. Due this condition farmers clear land to remove some large grasses and bushes and let rosemary to expand around the area freely on the cleaned land without any sufficient management practices. Land preparation before the rosemary plantation got little attention in the area. Reports from other parts of Ethiopia also showed that one of the factors limiting production of spice in Ethiopia is sub-optimal agronomic practices. Despite land preparation has great impact on the productivity of spice crops, farmers give prior attention to food crops (cereal, Enset, etc…) while giving little attention to rosemary production (Tesfa *et. al.,* 2017).

It is surprising that there was almost no improved varieties user of the rosemary spice and all farmers used long stayed local. The absence of improved variety limited producers' production and productivity improvement capability as they were simply struggling with local variety coupled with problems of low yield and climate change effect. The rosemary species can easily be planted or propagated from both cuts and rootstalks (Mulatu *et. al*., 2020).

Table 5:- Descriptive result of dummy, categorical and discrete variables

Discrete variables		Freq.	Percent
sex of respondent	female	47	12.21
	male	338	87.79
	Total	385	100.00
marital status of respondent	single	38	9.87
	married	312	81.04
	widowed/divorced	14	3.64
	polygamy	21	5.45
	Total	385	100.00
land preparation mechanism	hand digging	152	39.48
	oxen plough	90	23.38
	both	143	37.14
	Total	385	100.00
rosemary seedling source	local	375	97.40
	improved	10	2.60
	Total	385	100.00
Market price information	No	26	6.75
	Yes	359	93.25
	Total	385	100.00
Number of oxen (OXN)	0	0	0
	1	100	25.97
	2	190	49.35
	3	95	24.68
Education level (EDU)	Uneducated	0	0
	Primary	288	74.81
	Secondary	38	9.87
	Diploma & above	59	15.32
Household size (HHS)	1	60	15.58
	2	85	22.08
	3	82	21.30
	4	80	20.78
	5	78	20.26

Source: survey data and own computation (2023)

According to the report from the survey result, almost 97.4 percent of respondents were familiar with this practice (table-5). Due to this practice, the use of seedling for plantation was weak as only very few farmers practiced. During focus group discussion, participants mentioned that planting of suckers from seedling via nursery management gives high yield than directly cut and planting. Reports showed that little attention was given regarding establishment of new plantations in the sector (Mulatu and Gadisa, 2020).

Market price information was important of effective and efficient production and marketing of a commodity. Regarding access of market information, nearly 6.75 percent of respondents told that they had no price information. On the other hand, those farmers who have accessed also hesitate about the quality of information they got. Major source of information were traders and neighboring famers (Table 5).

As indicated (table 5), 25.97 percent, 49.35 percent and 24.68 percent of the respondent have 1, 2 and 3 number of oxen respectively. The highest number of the respondents' which was 74.81 percent has an educational level of primary. The rest of 9.87 percent and 15.32 percent were secondary and diploma/above education level respectively.

The table-5 result showed that 15.58 percent, 22.08 percent, 21.30 percent, 20.78 percent and 20.26 percent of the respondents have a family size of 1, 2, 3, 4 and 5 respectively. Since rosemary production is known by its huge labor employment, this condition would be considered as good opportunity if participated in the rosemary production efficiently.

4.2. Level of Rosemary Production

Commercialization level of smallholder farmers in the study area was examined both on input side and output side. Household production index (HPI) was used to measure household commercialization level among the sample respondents. The formula was used by previous studies (Nwafor, 2020; Kifle *et al,* 2022 and Mulualem, 2022) to measure household commercialization level. They are discussed below from both input and output sides separately.

The input production level was measured by Household Production Index (HPI) which was calculated as the ratio of the value of all inputs obtained from the market for the production of rosemary to gross value of rosemary produced in 2021/2022 production season multiplied by

100. The value of inputs implies all costs incurred for the production of rosemary which include cost of input purchase, cost of labor, cost of machineries rents for ploughing and harvesting. Similarly, the output of rosemary production level was measured by Household Production Index (HPI) which was calculated as the ratio of the value of all rosemary sold to the value of all rosemary produced in 2021/2022 production season multiplied by 100 (table 6).

Table 6:- Production indices of rosemary among households

Production index (%)	Obs (n=385)	Mean	Std. Dev.	Min	Max
Input side HPI of rosemary **(%)**	385	21.30	83.77	.003	980
Output side HPI of rosemary **(%)**	385	66.15	30.64	0	100

Source: Own computation from survey data, 2023

As presented in table 6 above, the average input production index of combined rosemary was 21.3%. Similarly, the average output production index of combined rosemary was 66.15%. The result further showed that the household level of input side production in the area was low. In contrary, the household level of output production among smallholder famers in the area was high. This means smallholder farmers' input use is very low for the production of rosemary and their participation in output marketing is medium.

4.3. Factors affecting rosemary production

The existence of multi-collinearity amongst the hypothesized explanatory variables was checked by using Variance inflation factor (VIF) for continuous and contingency coefficient (CC) for dummy variables before running the model. As displayed in Appendix 6.6, the value of VIF did not show any serious problem of multicollinearity among the continuous variables (vif = 1.52). Also the contingency coefficient (CC), shown in Appendix 6.3, indicated that there is no serious problem of association among dummy independent variables. Therefore, no variables were excluded from the analysis. The Breusch-pagan/cook-weisber test for heteroscedasticity problem showed that the variance of the fitted values of gross rosemary yield was constant by promising that no heteroscedasticity problem (chi2=0.4184) (Appendix 6.2).

As indicated by the tables 6, The Cobb Douglas production function model for rosemary production in the study site was found to be best fit as the F-ratio was highly significant (P-

value=0.0000). Coefficient determination of R^2 that measures the proportion of the variation in our dependent variable(Y) explained by our independent variables(X) for a linear regression. The coefficient of multiple determinations (R^2) of the estimated log linear form of Cobb-Douglas production function model was 0.8256, which indicated that 82.56 percent of the variation in rosemary production in value term could be explained by the variables included in the equation. Adjusted R^2 means the better model when we compare models that have a different amount of variables the logic behind it is, that R^2 always increases when the number of variables increases. Meaning that even if we add that means standard variable contribution is zero. In my regression result the adjusted R^2 value was 81.90 indicating better model for the data to describe the dependent variable by explanatory variables all together. The Standard error of the regression was the average distance that the observed values fall from regression line, smaller the regression means more accurate results (the difference between the actual and predicted value). Here also root MSE value was 0.11955 meaning that the regression result is more accurate.

There were 14 independent/explanatory variables selected and all had positive coefficients except level of education and labor. Coefficients for three independent/explanatory variables (age, marital status and land preparation mechanism) were found to be positive and the result was not significant. Coefficient for three independent variables ((level of education, family size and labor) were found to be negative and the result was not significant. Coefficients of two independent variables (gender and contact of extension service) were found to be positive and significant at 10% level of significance on gross rosemary product. Coefficients of two independent variables (rosemary seedling and rosemary farming experience) were found to be positive and significant at 5% level of significance on gross rosemary product.

Coefficients of four independent variables (fertilizer use, number of oxen, rosemary farm land size and total farm land size) were found to be positive and significant at 1% level of significance on gross rosemary product. Based on the log linear regression result of cobb-Douglass production function model, the significant variables are discussed below.

Sex of household head showed positive relation as a prior hypothesis and significant at 10% level of significance. The model output showed that, if a dummy changed from being female to male headed households, the gross rosemary product increases on average by 8.09 percent, ceteris paribus. This might be due to the reason that, men usually own larger farm lands and have

better practice of income diversification compared to women. In addition, production of rosemary needs continuous labor participation. Regarding this being male headed household puts relatively in a better position for management and production of the output. This result was similar to the study of (Agitew *et. al.*, 2023; Azzarri & Nico, 2022) that being male household farmers produce more yield rosemary than being female.

Fertilizer use was affected the gross rosemary product positively and significant at 1% level of significance. The model output result showed that if producers had 1 more quintal of fertilizer, the gross rosemary product would increase on average by 5.22 percent, holding other things remains constant. This result was similar to the study of (Lagiso *et al.*, 2020), increasing input variables of fertilizer would increase yield. And also (Özyazici, 2021) found that any additional use of organic and inorganic fertilizer, increases yield and quality than from the lesser.

Rosemary seedling affected the gross rosemary product positively and significant at 5% level of significance. The model output showed that if producer have 1 more bundle of seedling, the gross rosemary product was increased on average by 2.41 percent, holding other things remain constant. This result was similar to the study of (Lagiso et al., 2020), increasing input variables of seedling would increase yield. And also according to the study of (Seid, Mohammed, & Atilaw, 2019), if the number of seedling or population of seedling increases the yield per a given land will be increased.

Number of oxen in rosemary production affected the gross rosemary product positively and significant at 1% level of significance. The model output showed that if producer have 1 more number of oxen, the gross rosemary product would increase on average by 12.71 percent, holding other things remain constant. A farmer with more oxen has better opportunity to cultivate rosemary in larger amount with help of oxen which lowers time loss and gets more output than those with lower numbers. This result was similar to the study of (Abate *et al.*, 2019 ; Agitew *et al.,* 2023; Lagiso *et al.,* 2020), increasing input variables of number of oxen would increase yield.

Contact of extension service of household head affected gross rosemary product positive and significant at 10% level of significance. This indicated that a one more contact time of extension increased the gross rosemary product on average by 3.66 percent, keeping the other things

remains constant. This is because, being advised may put households in a relatively better position to gather, understand and realize information on production of rosemary spice. This result was similar to the study of (Agitew *et al.*, 2023; Girma & Kuma, 2022) increasing input variables of extension service contact times, would increase yield.

Rosemary farm land size owned by household affects the gross rosemary products positively and significant at 1% level of significance. For a one more hectare increase in land, the gross rosemary output increases on average by 18.05 percent, ceteris paribus. Farmers who owned larger land size would have probability of owning more plantations of rosemary and which in turn provides good opportunity for producing rosemary in larger area than those with small size of land size.

Experience in rosemary production affected the gross rosemary product positively and significant at 5% level of significance. The model output showed that if producer have 1 more year of experience in rosemary production, the gross rosemary product will increase on average by 2.87 percent, holding other things remain constant. A farmer with more experience has better opportunity to cultivate rosemary in larger amount with help of indigenous knowledge which lowers quality loss and gets more output than those with lower experience. In addition they learned from the past different challenges and egger to solve and produce more. This result was similar to the study of (Agitew *et al.*, 2023; Bidzakin, *et al.*, 2020) the more farmers have experienced in year of farming, the higher rosemary product would be.

Total farm land size owned by household affected the gross rosemary products positively and significant at 1% level of significance. For a one more hectare increase in total land holding, the gross rosemary output increased on average by 7.68 percent, ceteris paribus. Farmers who owned larger land size would have probability of owning more plantations of rosemary and which in turn provides good opportunity for producing rosemary in larger area than those with small size of land size. Since rosemary is marketable commodity, the probability of supplying the entire output harvested in the production season to the market is high as home consumption was in insignificant amount. This result was in argument with the result of (Alemu *et al.*, 2017; Paul & wa Gĩthĩnji, 2018), he found that the higher the large farm land owning farmers will produce more yield.

The sum of regression coefficients obtained from Cobb Douglas production function was 2.9389 which indicated that the increasing returns to scale because of having >1. This means if all the variables specified in production function were increased by 100 percent then the production would increase by 293.89 percent. Regression coefficients of different inputs used in the production functions were estimated and result was presented in table 7 below.

Table 7:- log regressions output of cobb-Douglass production function for rosemary production

logY	Coef.	Std.Err.	t	P>/t/
logAGE	0.0383425	0.0348116	1.1	0.271
logGEN	0.0808705	0.0425765	1.9	0.058*
logEDU	-0.0293417	0.0235182	-1.25	0.213
logHHS	-0.0037982	0.0116954	-0.32	0.746
logFU	0.0522192	0.0047863	10.91	0.000***
logLAB	-0.0068565	0.0074663	-0.92	0.359
logSDL	0.0240922	0.0105324	2.29	0.023**
logOXN	0.1270932	0.0186534	6.81	0.000***
logEXT	0.0365932	0.019083	1.92	0.056*
logRFLS	0.1804601	0.0202027	8.93	0.000***
logFEP	0.0286625	0.0120842	2.37	0.018**
logMST	0.0048096	0.0228225	0.21	0.833
logLPM	0.0022107	0.0130075	0.17	0.865
logTFLS	0.0768186	0.0149972	5.12	0.000***
cons	2.33211	0.1569188	14.86	0.000

Dependent Variable: Log of gross rosemary production in quintal, Pearson correlation coefficient (R) = 0.90862, R^2= 0.8256, Adjusted R^2 = 0.8190, F ratio = 125.10, Returns to scale = 3.116, p-value=0.0000, MSE=0.11955

Source: Survey data and own computation (2023).

*** For 1%, ** for 5% and * for 10% level of significance

4.4. Status of rosemary market participation

According to Gutu (2017); Ayalew *et al.,* (2021) and Belay (2022) households‟ production level can be categorized as fully subsistence, low producer, medium producer, high producer and very high level of producer if their HPI is 0, less than 25%, 25%-50%, 50%-75% and more than 75%, respectively. Thus, this classification was used to categorize households' production level in the study area.

Input side production status of sample households the result presented in table 8 below showed that among sampled rosemary producers, 3.38% of them were fully subsistent, while 88.8% and 5.56% of them were low and medium producers respectively for input side production indices. There were also 0.7% high and 1.56% were very high producers. The result showed input production of sample respondents was low which implied majority of the farmers in study are less depends on market to acquire input for the production of rosemary.

Table 8:-rosemary market participation status of households

item	Percentage of households (%) (n=385)				
	Subsistence (0%)	Low (<25%)	Medium (25-50%)	High (50-75%)	Very high (>75
Input HPI of rosemary	3.38	88.8	5.56	0.7	1.56
Output HPI of rosemary	47(12.2%)	47(12.2%)	63(16.4%)	228(59.2%)	0

Source: Own computation from survey data 2023

Output side production status of sample households the result presented in table 12 below depicted that among sampled rosemary producers, 12.2% of them were fully subsistent, 12.2% of them were low, 16.4% medium producers and 59.2% of them were high producers. There were no sample respondents having high (>75%) output production status (table-8). The result showed that the output production level of the rosemary producers in the area was very high which means farmers in the area are supplying majority of their rosemary product to the market.

4.5. Influential Determinants of Rosemary Market Participation

Market participation is defined as the quantity or proportion of harvested output that is marketed. The existence of multi-collinearity amongst the hypothesized explanatory variables was checked

by using Variance inflation factor (VIF) for continuous and contingency coefficient (CC) for dummy variables before running the model. As displayed in Appendix 6.6 the value of VIF did not show any serious problem of multi-collinearity among the continuous variables because, all values are below 5(vif=1.37). Also the contingency coefficient (CC), showed in Appendix 6.3, indicated that there is no serious problem of association among dummy independent variables. Therefore, no variables were excluded from the analysis. Rosemary market factors were identified by using 2022 survey data. The value of Prob > chi2 showed that the model was statistically significant (Prob > chi2 = 0.0000) at less than 1% level of significance. This showed that the model was best fitted for the analysis.

The double-hurdle model was fitted with 15 explanatory variables as presented in Table 9. The first-stage model result showed that ten variables Rosemary yield, Age, Education, household size, livestock holding, land allocation for rosemary, market price information, Prices of output, Market distance and Extension service significantly affected the intensity of market participation of smallholder rosemary producer farmers. While the second-stage result confirmed that six variables Rosemary yield, Education, number of ox, Prices of output, marketing experience and Storage significantly affected the quantity of supply to market by smallholder rosemary producer.

In order to check whether the samples were from the planed population or within the same population or not, the comparison of chi2 test and t-test values with the p-value. That means Mean difference between participant and non-participant respondents. Mean difference was used to know whether the difference between sample means was a real one or whether it could be reasonably attributed by chance. According to (Burns et al. (1981), Law p-value (<5%) confidence interval excludes 0 means reject Ho means accept Ha meaning that the two samples were from different population. In other words High p-value (>5%) confidence interval includes 0 means fail to reject Ho means can’t accept Ha meaning that the two samples were from the same population.

Table 9: descriptive result of chi2 for category, discrete and dummy variables between participants and non-participants

Variable description		Participant (n= 338)		Non-participant (n = 47)		combined (n = 385)		chi2 value	P-value
		No.	%.	No.	%.	No.	%.		
Gender	female	41	87.23	6	12.77	47	100	0.270	0.603
	male	285	84.32	53	15.68	338	100		
Price information	non inf.	21	80.77	5	19.23	26	100	0.328	0.567
	informed	305	84.96	54	15.04	359	100		
Extension service	weekly	61	67.78	29	32.22	90	100	49.189	0.000***
	monthly	219	95.22	11	4.78	230	100		
	quarterly	46	70.77	19	29.23	65	100		
Storage	no store	214	86.29	34	13.71	248	100	1.401	0.237
	yes store	112	81.75	25	18.25	137	100		
Education	Primary	248	86.11	40	13.89	288	100	2.510	0.285
	Secondary	32	84.21	6	15.79	38	100		
	Dip. & above	46	77.97	13	22.03	59	100		
Household size	1	56	93.33	4	6.67	60	100	7.954	0.093*
	2	70	82.35	15	17.65	85	100		
	3	70	85.37	12	14.63	82	100		
	4	70	87.5	10	12.5	80	100		
	5	60	76.92	18	23.08	78	100		

Source: Survey data and own computation (2023).
*** For 1% and * for 10% level of significance

As presented in the table 9, the study result depicted that, the extension service deliver's contact by smallholder farmers was 41(67.78%) for rosemary market participants and 29(32.22%) for non-participants. This showed that the two groups were from the same population (p=0.000). This might be smallholder rosemary producers who had frequently contacted with development agent could get practical information on new technologies and agronomic practices which might boost their rosemary production and market participation due to having mor production. Development might spent their time with farmers talking

about other issues which are directly related to enhance farmers' production and market issues instead agents out of their profession.

The family size of the rosemary market participants was 53(93.33%) and 4(6.67%) for non-participants. This implies that having large family gives a chance to participate in rosemary market rather than having small family size. This may be due to sharing workloads from family members to cover the family head's work time and labor demand.

Table 10:- descriptive result of t-test for continuous variables between market participants and non-participants

Variable description	Participant (n= 338)	Non-participant (n = 47)	Combined (n = 385)	t- value
	Mean (std. dev.)	Mean (std. dev.)	Mean (std. dev.)	
rosemary yield	22.825(5.56)	19.119(5.35)	22.257(5.68)	-4.7397***
Age	44.015(7.60)	38.831(6.32)	43.22(7.64)	-4.9393***
Household income	486724(193002)	380512(216427)	470447(200173)	-3.816***
livestock holding	5.642(2.08)	4.4715(1.10)	5.462(2.11)	-4.0032***
rosemary farm land	0.696(0.01)	0.45517(0.02)	0.659(0.01)	-7.8621**
Prices of output	43.353(14.91)	14.034(23.39)	38.859(19.56)	-12.576*
Market experience	5.386(2.21)	4.2034(1.48)	5.205(2.16)	-3.952***
Market distance	8.656(3.07)	10.186(3.03)	8.89(3.11)	3.5261***

Source: *Survey data and own computation (2023*).
*** For 1%, ** for 5% and * for 10% level of significance

The survey result indicated that the average age of rosemary market participants was about 44.015 years while for non-participants was about 38.831 years as presented in Table 10. This showed that, aged household heads were more participated in rosemary market than younger households.

As presented in Table 10, the average land allocated for rosemary by market participant households was 0.696 hectare while that of non-participants were 0.455 hectare. The result showed that land allocated for rosemary was statistically significant at 5%. Thus, the mean land of market participants was greater than that of nonmarket participants. This may indicated land allocated for rosemary was seen as an incentive to produce surplus for market.

The average annual rosemary production for market participants was 22.825 kg while that of nonmarket participants was 19.119 kg. Thus, high quantity of harvest was leaded households to higher level of market participation.

As presented in Table 10, selling experience for rosemary market participants was 5.387 years while that for non-market participants was about 4.203 years.

In the study area, the survey result in Table 10 depicted that average distance to the nearest market for the rosemary market participants was 8.656 while of non-participants was 10.186 km. Thus, there was statistically significant difference in distance to the nearest market across the rosemary market participants and non-participant households at 1% significance level.

4.5.1. Determinants of smallholder farmers' rosemary market participation decision

As indicated in the table 11, Gender negatively and significantly affected the probability of participation at 1% significant level. The negative relationship between the variables indicated that as the farmers' sex changed from female to male, the probability of rosemary market participation also decreases. The result confirmed that being male leads to average decline of the probability of rosemary market participation by 403% with keeping other factors constant (table 11).

Number of oxen owned had significant and positive effect on the level of household participation in rosemary market at 1% level of significance. Ox was a production asset used in the study area. This implied that on average the level of farmers' participation in rosemary market increased by 201% as one additional ox increases to the rosemary producers', with keeping other factors constant (table 11). Thus, farmers owning higher number of ox can produce more rosemary output which increases marketable surplus. This finding was in agreement with finding of Matz (2014) who found that ownership of oxen increases output market participation due to its effect on production.

Quantity of rosemary produced positively and significantly affected the probability of participation at 5% significant level. The positive and significant relationship between the variables indicated that as the amount of rosemary output produced increases, the probability

of rosemary market participation also increases. The marginal effect of the variable also confirmed that an increase in a 1 more quintal of rosemary produced leads to the rise of the probability of rosemary market participation on average by 27.8%, by keeping other factors constant (table 11). This can be explained by the fact that the higher the produce, the higher the farmers' motivation to participate more to generate additional income. This result also suggested that building the capacity of households to produce surplus production could be critical in improving households' participation in the market. This finding was similar with that of Tufa *et. al,.* (2014), who found that in Ethiopia when farmers produce more, they will be, motivated to sell more. This means the higher the output, the higher was the farmer willing to participate in the market.

Table 11:- Factors Influencing Farmer's Decision and Extent of Contract Farming Participation

Variable description	Cragg's double hurdle model					
	first hurdle (Decision Model)			second hurdle(selection-ll)(Extent Model)		
	Coefficient	Std. Err.	P > z	Coefficient	Std. Err.	P > z
AGE	0.07377	0.051227	0.15	0.013065	0.0187979	0.487
GEN						
.male	-4.03159	1.528826	0.008***	0.324474	0.4746674	0.494
EDU						
.Secondary	-0.95329	1.285691	0.458	-0.66421	0.3771949	0.078*
.Diploma & above	-0.71095	1.076333	0.509	-0.61174	0.3175684	0.054*
HHS	-0.26023	0.276713	0.347	-0.10814	0.1002933	0.281
PR	0.032074	0.027849	0.249	0.040999	0.0065752	0.000***
EXT						
.monthly	1.204117	0.990857	0.224	0.356376	0.3097201	0.25
.quarterly	1.728907	1.29679	0.182	0.015141	0.3208224	0.962
RFLS	0.487836	2.334987	0.835	2.236034	0.907683	0.014**
MDC	0.137217	0.130297	0.292	-0.08193	0.0447993	0.067*
MPI						
.yes	-1.80819	1.566157	0.248	0.253214	0.4650745	0.586
SEP	0.083339	0.173377	0.631	0.102387	0.0676629	0.13
OXN	2.010478	0.718214	0.005***	-0.25004	0.1989144	0.209
Y	0.278238	0.115499	0.016**	0.023899	0.0491709	0.627
TLU	-0.07871	0.183887	0.669	0.040786	0.063064	0.518
ST						
.yes storage	-0.43388	0.93621	0.643	-0.6478	0.2782737	0.02**
lnHHI	-0.07186	0.714648	0.92	-0.14541	0.1836589	0.429
_cons	8.238812	9.314508	0.376	0.209748	2.43356	0.931
Lnsigma cons				6.545631	0.268148	0.000***
Lnsigma sigma				696.1958	186.6833	

Log likelihood = -1177.1045 , Number of obs = 385, LR chi2(16) = 197.77, Prob > chi2 = 0.0000, Pseudo R2 = 0.0775

Source: *Survey data and own computation (2023).*

*** For 1% level of significance, ** for 5% level of significance and * for 10% level of significance

4.5.2. Influential determinants of level of rosemary market participation

The estimated factors affecting level of market participation second-stage of double-hurdle (selection) model was employed. According to the model output, Lnsigma MP or selectivity bias correction factor had a positive impact on farm households' rosemary product market participation at a 1% significance level. And, the positive sign shows that the existence of unobserved factors that positively influenced both participation decision and level of rosemary output marketed (Table 11). This indicated that sample selection bias and the existence of some unobservable household characteristics determining livelihood to participate in rosemary market.

Educational level of the household was found to have a negatively and significant at a 10% significance level. The result showed that a change from primary to secondary education level decreased by 66.4% in the same way a change from primary to diploma and above level the quantity of rosemary marketed decreased by 61.2% on average, keeping other factors constant. This implied that as the level of education status achieved by the farmers' beyond primary, the quantity of rosemary to go into market decreases. This indicated that as the household years of schooling increased, they would shift from rosemary production into high value or cash crop farming like (chat, fruits, and others) which didn't need more farm practices. And also, educated households are eager to engage in other professional activities and they fear to take a risk selling with current price level more quantity, so they think price increment may occur. This result was in line with the findings of Muhammad-Lawal *et al.* (2014) who found that education status achieved by the farmers' increases, the level of market participation decreases. Also, the result was supported by Lighton and Emmanuel (2016) found that educated members of the households tend to ignore rural agricultural life and instead go for higher faster paying professions.

As indicated in Table 11, households' perception towards lagged year market price significantly and positively affected the level of rosemary market participation at less than 1%. It was expected that farmers could have different perceptions regarding with rosemary market lagged year price. According to the model result as compared to households who perceive low lagged year prices, households who perceived high lagged year price level increases on average by 4.1% in quantity of rosemary to the market, other factors remaining constant. The finding was in line with the finding of Mihretie (2020), who stated that high perception of lagged year price enabled level of market participation.

Land allocated for rosemary production had a positive and significant contribution to the decision of rosemary market participation at less than 5% level of significance (Table 9). An increase in one hectare of land for rosemary results an average increment of amount of participation by 223.6% by keeping other factors constant. This was due to the reason that owning of the large area of land enables them to produces for market purposes and supply more mount of rosemary product to the market. This result was in confirmatory with the finding of Geremew *et al.,* (2018) and Tilahun *et al.,* (2022) found that land allocated for output production positively affected marketable surplus of outputs and market participation decision.

Distance to nearest market had negative effect on rosemary market participation and found to be statistically significant at 10% significance level. The negative relationship indicated that the further was a household from the rosemary market, the more difficult and costly to get involved in the rosemary market. The nearer a farmer to the market, the easier to take the products to the market since the farmer may not incur a high cost for transportation. The marginal effect also confirmed that an increase in one kilometer to the nearest market from the farm owner reduces the probability of participation decision in rosemary market on average by 8.2%, keeping other factors constant. The result was in agreement with previous studies who found significant and negative relationship between distance to the market and market participation decision (Kussie *et al.,* 2022; Tabe-Ojong *et al,.* (2022); Falola *et al.,* 2022).

Storage facility influenced market supply of rosemary negatively and significantly at 5% level of significance. This showed that if households who had storage facility, the supply of rosemary to the market will decrease on average by 64.9% holding other things remain constant. The study findings further showed that farmers who have no storage sell fresh rosemary, particularly at the farm gate since they lack materials for dehydration as well the storage facilities than who have storage facility. Also this implied that these poor storing practices contribute to reducing rosemary quality and gradually may lead to losing the product at all. This result was in lined with the findings of Sharangi *et al.* (2011) that farmers lack quality of their spices due to poor storage. And also Spices are supposed to be stored in a dried and well-ventilated place to maintain their quality (Tesfa *et al.,* 2017).

5. SUMMARY, CONCLUSIONS AND RECOMENDATIONS

5.1. Summary and Conclusions

Considering the smallholder farmers' production and market participation was a critical issue in improving household. However, given the area coverage and high production of major cash crops such as rosemary by smallholder farmers, they face several constraints that make it difficult for them to participate in the agricultural production and markets. The study result find out good information through employing descriptive statistics, cobb-Douglass production function and double-hurdle models approaches on constraints hindered the smallholder farmers' on rosemary production and market participation decision.

According to descriptive statistics output result Smallholder rosemary farmers' input use is very low for the production of rosemary (HPI=21.3%) and their participation in output marketing is medium (HPI=66%). the output market participation of the rosemary producers in the area was high (59.2%) which means farmers in the area are supplying majority of their rosemary product to the market.

In the production side the cobb-Douglas production function model results of cross-sectional survey indicated that out of 14 checked independent variables of gender, contact of extension service, rosemary seedling, rosemary farming experience, fertilizer use, number of oxen, rosemary farm land size and total farm land size were found to be affected positively the gross rosemary production.

In the marketing side, out of total sampled 385 rosemary producers, 338(87.7%) households were rosemary market participants and 47(12.3%) households were non-participants based on 2021/2022 production year survey data. The double-hurdle model findings suggested that Based on the double hurdle model results, out of 15 checked independent variables 3 (gender, number of oxen and gross rosemary yield) were significantly affect rosemary market participation decision. From those gender was negative factor and the rest were positive factors. In the extent of rosemary market side, 6 (education, lagged price, rosemary farm land size, market distance and storage) were significantly affect level rosemary market participation. Out of them education, market distance and storage were negative factors and the rest lagged price and rosemary farm land size were positive factors.

5.2. Recommendations

Gender negatively affected the probability of rosemary market participation decision. The negative relationship between the variables indicated that as the farmers' sex changed from female to male, the probability of rosemary market participation also decreases. Therefore the concerned government sectoral body should give awareness creation to decide jointly about rosemary product market participation.

Distance to the market significantly and negatively affected market participation extent. Therefore, government and concerned body have to develop road infrastructural facilities and create market linkages between farmers and buyers to reach market easily and create additional wealth; thereby increase volume of production as a result market supply and improve their market participation level. And also the Government and concerned stakeholders should focus on promoting improved rosemary variety, promoting farmers' cooperatives and improving market linkage should be created. The enhancement of Rosemary producers' bargaining power through cooperatives is the best measure that should target at reducing the oligopolistic market structure in the area. Such measure also facilitates the regular supply of rosemary at reasonable price to consumers.

Storage facility influenced market supply of rosemary negatively affected level of market participation. The study findings further showed that farmers who have no storage farmers sell their fresh rosemary, particularly at the farm gate since they lack of holding mechanism as well the storage facilities than who have storage facility. Their fore the extension givers should create awareness to prepare storing mechanism to hold their rosemary product while the price declines or they did not want to sell. In addition the government should give continuous trainings for farmers relating national and export standardize quality condition to be considered while holding or storing the rosemary product.

Educational level of the household was found to have a negatively with extent of rosemary market. The result showed that a change from primary to secondary education level decreased by 66.4% in the same way a change from primary to diploma and above level the quantity of rosemary marketed. Therefore the government should give trainings about how to hold the product with standardized quality, what condition and issues should be considered before

holding the product and special training should be given based on sectoral behaviors and condition to be considered especially for farmers who are diploma and above education level.

This study focused on level of rosemary production, determinants of rosemary production, stage of rosemary market participation and factors affecting rosemary market participation rather than. Market channels and production technical efficiency, as well as value chain of rosemary were not covered. Therefore, future research has to focus on these areas.

6. REFERENCES

Abate, T. M., Dessie, A. B., & Mekie, T. M. (2019). Technical efficiency of smallholder farmers in red pepper production in North Gondar zone Amhara regional state, Ethiopia. *Journal of Economic Structures, 8*, 1-18.

Abay, A. (2010). *Market chain analysis of red pepper: the case of Bure woreda, west Gojjam zone, Amhara National Regional State, Ethiopia.* Haramaya University,

Abebaw, L., Birru, W. T., & Alemu, D. (2023). Determinants of Commercializing Crop Outputs of Smallholder Farmers in West Gojjam Zone, North-western Ethiopia. *East African Journal of Sciences, 17*(1), 19-32.

Abobi, S. M. (2023). Ghana Case Study One: Challenges and Opportunities in Marine Fisheries Governance in Ghana. In *Challenges in Tropical Coastal Zone Management: Experiences and Lessons Learned* (pp. 41-52): Springer.

Adafre, A. N. (2019). Estimation of yield advantage and competitiveness of onion-rosemary intercropping over sole cropping at Wondo Genet, Southern Ethiopia. *Academic Journal of Plant Sciences, 12*(3), 52-60.

Agitew, G., Berhanie, Z., & Gebremedhin, S. (2023). Nutrition Sensitivity of Smallholder Agricultural Production in Northwest Ethiopia.

Agize, M., & Zouwen, L. (2016). Spice and medicinal plants production and value chain analysis from South-West Ethiopia. *Journal of Pharmacy and Alternative Medicine, 10*, 126-144.

Alemu, G. T., Berhanie Ayele, Z., & Abelieneh Berhanu, A. (2017). Effects of land fragmentation on productivity in Northwestern Ethiopia. *Advances in Agriculture, 2017*.

Amevenku, F. K., & Asravor, R. (2023). Triple hurdle approach to market orientation of peri-urban fishery: a case of Dawhenya reservoir, Ghana. *Development in Practice*, 1-15.

Aristei, D., & Perugini, C. (2022). Credit and income mobility in Russia. *The Journal of Economic Inequality, 20*(3), 639-669.

Ashenafi Nigussie, et.al.,, "Competitiveness and Yield Advantage of Carrot-Rosemary Intercropping over Solitary at Wondo Genet, Southern Ethiopia" International Journal of Research Studies in Agricultural Sciences (IJRSAS), 2020; 6(8), pp. 1-9, https://doi.org/10.20431/2454-6224.0608001

Azzarri, C., & Nico, G. (2022). Sex-disaggregated agricultural extension and weather variability in Africa south of the Sahara. *World Development, 155*, 105897.

Banjaw, D., Wolde, T., Gebre, A., & Mengesha, B. (2016). Rosemary (Rosmarinus officinalis L.) variety verification trial at Wondogenet, South Ethiopia. *Med Aromat Plants (Los Angel), 5*(267), 2167-0412.1000267.

Bekele, T., & Georgis, A. H. (2023). Effect of Seed Rate and Variety on Yield and Yield Contributing Traits of Black Cumin (Nigella sativa L.) at Andracha Woreda, Southwestern Ethiopia. *Sarhad Journal of Agriculture, 39*(1).

Bidzakin, J. K., Fialor, S. C., Awunyo-Vitor, D., & Yahaya, I. (2020). Contract farming and rice production efficiency in Ghana. *Journal of Agribusiness in Developing and Emerging Economies, 10*(3), 269-284.

Binswanger-Mkhize, H. P., & Savastano, S. (2017). Agricultural intensification: the status in six African countries. *Food Policy, 67*, 26-40.

Chowdhury, M. S. R., & Islam, M. (2015). An analysis of the production function of ready-made garments industry in Bangladesh: A case of Tex-Town Group Limited. *International Journal of African and Asian Studies, 14*(1), 1-6.

Cook, K. S., & Gerbasi, A. (2015). Homans and Emerson on Power: Out of the Skinner Box?. In George C. Homans (pp. 157-176). Routledge.Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. *Handbook of mixed methods in social and behavioral research, 209*(240), 209-240.

Degu, B., Leulseged, T., Fikadu, D., & Melka, B. Beemnet Mengesha, Zewdinesh Damtew, Zinash Teferi, H/silase G/meskel.

Dessie, A. B., Abate, T. M., Adane, B. T., Tesfa, T., & Getu, S. (2020). Estimation of technical efficiency of black cumin (Nigella sativa L.) farming in northwest Ethiopia: a stochastic frontier approach. *Journal of economic structures, 9*(1), 1-14.

Dessie, M., Jailan, M., Mosi, H., & Mekonnen, G. (2018). Value Chain Analysis of Red Pepper: The Case of Mareko District, Guragie Zone, Southern Ethiopia.

Dessie, M., Woldeamanuel, T., & Mekonnen, G. (2017). Value chain analysis of red pepper: the case of Abeshge District, Guragie Zone, South Ethiopia. *International journal of environmental science and natural resource, 2*(3), 01-08.

Diriba, G. (2018). Agricultural and rural transformation in Ethiopia. *Ethiopian Journal of Economics, 27*(2), 51-110.

Fufa, B., & Hassan, R. M. (2003). Stochastic maize production technology and production risk analysis in Dadar district, East Ethiopia. *Agrekon, 42*(2), 116-128.

Gebreyesus, F. (2016). Determination of important factors affecting production and marketing of korarima (Aframomum Corrorima (braun) PCM Jansen) in Western Ethiopia. *International Journal of Engineering Development and Research, 4*(2), 2321-9939.

Geta, E., & Kifle, A. (2011). Production, processing and marketing of ginger in Southern Ethiopia. *Journal of Horticulture and Forestry, 3*(7), 207-213.

Getachew Abebe, T. (2021). *TECHNICAL EFFICIENCY, MARKET PARTICIPATION AND FOOD SECURITY OF WHEAT PRODUCERS IN NORTH SHEWA ZONE OF AMHARA REGION, CENTRAL ETHIOPIA.* Haramaya university,

Geyo, G. B. (2023). Value Chain Analysis of Medicinal and Aromatic Plants: The Case of Rosemary (Rosemarinus Officinalis L.) in Ethiopia.

Gezehagn Gesese Gelgelo, S. E. N., Tsegaye Bekele Mekonnen and Kendisha Soekardjo Hintz (2021). *Marketing and Value Addition of Artemisia Annua Species and Other Potential Medicinal Plants in Southern Ethiopia.*

Gil, L., Tadesse, W., Tolosana, E., & Lopez, R. (2010). Ethiopian Institute of Agricultural Research (EIAR): Addis Ababa. In: Ethiopia.

Girma, Y., & Kuma, B. (2022). A meta analysis on the effect of agricultural extension on farmers' market participation in Ethiopia. *Journal of Agriculture and Food Research, 7*, 100253.

Goshme, D., & Ayele, T. (2019). Factors affecting production and marketing of spices in Ethiopia: A review. *International Journal of Forestry and Horticulture (IJFH), 5*(2), 14-18.

Guchale, M. G. (2021). Ethnobotanical study of medicinal plants in Tarmaber District, Central Ethiopia: Implication for conservation of biodiversity (Doctoral dissertation, Technische Universität Dresden).

Haile, K., Gebre, E., & Workye, A. (2022). Determinants of market participation among smallholder farmers in Southwest Ethiopia: double-hurdle model approach. *Agriculture & Food Security, 11*(1), 18.

Hanson, W. E., Creswell, J. W., Clark, V. L. P., Petska, K. S., & Creswell, J. D. (2005). Mixed methods research designs in counseling psychology. *Journal of counseling psychology, 52*(2), 224.

Hasan, M. H., Newton, I. H., Chowdhury, M. A., Esha, A. A., Razzaque, S., & Hossain, M. J. (2023). Land Use Land Cover Change and Related Drivers have Livelihood Consequences in Coastal Bangladesh. *Earth Systems and Environment*, 1-19.

Helfand, S. M., & Levine, E. S. (2004). Farm size and the determinants of productive efficiency in the Brazilian Center-West. *Agricultural economics, 31*(2-3), 241-249.

Hibistu, T. (2020). Spice value chain in Ethiopia: Scoping review for sustainable management. *International Journal of African and Asian Studies An International Peer-reviewed Journal, 61*, 19-22.

Himed-Idir, H., Mouhoubi, K., Siar, E. h., Boudries, H., Mansouri, H., Adjeroud, N., . . . Boulekbache-Makhlouf, L. (2021). Effect of rosemary (Rosmarinus officinalis L.) supplementation on fresh cheese: Physicochemical properties, antioxidant potential, and sensory attributes. *Journal of Food Processing and Preservation, 45*(1), e15057.

Hordofa, T. S., & Tolossa, T. T. (2020). Cultivation and postharvest handling practices affecting yield and quality of major spices crops in Ethiopia: A review. *Cogent Food & Agriculture, 6*(1), 1788896. doi:10.1080/23311932.2020.1788896

Industry, A. (2021). Rosemary Extracts Market—Industry Analysis, Market Size, Share, Trends, Application Analysis, Growth and Forecast 2021–2026. *accessed on, 13*.

Jayne, T. S., Snapp, S., Place, F., & Sitko, N. (2019). Sustainable agricultural intensification in an era of rural transformation in Africa. *Global Food Security, 20*, 105-113.

Jemal, O. M., Callo-Concha, D., & van Noordwijk, M. (2021). Coffee agroforestry and the food and nutrition security of small farmers of south-western Ethiopia. *Frontiers in Sustainable Food Systems, 5*, 608868.

Jones, A. M. (2014). Double hurdle model. *Wiley StatsRef: Statistics Reference Online*, 1-9.

Kalawa, G., Mwenjeri, G., & Ngare, L. (2022). Analysis of Sorghum Market Structure, Conduct and Performance in Isiolo County, Kenya. *East African Agricultural and Forestry Journal, 86*(3 & 4), 7-7.

Kholif, A., Matloup, O., Morsy, T., Abdo, M., Elella, A. A., Anele, U., & Swanson, K. (2017). Rosemary and lemongrass herbs as phytogenic feed additives to improve efficient feed

utilization, manipulate rumen fermentation and elevate milk production of Damascus goats. *Livestock science, 204*, 39-46.

Kifelew, H., Getachew, W., Luleseged, T., Mitiku, H., Bekele, D., & Fikere, D. (2017). Seed spices production guideline.

Komarek, A. M., De Pinto, A., & Smith, V. H. (2020). A review of types of risks in agriculture: What we know and what we need to know. *Agricultural Systems, 178*, 102738.

Lagiso, D., Geta, E., Tasew, W., & Mamo, H. (2020). Technical Efficiency of Red Pepper Production: The Case of Dalocha District, Southern Ethiopia. *Industrial Engineering Letters. red, 10*(1).

M.I.Zuberi, B. K., and Teklu Gosaye. (2013). *An assessment of trade of homestead based herbal plants in the local market of Ambo for Poverty alleviation and sustainable use*. Retrieved from Ambo, Ethiopia:

Mather, D., Boughton, D., & Jayne, T. (2013). Explaining smallholder maize marketing in southern and eastern Africa: The roles of market access, technology and household resource endowments. *Food Policy, 43*, 248-266.

Matthews, M., & Jack, M. (2011). *Spices and herbs for home and market*: FAO.

Mefekir, T. A. (2019). *FACTORS AFFECTING CUSTOMERS'PREFERENECE TOWARDS FOREIGN AND DOMESTIC LEATHER FOOTWEAR PRODUCTS (A CASE OF HAWASSA CITY).* Hawasssa University,

Mehraban, N., Debela, B. L., Kalsum, U., & Qaim, M. (2022). What about her? Oil palm cultivation and intra-household gender roles. *Food Policy, 110*, 102276.

Melanie, M., & Michael, J. (2011). Spices and herbs for home and market. *Rural Infrastructure and Agro-Industries Division Food and Agriculture Organization of the United Nations*, 1-70.

Mengesha, B., Mohammed, O., Tessema, T., & Abate, S. (2010). Production, Processing and Utilization of Aromatic Plants. *Ethiopian Institute of Agricultural Research*.

Miyamoto, H., Shigeta, K., Suda, W., Ichihashi, Y., Nihei, N., Matsuura, M., . . . Sato, M. (2023). An agroecological structure model of compost—soil—plant interactions for sustainable organic farming. *ISME communications, 3*(1), 28.

Momin, K. C., Suresh, C., Singh, Y., & Momin, B. C. (2018). The promising spices of North East India: India's flavourful contribution to the world. *Indian Spices: The Legacy, Production and Processing of India's Treasured Export*, 47-61.

Mpombo, L., Chegere, M. J., & Osoro, O. (2022). Determinants of Market Orientation and Market Participation among Smallholder Rice Farmers in Tanzania. *The African Review*, *1*(aop), 1-26.

Mugera, A. W., & Langemeier, M. R. (2011). Does farm size and specialization matter for productive efficiency? Results from Kansas. *Journal of Agricultural and Applied Economics*, *43*(4), 515-528.

Mushi, G. E., Di Marzo Serugendo, G., & Burgi, P.-Y. (2022). Digital technology and services for sustainable agriculture in Tanzania: a literature review. *Sustainability*, *14*(4), 2415.

Musumba, M., Palm, C. A., Komarek, A. M., Mutuo, P. K., & Kaya, B. (2022). Household livelihood diversification in rural Africa. *Agricultural economics*, *53*(2), 246-256.

Negera, D. G. (2015). Analysis of factors determining the supply of Ethiopian cardamom spice (Aframomumcorrorima): A case from Bench Maji Zone of SNNPR, Ethiopia. *European Journal of Business and Management*, *7*(1), 56-63.

Nigussie, A., Gadissa, M., & Tadesse, N. Competitiveness and Yield Advantage of Carrot-Rosemary Intercropping over Solitary at Wondo Genet, Southern Ethiopia.

Onuwa, G., & Folorunsho, S. (2022). Determinants of tomato farmers participation in Agricultural Services and Training Centre (ASTC) activities. *Turkish Journal of Agriculture-Food Science and Technology*, *10*(8), 1369-1376.

Opata, P. I., Ezeibe, A. B., & Arua, R. N. (2020). Drivers of farmers market participation in southeast Nigeria.

Özyazici, G. (2021). Influence of organic and inorganic fertilizers on coriander (Coriandrum sativum L.) agronomic traits, essential oil and components under semi-arid climate. *Agronomy*, *11*(7), 1427.

Paul, M., & wa Gĩthĩnji, M. (2018). Small farms, smaller plots: land size, fragmentation, and productivity in Ethiopia. *The Journal of Peasant Studies*, *45*(4), 757-775.

Pradhan, K. (2018). Exploration and Extrapolation of Extension Strategy for Promotion of Spice Production and Processing in India. *Indian Spices: The Legacy, Production and Processing of India's Treasured Export*, 421-438.

Qiao, D., Xu, S., Xu, T., Hao, Q., & Zhong, Z. (2022). Gap between Willingness and Behaviors: Understanding the Consistency of Farmers' Green Production in Hainan, China. *International Journal of Environmental Research and Public Health, 19*(18), 11351.

Quagrainie, K. K., & Chu, J. (2019). Determinants of catch sales in Ghanaian artisanal fisheries. *Sustainability, 11*(2), 298.

Rutgers, T. (2010). *An analysis of supply side constraints on Ethiopian red pepper and paprika capsicum production and export: a global value chain approach.*

Sarkar, S., Skalicky, M., Hossain, A., Brestic, M., Saha, S., Garai, S., . . . Brahmachari, K. (2020). Management of crop residues for improving input use efficiency and agricultural sustainability. *Sustainability, 12*(23), 9808.

Sedgwick, P. (2014). Multiple hypothesis testing and Bonferroni's correction. *Bmj, 349*.

Seid, H., Mohammed, W., & Atilaw, A. (2019). Correlation and path coefficient analysis among yield component traits of Ethiopian korerima [Aframomum corrorima (Braun) PCM Jansen] genotypes at Tepi, Ethiopia.

Serkalem, S. Y., Haimanot, G. M., & Ansha, N. A. (2014). Determinants of occupational injury in Kombolcha textile factory, North-East Ethiopia. *The International Journal of Occupational and Environmental Medicine, 5*(2), 84.

Sharangi, A. B., & Acharya, S. (2018). Spices in India and beyond: the origin, history, tradition and culture. *Indian Spices: The Legacy, Production and Processing of India's Treasured Export*, 1-11.

Tamsah, H., & Yusriadi, Y. (2022). Quality of agricultural extension on productivity of farmers: Human capital perspective. *Uncertain Supply Chain Management, 10*(2), 625-636.

Taye T., D. A., Asmare D., Deganchew B., Fekadu G., Tewodros M. and Wogayehu W. (2024). *Proceedings of Crops Improvement and Management Research Results 20220/21*. Retrieved from Addis Ababa, Ethiopia:

Tegegne, B., Ketema, M., Beyene, F., & Tesfahun, G. (2022). Determinants of Market Participation for Crop Producer Farmers in Irrigated Areas of Amhara Region, Ethiopia. *Ethiopian Economics Association (EEA)*, 384.

Temesgen, A., & Tufa, A. (2017). Analysis of coffee farm productivity in Darolabu district, West Hararghe Zone, Ethiopia. *American Journal of Environmental and Resource Economics, 2*(4), 158-161.

Tesfay, M. (2018). *Adoption of diversified farm technology in a semi arid of northern Ethiopia: A Panel Data Analysis*. Retrieved from

Vijayalaxmi, H., & Sreepada, H. (2014). An economic overview of ginger production in Ethiopia. *International Journal of Science and Research, 3*(12), 2052-2054.

Wako, F. L. (2020). Black cumin (Nigella sativa L.) Production: A Mini Review.

WOLDEMICHAEL, A. (2020). *DETERMINANTS OF PULSE EXPORT PERFORMANCE IN ETHIOPIA.* ST. MARY'S UNIVERSITY,

Woldetsadik, D., Hailu, H., Gebrezgabher, S., Adam-Bradford, A., Mengistu, T., Evans, C. T., . . . Fleming, D. E. (2023). Estimating the potential of spices for mineral provision in a refugee context in East Africa. *SN Applied Sciences, 5*(1), 1.

Xylia, P., Fasko, K. G., Chrysargyris, A., & Tzortzakis, N. (2022). Heat treatment, sodium carbonate, ascorbic acid and rosemary essential oil application for the preservation of fresh Rosmarinus officinalis quality. *Postharvest Biology and Technology, 187*, 111868.

Yamane, T. (1973). Statistics: An introductory analysis.

Yimer, M. (2019). Market profile on spice in Ethiopia, Addis Ababa, Ethiopia. In.

Zigene, Z. D., Kassahun, B. M., & Degu, B. (2018). Agronomic Characteristics and Essential Oil Yield of Java Citronella (Cymbopogon Winterianus Jowitt) as Affected by Harvesting Age and Plant Population Density. *Acad. Res. J. Agric. Sci. Res. ARJASR, 6*, 70-76.

7. APPENDICES

APPENDIX 1: Rosemary Producers' Survey Questionnaire

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Dear respondents, this is a questionnaire to collect the data from the producers of rosemary product to wright a thesis on the title of "factors affecting rosemary production and marketing of smallholderfarmers in Silte district, Ethiopia" for M.Sc. Research.

1. General Information

Questionnaire number: _____Name of the enumerator:_____

Signature: ___Date:_____/_____/_____Name of district _____

Name of Kebele _____Name of the village _____

2. Household Characteristics

1. Name of the respondent _____ 2. Who is the head of the household, i.e. decision maker? _____ 3. Age of the household head _____

4. Sex of the household head, 1.Male [ ] 2. Female [ ]

5. Marital status of the household head, 1.Single [ ] 2. Married [ ] 3. Divorced [ ] 4. Widowed [ ] 5. Polygamous [ ]

6. Education level of the household head (Number of years in school)_____

7. Rosemary Farming experience of household head: _____ years

8. Number of family including the respondent _____

code, age, sex, and education level of family (Use the code)

1……/ …..……/ ……./ ……..
2……/ …..……/ ……./ ……..
3……/ …..……/ ……./ ……..

3. Land Use

Total land holding owned___(ha), Total land hired in_____(ha) and Total Cultivated area _____(ha). Rosemary growing area (ha), Land allocated for other crops_____(ha).

4. Production aspects

1. Production of Rosemary and major crops in 2022.

No	Type ofcrop	Quantity produced	Quantity consumed	Stored for seed (kg)	Gift(kg)	Quantity sold 2022	Price in 2022 per 100 kg
1	Rosemary						
2	Bean						
3	Enset /False banana/						
4	Barley						
5	Pea						
6	Maize						

1. The best cash crops relative to level of income 1st __2nd_____3rd ___
2. Which type of Rosemary Variety are you using?

   1. Local [ ] 2. Improved [ ] 3. Both [ ]

3. Is labor force available for production of Rosemary?

   1. Yes [ ] 2. No [ ]

4. What is your source of labor for producing Rosemary?

   1. Family labor [ ]. 2. Hired labor [ ] 3.Debo [ ] 4.All [ ]

5. Production inputs data

Items	Cost (Abebaw et al.)	Remark
Number of Labor (from plowing up threshing)	Quantity/amount	
Amount of Seedling use in plot/bundle		
Amount of Fertilizer quintal		
Compost in quintal		
Pesticide in litr		
Organic and inorganic fertilizer		

5. Marketing aspects

1. Are you selling Rosemary to any market? 1. Yes [ ] 2. No [ ]

(The following questions (2 up to 5) under this sub topic is only for those who are participating in the market)

2. Experience in the marketing of rosemary (in Years) _____

3. Total quantity sold and average selling price:

rosemary product type	Total quantity sold			Average selling price		
	2020	2021	2022	2020	2021	2022
herbs						
Dried						

4. How do you transport rosemary from farm to market?

1. Head loading [ ] 2.Pack animals [ ] 3.Animal cart [ ] 4.Trucks [ ] 5. Others _____

5. How many kilometers you need to travel to get the following?

1. The nearest Cooperatives_____Km 2.The nearest market for selling rosemary____Km, 3. The district market___ Km

6. Do you have your own transportation means like donkey, horse, mule, cart, and track?

1. Yes [ ] 2. No [ ]

7. Did you know the nearby market price before you sold your rosemary?

1. Yes [ ] 2. No [ ]

8. If you say 'yes' for the question no. 9, from which source did you get information on supply of rosemary markets?

1. Other rosemary farmers [ ] 2.Personal observation [ ] 3.Radio [ ] 4.Broker [ ]

5. On TV [ ] 6.Telephone [ ] 7.Extension agents [ ] 8.Newspaper [ ] 9. Other ……

9. Which one is/are your source of information on demand of rosemary markets?

1. Other rosemary farmers [ ] 2.Personal observation [ ]3.Radio [ ] 4. Broker [ ]

5. TV [ ] 6.Telephone [ ] 7.Extension agents [ ] 8.Newspaper [ ] 9.Other……

10. Which one is/are your source of information on price of rosemary markets?

1. Other rosemary farmers [ ] 2. Personal observation [ ] 3.Radio [ ] 4.Broker [ ]

5. On TV [ ] 6.Telephone [ ] 7.Extension agents [ ] 8.Newspaper [ ] 9.Other…….

11. Do you have awareness about the quality or variety of rosemary that is important for market?

1. Yes [ ] 2. No [ ]

12. What type of farm land preparation method are you using?

1. Hand digging [ ] 2.oxen farming [ ] 3.both [ ]

13. Have you rosemary product storing facility?

1. Yes [ ] 2. No [ ]

14. If your answer is 'yes' for the question no.16, how can you waiting mechanism of product until marketing? .....

6. Extension Service

1. Do you have access to extension service?

1. Yes [ ] 2. No [ ]

2. Did you get extension service in relation to rosemary production in 2021?

1. Yes [ ] 2. No [ ]

3. If yes, what type of extension service did you get?

1. Technical advice	1. Yes [ ]	2. No [ ]
2. Price information	1 Yes [ ]	2. No [ ]
3. Input use	1. Yes [ ]	2. No [ ]

4. Other _____

4. How often the extension agent contacted you?

1. Weekly [ ] 2.monthly [ ] 3.quarterly [ ]

4. Twice in the year [ ] 5. Any time when I ask them [ ]

5. Have you ever heard about quality standards rosemary that is excellent for exporting?

1. Yes [ ] 2. No [ ]

If 'yes' from where? 1. Cooperatives [ ] 2.other farmers [ ] 3.From radio [ ]

4.Extension agents [ ] 5.Never heard [ ] 6.Other….

7. Other income

1. What is the type of off-farm activity in which the household is involved in?

1. Paid daily labor [ ] 2.Petty trade [ ] 3.Handcraft [ ] 4.Other, specify _____

2. What was the estimated amount of off farm income for last year (2021)? Birr.

3. How many livestock do you have? Ox _____, Cow ____ , Sheep _____, Goat_____, Donkey____, Mule_____, Horse ___, chicken_____

4. Please, could you tick the major constraints that you are facing to supply rosemary product in the market?

No.	descriptions	Yes	No
1	Access to improved seed		
2	Access to fertilizer		
3	Inconsistent demand		
4	Ownership of oxen for plough		
5	Price fluctuation		
6	Distance to market		
7	Access to price information		
8	Transport service		
9	Absence of demand		
10	Storage facilities		
11	Lack of awareness on the type of variety		
12	Lack of awareness on quality standard for marketing		
13	Shortage of farmland		
14	Less return from selling		

APPENDIX 2: Checklist for Focus Group Discussion (CFGD)

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Dear respondents and participants, this is Focus group discussion with rosemary producers and key informants in order to collect the data used to wright MSc. thesis on the title of factors affecting rosemary production and marketing of smallholder farmers in Silte zone, Ethiopia.

1. Is there land shortage for rosemary production? How do you transport the produce?
2. Which types of rosemary variety is common in the district? Why? What about availability?
3. What is the average amount of rosemary that can be produced from one ha of land?
4. What are the main strengths and weaknesses of the chain?
5. What are the major factors that affect producers‟ decision to participate in rosemary production and the amount they are supplying to the market?

APPENDIX 3: Lists of rosemary farmers attended in the FGD

No	Name	Village	Sex	Education status	Occupation in the value Chain
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Name of the KA …….., Place where the FGD held ……..,
Date of FGD ……..……, Starting time ……. Ending time ……...
Number of people who attend the FGD …….

Appendix 4: Checklists for Field observation

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1. How do the smallholder farmers carried out rosemary production?
2. What are the conditions of smallholder farmers and rosemary market in the district?
3. What are the main influential constraints that hinder production of rosemary for smallholder farmers?
4. What does hinder the participation of small holder farmer's in the rosemary marketing?
5. What is the perception of community /smallholder farmers regarding to rosemary production and marketing look like?
6. What are the contributions of DAs and other responsible bodies on production and marketing of rosemary?

Appendix 5: Conversion Factor for Tropical Livestock Unit (TLU)

No	Animal Category	Tropical Livestock Unit (TLU)
1	Calf	0.25
2	Weaned calf	0.34
3	Heifer	0.75
4	Cow and Oxen	1
5	Horse	1.1
6	Donkey (adult)	0.7
7	Donkey (Young)	0.35
8	Camel	1.25
9	Sheep and Goat (adult)	0.13
10	Sheep and Goat (young)	0.06
11	Chicken	0.013

Source: Storck *et al.* (1991)

Appendix 6: Assumption test results

```
Test scale = mean(unstandardized items)
Reversed item:  logEDU

Average interitem covariance:     .0714447
Number of items in the scale:           15
Scale reliability coefficient:      0.7096
```

Appendix 6.1:- Internal consistency test of Production factors result

```
Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of logY

H0: Constant variance

    chi2(1) =   0.38
Prob > chi2 = 0.5368
```

```
Ramsey RESET test for omitted variables
Omitted: Powers of fitted values of SRY

H0: Model has no omitted variables

F(3, 366) =    1.56
 Prob > F = 0.1986
```

Appendix 6.2.:- heteroscedasticity and omitted variable test in gross production regression and market decision result

```
. corr logGEN logEXT logMST logLPM
(obs=385)
```

	logGEN	logEXT	logMST	logLPM
logGEN	1.0000			
logEXT	0.3370	1.0000		
logMST	0.0228	0.1193	1.0000	
logLPM	0.0686	0.0154	-0.0073	1.0000

```
. corr GEN EXT MPI ST MP
(obs=385)
```

	GEN	EXT	MPI	ST	MP
GEN	1.0000				
EXT	0.0491	1.0000			
MPI	-0.0371	-0.0382	1.0000		
ST	-0.0708	-0.0602	0.0271	1.0000	
MP	-0.0265	-0.1879	0.0292	-0.0603	1.0000

Appendix 6.3.:- contingency coefficients of discrete and dummy variables in gross production and market decision test result

```
. sktest AGE EDU HHS PR OIF LAB SDL RFLS FEP TFLS SEP MDC TLU TFLS RFLS
```

Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	joint adj chi2(2)	joint Prob>chi2
AGE	385	0.7468	0.0587	3.69	0.1581
EDU	385	0.0901	0.4127	3.55	0.1691
HHS	385	0.1705	0.2069	3.48	0.1753
PR	385	0.0256	0.6976	5.14	0.0765
OIF	385	0.2176	0.1350	3.76	0.1522
LAB	385	0.0804	0.2246	4.54	0.1032
SDL	385	0.6508	0.1191	2.64	0.2667
RFLS	385	0.6050	0.3441	1.17	0.5573
FEP	385	0.1344	0.2412	3.63	0.1632
TFLS	385	0.3550	0.2106	2.43	0.2964
SEP	385	0.7647	0.0274	4.97	0.0835
MDC	385	0.8127	0.0787	3.16	0.2063
TLU	385	0.6547	0.7066	0.34	0.8430
TFLS	385	0.3550	0.2106	2.43	0.2964
RFLS	385	0.6050	0.3441	1.17	0.5573

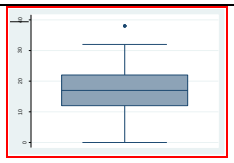
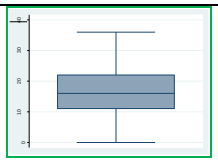
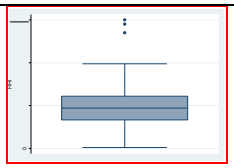
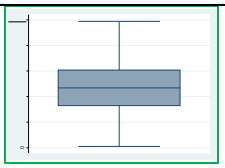
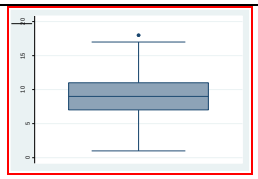
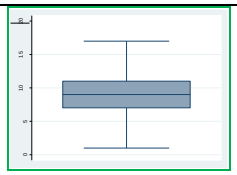
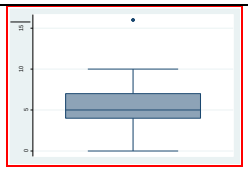
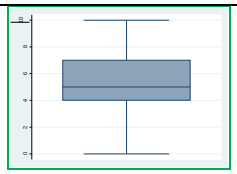
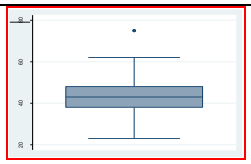
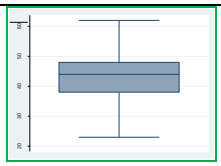
Appendix 6.5:- linearity assumption test result of continuous variables

```
. vif

    Variable |      VIF       1/VIF
-------------+----------------------
       logOIF |     2.56    0.391026
       logGEN |     2.50    0.400642
      logTFLS |     2.03    0.492931
      logRFLS |     1.99    0.503240
       logSDL |     1.61    0.622551
       logOXN |     1.49    0.669483
       logLAB |     1.37    0.731892
       logEXT |     1.28    0.781374
       logMST |     1.11    0.897511
       logFEP |     1.09    0.913569
       logAGE |     1.09    0.916235
       logLPM |     1.08    0.929038
       logHHS |     1.07    0.930680
       logEDU |     1.02    0.979230
-------------+----------------------
    Mean VIF |     1.52
```

```
. vif

    Variable |      VIF       1/VIF
-------------+----------------------
           Y |     2.85    0.350963
     logRFLS |     2.17    0.461608
         OXN |     1.80    0.555697
          PR |     1.35    0.741883
          ST |     1.26    0.796291
         AGE |     1.23    0.814931
      logHHI |     1.18    0.847673
         MDC |     1.18    0.848905
         TLU |     1.16    0.862666
         SEP |     1.11    0.903909
         GEN |     1.10    0.910251
         HHS |     1.07    0.935136
         EXT |     1.07    0.937190
         EDU |     1.04    0.964095
         MPI |     1.04    0.965340
-------------+----------------------
    Mean VIF |     1.37
```

Appendix 6.6:- variance inflation factor of continuous variables for production and market decision

Appendix Table 6.7:- outliers test before and after correction

variables	Before	After outlier correction
Surplus rosemary product		
Householder income		
Market distance		
Rosemary selling experience		
Householder age		
Education