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EFFECTS OF SOYBEAN VALUE ADDITION ON INCOME AND FOOD SECURITY OF FARM HOUSEHOLDS IN SABOBA DISTRICT

ANTHONY BILILEE BILANDAM

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THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL AND FOOD ECONOMICS, FACULTY OF AGRICULTURE, FOOD AND CONSUMER SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY IN AGRICULTURAL ECONOMICS

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DECLARATION

I hereby declare that this thesis is the result of my original work and that no part of it has been presented for another degree in this University or elsewhere:

Candidate's signature……………………………........ Date …03-03-2025…………

Name: Anthony Billiee Bilandam

Supervisor

I hereby declare that the preparation and presentation of this thesis was supervised following the guidelines on supervision of thesis laid down by the University for Development Studies.

Supervisor's signature……………….…..... Date…03-03-2025……………

DR. Margaret Akuriba

Signature…………………………………………………… Date: 03-03-2025…………

Head of Department: Prof. Benjamin Tetteh Anang

DEDICATION

This work is dedicated to Almighty God, my parents, my wife and children, and my brothers and sisters, whose unwavering support and encouragement have been instrumental in bringing this work to fruition.

ABSTRACT

Despite the increasing cultivation of soybeans in Saboba District, limited research exists on how value addition affects household income and food security. This study examines the impact of soybean value addition on the income and food security of farm households in Saboba District. A purposive and simple random sampling technique was used to select 401 farm households who were interviewed using semi-structured questionnaires. Additionally, desk research was conducted to review the relevant literature, and the Endogenous Switching Regression (ESR) model was employed to analyze the effects of soybean value addition on household income and food security.

The findings indicate that training on soybean value addition, access to inputs, tractor services, household size, sex of respondents, and membership in farmer-based organizations (FBOs) significantly influences farmers' participation in soybean value addition. While age, extension service access, and land ownership negatively affected participation, other factors such as training and access to processing inputs had a positive impact. The study reveals that households engaged in soybean value-added experience higher per capita income levels than non-participants. Additionally, soybean value addition significantly reduced household food insecurity by increasing food availability, affordability, and dietary diversity.

Based on these findings, this study recommends that the Ministry of Food and Agriculture (MoFA), in collaboration with non-governmental groups like the World Food Programme (WFP) and the Alliance for a Green Revolution in Africa (AGRA), promote soybean value addition among farmers as a strategy to improve household income. Furthermore, it is suggested that MoFA, along with key stakeholders such as the Ghana School Feeding Programme (GSFP) and the Savannah Agricultural Research Institute (SARI), integrate soybean value addition into food security strategies to enhance the nutritional outcomes and economic stability of farm households.

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ACRONYMS

FAO	Food and Agriculture Organization
FBO	Farmer-Based Organization
MoFA	Ministry of Food and Agriculture
NGO	Non-Governmental Organization
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
IITA	International Institute of Tropical Agriculture
SARI	Savannah Agriculture Research Institute
AGRA	Alliance for a Green Revolution in Africa
ESR	Endogenous Switching Regression
UDS	University for Development Studies
GSS	Ghana Statistical Services
USAID	United States Agency for International Development
DANIDA	Danish International Development Agency
MEDA	Mennonite Economic Development Associates
WFP	World Food Programme
GDP	Gross Domestic Product
YIA	Youth in Agriculture
UNDP	United Nation Development Programme
NRGP	Northern Rural Growth Program
GSFP	Ghana School Feeding Programme

CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture has traditionally been a cornerstone of Ghana's economy, however, recent data show that the services sector has become the largest employer, accounting for over 41% of the total employment, while agriculture employs approximately 39.5% of the workforce (Nyamekye *et al.,* 2021; Ferreira *et al.,* 2022). Additionally, the services sector now contributes more to Ghana's GDP, growing by 4.5% in the first half of 2024 compared to 5.1% growth in agriculture during the same period. The underperformance of the agricultural sector is mainly due to low crop yields among farmers. According to Fischer (2019), in the sub-Saharan Africa (SSA) region, average crop yields have stalled at below 30% of the potential yield of the region. Most agricultural production is carried out by smallholder farmers, who typically have land holdings of less than 2 hectares within farming communities. Low levels of modern technology adoption together with extremely low levels of processing activities add on to the challenges faced in the sector. The crop production sector in Ghana relies heavily on rainfall, which makes it highly vulnerable to climate variability. Additionally, only a small portion of the total cultivated land in the country is irrigated, further exposing farmers to the risk of erratic weather patterns. (Biczkowski et al., 2021). Given the importance of the agricultural sector on majority of livelihoods and its significance to the economy, there is the need for efforts to be made for its improvement (Todaro and Smith, 2011; Biczkowski et al., 2021).

According to the Ministry of Food and Agriculture (MoFA, 2020), the Northern region alone accounted for 373,707 households engaged in agriculture, which represents about

14% of the national total. An estimated 52.6% of the population in Northern Ghana resides in rural areas (GSS, 2020). These regions are key producers of cereals and legumes; however, like other parts of the country, their recorded yields remain significantly lower than achievable levels (MoFA, 2015). Agriculture in northern Ghana is particularly vulnerable to climate variability due to the unimodal rainfall pattern prevalent in these areas (Adu-Boahen *et al.,* 2019; Baffour-Ata *et al.*, 2021). In the Northern region, agricultural challenges, combined with widespread poverty, render rural communities more prone to food insecurity and other livelihood difficulties.

Food security is defined as a condition where all individuals have both economic and physical access to enough safe and nutritious food to fulfill their dietary requirements for a healthy and active life (FAO, 1996; Coates, 2007). In developing regions, food insecurity and poverty are particularly detrimental (Quaye, 2008; Asale et al., 2024). It is believed that smallholder farmers constitute half of the world's hungry population, and potentially three-quarters of those in Africa (Fan & Rue, 2020; FAO, 2020). The extent of food insecurity is particularly acute in sub-Saharan Africa. In Ghana, the problem of food insecurity is closely tied to poverty, particularly affecting the northern regions, which face greater food shortages than those in the south (Hesselberg and Yaro, 2006; Baba et al., 2021; Adjei-Nsiah et al., 2022). While the country has made significant strides in meeting the Sustainable Development Goal of reducing hunger by half (Duah *et al.*, 2020; Kipo-Sunyehzi *et al.*, 2024), this advancement has not been uniform, with the northern areas still trailing the national average (Kleemann *et al.*, 2017). Recent studies have highlighted the significant food insecurity in Northern Ghana. For instance, a study conducted in the Tamale Metropolis revealed that 86% of households were food insecure, 8.66% were severely food insecure, 36.67% were moderately food insecure, and 40.67% were mildly food insecure (Alidu, 2020). Another study reported that 60% of farm households in the Central Region of Ghana were food-insecure (Acheampong *et al.*, 2022). Given the severity of poverty, food insecurity, and hunger, numerous international organizations have allocated resources to address these issues in Ghana (Batinge and Jenkins, 2018). Many of these programs are concentrated in the northern regions, including initiatives such as the Northern Rural Growth Program (NRGP), Youth in Agriculture (YIA), USAID projects, and DANIDA projects, all of which promote soybean production and utilization through value chain improvements (Dogbe et al., 2013; Batinge and Jenkins, 2018; Odonkor, 2021). Over the past decade, significant research and investment have been dedicated to soybean in sub-Saharan Africa (Khojely *et al.*, 2018; Siamabele, 2021). Soybean was first introduced to Ghana in the early 20th century to enhance the nutritional quality of traditional diets (Mbanya, 2011). More recently, agricultural development programs have promoted the crop as a key protein source for both the livestock and aquaculture value chains, in addition to human consumption (Dogbe et al., 2013; Odonkor, 2021). In Ghana, more than 70% of soybean production comes from Northern Ghana (Mohammed *et al.,* 2016; Asodina *et al.,* 2020).

Various interventions targeted at soybean production saw an increase in yields from 110,264 MT in 2009 to 144,964 MT in 2010 (SRID, 2011). Irrespective of the increase in yields, the performance of soybean production in the country is pale in comparison when considering other countries like Nigeria, South Africa and Uganda on the African continent and that of China, India and the USA (Osman et al., 2018). The crop is growing in popularity among farmers in the country and the Northern region, especially in the Saboba district (Etwire et al., 2013; Adjei-Nsiah et al., 2022). Soybean holds significant importance for rural farming households in these areas of the country. According to Abass et al. (2020), the crop is perceived to be a major cash crop with small-scale farmers dominating production through relatively crude means. Its production is also being promoted by MoFA as a means of growing incomes and improving the nutritional status of households (Adjei-Nsiah et al., 2022; MoFA, 2020)).

Soybean processing in Ghana, like other soybean producing nations is done either on a large or small scale. According to Plahar (2006), large-scale soybean processing includes producing animal feed, extracting oil, creating soy flour and high-protein foods, as well as soymilk and soy curd. In contrast, household soybean processing typically utilizes simple, locally made machines (Abdulai and Al-Hassan, 2016). Locally processed or value-added soy products are in the form of weaning mix, dawadawa (local spice), soy dough, soy flour, tofu and soymilk among others. The sale of these products should likely supplement household income which ultimately leads to improved livelihood outcomes.

1.2 Problem Statement

Food insecurity and poverty are pressing challenges for marginalized populations in Sub-Saharan Africa (SSA). The impacts of these challenges are disproportionately felt by infants, children, and lactating mothers in deprived areas of SSA (Khojely et al., 2018). In many African households, diets often lack essential nutrients like iodine, iron, and vitamin A (Friesen *et al.,* 2020; Kubuga *et al.,* 2025). As a result, malnutrition-related issues such as stunting, underweight, wasting, and macronutrient deficiencies are prevalent, as highlighted by Kleeman (2017). In Ghana, it was estimated that in 2014, 19% of children under the age of five were stunted, while 11% were underweight (Ghana Demographic and

Health Survey, 2014). Despite the rates of stunting and underweights going down between 2003 and 2014, the numbers still remained relatively high in the northern parts of Ghana with records showing 33% stunting. Recent data indicate that malnutrition remains a significant concern in Ghana, particularly in the northern regions. Nationally, 17.5% of children under five years of age were stunted, 12% were underweight, and 6.8% were wasted. In the Northern Region, the prevalence of stunting was higher, with 33% of the children affected. These figures highlight the persistent regional disparities in child nutrition and underscore the need for targeted interventions to address malnutrition in vulnerable areas (Atosona *et al.*, 2025; DHS, 2022).

Poverty and food security are directly interconnected. According to the United Nation Development Programme, (2005), low-income countries depend more directly on natural resources than their high-income counterparts. High dependency on rain-fed agricultural production makes African farmers and their livelihoods extremely vulnerable to climatic and environmental shocks which partly causes food insecurity in the continent (Lesk et al., 2016). The northern part of Ghana is the poorest and most hunger-stricken part of the country (GSS, 2020). The poverty situations in these parts tend to limit their access to certain kinds of food and nutrient sources. Khojely et al. (2018) stated that high cost of animal sourced proteins generally tends to be out of the range of low-income households and this might be the case in The Saboba District. Soybean is an important crop in Northern Ghana. In 2012, this region represented more than 50% of the total land used for soybean farming in the country (Statistics Research and Information Directorate, 2012). Efforts to boost soybean productivity and production have led to the establishment of numerous demonstration farms by both government and non-governmental organizations in the region (Dogbe et al., 2012; Asodina et al., 2021). Etwire et al. (2013) noted that farmer adoption of soybean in the Saboba District is high, with the crop steadily gaining popularity.

Soybean production presents a great opportunity to bring economic relief to the livelihoods of households in Northern Ghana and to a large extent the whole country. Osman et al. (2018) highlight that soybean has the potential to enhance household incomes as well as improve food and nutrition security. Numerous studies have investigated soybean in Northern Ghana, covering various topics in different districts, including the Saboba District. However, there is a lack of research focusing specifically on the effects of soybean value addition on the income and food security of farming households in Saboba. This study intends to examine how soybean value addition influences the income and food security of these households in the Saboba District.

1.3 Research Questions

The questions guiding this research are:

1. What factors Influence soybean value addition in the Saboba District?
2. How does soybean value addition impact household income in the Saboba District?
3. How does soybean value addition impact the food security of households in the Saboba District?

1.4 Research Objectives

The main goal of this study is to assess the impact of soybean value addition on the income and food security of farming households in the Saboba District.

1.5 Specific objectives

1.6 The specific objectives of the study are to:

1. investigate the factors that influence soybean value addition among households in the Saboba District.
2. analyze how soybean value addition affects the incomes of households in the Saboba District.
3. evaluate how value addition affects the food security status of households involved in soybean farming in the Saboba District.

1.6 Justification of the Study

This study is crucial as it fills significant gaps in the existing literature and enhances the understanding of agricultural practices, household economics, and food security in the Saboba District of Ghana. Despite the increasing popularity of soybean farming in Northern Ghana, particularly in Saboba District, limited research exists on how value addition affects household income and food security. This study sought to address these gaps by providing empirical insights into the socioeconomic dynamics of soybean value addition.

For the government, the study aligns with Ghana's agricultural and economic development goals by supporting key policies under the Ministry of Food and Agriculture (MoFA). These findings will aid policymakers in formulating strategies to enhance agricultural value chains, improve rural livelihoods, and strengthen food security initiatives. Additionally, it contributes to the attainment of Sustainable Development Goals (SDGs), specifically SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 8 (Decent Work and Economic Growth), by providing evidence-based recommendations for poverty reduction and agricultural productivity.

For farmers, particularly smallholder soybean farmers, this study provides insights into how value addition can improve income levels and reduce food insecurity. Identifying the key determinants of participation in soybean value addition will offer farmers actionable knowledge of best practices, market opportunities, and strategies to maximize profitability. Increased access to value-added processes also enhances farmers' competitiveness and economic resilience.

For consumers, this study highlights the benefits of soybean value addition in increasing the availability and affordability of soybean-based food products. Improved processing, preservation, and diversification of soybean products can contribute to better dietary diversity, enhanced nutrition, and lower food prices owing to increased production efficiency. This is particularly important in addressing malnutrition and improving food security at household and national levels.

For non-governmental organizations (NGOs), such as the Alliance for a Green Revolution in Africa (AGRA), the World Food Programme (WFP), and USAID, the findings will be instrumental in designing targeted interventions to improve food security and rural development. This study can help NGOs prioritize investments in soybean processing, farmer training, and market linkages, ultimately fostering sustainable agricultural development and economic empowerment in rural communities.

This study contributes to the research on agricultural value chains, rural livelihoods, and food security. It provides empirical data on the effects of soybean value addition and serves as a foundation for future research in agricultural economics, rural development, and agribusiness.

These findings will be valuable to researchers, students, and institutions exploring the relationship between value addition, income, and food security, offering insights for further studies and policy recommendations.

1.7 Organization of the Study

This thesis is structured into five chapters. The current chapter functions as the introduction, providing the background, the problem statement that led to the study, the research questions, objectives, and the significance of the research. The second chapter is the Literature Review, which explores studies related to key concepts such as soybean value addition, food security, and income. Chapter three describes the study area, research design, data sources and types, theoretical and conceptual frameworks, measurements of key concepts, and the analytical methods used. Chapter four presents the results, both descriptive and based on objectives, while chapter five concludes with findings provide conclusions and draw policy recommendations from the conclusions.

CHAPTER TWO

LITERATURE REVIEW

2.0. Introduction

2.1 Soya beans and its importance

Soybeans offer both commercial and non-commercial benefits (Asodina *et al.,* 2020; Dukariya *et al.,* 2020). One significant non-commercial benefit of the crop is its capability to fix atmospheric nitrogen through biological nitrogen fixation (BNF), enabling farmers to use crop residues as feed for livestock. For resource-constrained farmers, the BNF capability significantly reduces production costs, especially for fertilizers. Moreover, soybean cultivation aids in controlling harmful parasitic weeds, such as Striga hermonthica, that impact other crops (David *et al.,* 2022). Thus, growing soybeans can be regarded as an effective smart agriculture strategy that improves soil fertility, resulting in higher yields of crucial staple crops like millet, rice, sorghum, and maize, which are vital for rural subsistence. Additionally, the crop serves as a cover crop, contributing to soil erosion prevention (IITA, 2015). From a commercial perspective, soybeans are processed into a variety of products, including soy oil, soymilk, soy flour, soy meat, soy spice, yogurt, biscuits, baby food, sauces, and breakfast cereals. These items are popular due to their affordability, appealing taste, and high nutritional content, significantly contributing to the daily protein intake of both children and adults (Anyalogbu *et al.,* 2021). Given that agricultural activities are primarily conducted by rural farmers relying on subsistence farming, value addition has become a crucial element of agricultural policy aimed at improving farmers' livelihoods. In recent years, there has been a growing focus on value addition in agriculture from both national and international authorities, recognizing its potential to extend the shelf life of agricultural products and improve farmers' incomes. This shift highlights a comprehensive approach that includes production, value addition, and marketing throughout the entire value chain, rather than relying solely on a production-centered strategy (Agwu *et al.,* 2015; Tobin *et al.,* 2016). Value addition does not necessarily entail altering a product; it may also involve adopting new handling or production methods that improve a farmer's skills and ability to meet consumer demands. By engaging in value addition, farmers can transform unprofitable operations into profitable ventures. They participate not only in producing raw commodities but also in enhancing their value, enabling them to tap into new markets or differentiate their products, thereby gaining a competitive edge (Trienekens, 2011).

Value addition activities aim to provide utilities such as form utility, time utility, location utility, and information utility, among others. As a product advances through the value chain, its consumption value increases. Liu (2000) noted that processed soybeans promote greater dietary diversity, offering consumers a wider variety of choices and nutritional benefits. Preservation, achieved through various methods, is the essential first step in soybean processing, guaranteeing year-round product availability (Liu, 2000). He also highlighted that value addition to soybeans can reduce post-harvest losses, allowing farmers to maximize their earnings and eliminate seasonality in the soybean supply chain. This chapter starts with a literature review that emphasizes the economic importance of soybeans, covering their global production and specific insights related to Ghana. It also explores concepts such as value chains, the soybean value chain, and food security, along with methods for measuring household food security and the study’s conceptual framework. Furthermore, the chapter examines existing literature on the factors affecting value addition among smallholder farmers and the impact of value addition on income and food security.

2.2. The Significance of Soybeans from an Economic Standpoint

Any rise in soybean production and productivity is likely to foster agribusiness development, leading to increased job opportunities. The growth rate of soybean production is outpacing that of other key crops. Soybean is a Worthwhile and commercially significant agricultural product for several reasons. It possesses advantageous agronomic traits, such as adaptability to different soils and climates, and the ability to improve soil fertility by fixing atmospheric nitrogen through root nodules and leaf decomposition at maturity (Uwaoma, 2015). Moreover, soybean has considerable economic importance as it meets the nutritional requirements of both humans and animals in various ways.

2.2.1. Soybean: An Important Source of Animal Feed

Soybeans and their byproducts play a significant role in animal feed, supplying vital oil and protein for both human diets and the animal feed industry. Rocha et al. (2008) noted that soybean meal is considered the best plant-based protein source in terms of nutritional value, effectively complementing cereal grains to meet the amino acid needs of livestock. Additionally, soybeans can serve as fodder, which can be converted into hay or silage. Moreover, soybean cake is an excellent source of nutrition for livestock and poultry. In many developing countries, particularly in rural areas, soybeans remain one of the most affordable and effective sources of protein for enhancing the nutritional quality of traditional diets. By the 1970s, the United States had significantly ramped up its soybean production, supplying two-thirds of the global market (Hartman *et al.*, 2011). Approximately 75% of soybean production is dedicated to animal consumption, which correlates with a rise in global meat production, especially in the pork and poultry sectors. Because of its high protein content, soybean flour is often favored by producers as animal feed compared to other options (Fehlenberg *et al.*, 2017). Goldsmith (2017) notes that only about 2% of soybean protein is consumed directly by humans, mainly in soy-based products like tofu, soy burgers, and milk alternatives. He adds that the vast majority, approximately 98%, is usually processed into soybean meal and used as feed for livestock such as pigs and chickens.

2.2.2. Soybean as a Source of Edible Oil

Soybean oil is popular for its flavor, nutritional benefits, and versatility in cooking. There has been significant growth in its consumption in recent years (Goldsmith, 2017). In comparison to other legumes and animal fats, soybean oil is comprised of around 85% unsaturated fat and is free from cholesterol (Agada, 2014). This suggests that soybeans have considerable potential to enhance the well-being and nutritional status of economically disadvantaged farming families. In addition to its nutritional benefits, soybeans possess medicinal properties that can aid in treating and preventing malnutrition, particularly in children. They are also beneficial in managing conditions such as diabetes, cancer, hypertension, ulcers, heart disease, and weight loss associated with HIV/AIDS (Agada, 2014). Due to its high unsaturated fatty acid content, including linolenic and linoleic acids, soybean oil is recognised as a healthy option (Raes *et al.,* 2004). The quality of the oil is considered superior (Uwaoma, 2015). Soy protein provides all essential amino acids in quantities that meet the nutritional requirements of humans and animals alike. Dashiell (2008) indicates that one kilogram of soybeans offers the same amount of protein as two kilograms of boneless meat, 45 cups of cow's milk, or five dozen eggs. In human nutrition, soy protein has various applications; it is frequently used to complement animal protein sources at a reduced price per unit. As an illustration, separated soy proteins can be combined with milk, fish, or meat to make processed foods like canned beef and sausages. Furthermore, soybean oil is utilized to enrich cereal products, including bread, cookies, and spreads (Naik and Gleason, 2010). Soybeans are also used to create high-protein foods for children, enhancing the protein quality and content of local cuisines.

2.2.3. Soybean as a Source of Foreign Exchange

Soybeans are a crucial source of foreign exchange for Latin American nations, particularly Argentina and Brazil. On the other hand, nations with strong processing sectors but low levels of soybean output turn to soybean exports in order to retain their labour force and continue operating and meeting the growing needs of the meat production sector for feed (Chete *et al.,* 2014). The production of soybeans, a growing cash crop that is improving living conditions for women and children in addition to soybean producers, is completely changing the rural economy. In some parts of Asia, soybean sales contribute to 30 to 60 percent of a farmer's average cash income, which is primarily used to buy inputs for the subsequent planting season. According to studies, the top exporters of soybean meal nowadays are Brazil and Argentina, accounting for 64% of global exports; the top importers of soybean meal are France, the Netherlands, and Italy, with 23% of imports. China has made a commitment to boosting its processing capacity since the mid-1990s. The country has updated its policies to encourage the use of soybean oil for human consumption and soybean meal for animal feed. As a result of this shift, China has emerged as a major importer of soybeans, primarily sourcing them from Brazil and the United States to sustain its expanding processing industry. Brazil exports 73% of its soybean production (including a small amount from imports), with 48% of the soybeans exported as meal and 52% as whole beans, driven by China's demand and Brazil's relatively small livestock sector (Goldsmith, 2017). Worldwide, there is a strong demand for soybean meal, as seen by the year-over-year rise in its production, imports, exports, and consumption. According to Fehlberg *et al.* (2017), there has been a comparable trend in recent years in both the worldwide production and consumption of soybean oil.

2.2.4. Soybean as a major raw material for industry

A vast array of industrial goods, including oil, soap, cream, inks, pastels, plastics, textiles, and biodiesel, depend on soybeans as a raw ingredient. Many enterprises have been established as a result of the conversion of soybean grains into consumable goods for human consumption. This provides a significant source of employment for a large number of individuals worldwide, which helps to lower the global unemployment rate. After China and Brazil, the United States continues to be the largest processor of soybeans. Soybean oil and meal are produced mostly from processed or crushed soybeans worldwide (Ali and Singh, 2010). Of the overall amount of food produced, 3 million metric tonnes are thought to be consumed directly by people, or 2% of the soybean production (Goldsmith 2008). The processing sector is crucial for providing adequate nutrition to the large population, as it effectively addresses the daily food requirements of different social classes in urban, semi-urban, and rural areas (Ogunsumi et al., 2005).

2.3. Global Soybean Production

The top three soybean producers in the world are the United States, Brazil, and Argentina, where the crop is cultivated over a vast geographic area. Over the past forty years, soybeans have seen the largest percentage increase in annual cultivation area among major food crops, expanding from 29 million hectares in 1968 to 97 million hectares in 2008. This represents nearly 6% of all farmland globally, although it remains behind maize, wheat, and rice in total cultivated area (Hartman *et al.*, 2011). The key factor driving soybean farming is its versatility, with applications in feed, oil, and various other products. Global demand for soybean oil has risen and is expected to continue increasing as the world's population grows, developing economies expand, and wealthier consumers shift their dietary preferences (Dei, 2011). Supermarkets today are filled with processed foods that list vegetable oil among their ingredients, as oil is commonly added to enhance flavour, provide additional nutrition, and improve cooking processes. As a result, soybean oil consumption has increased significantly over the past decade, with annual usage in Brazil and China reaching approximately 15% and 40%, respectively. While China averages 4 kilograms of soybean oil per person, Brazil leads in consumption at approximately 30 kilograms per person. In contrast, the United States consumes around 27 kilograms of edible soybean oil per person, reflecting a 21% decline over the past ten years (Goldsmith, 2017). Recently, the U.S. seems to have shifted its emphasis from high levels of human consumption to biodiesel production, creating a new and significant market for soybean oil, which now represents 15% of the country's requirements (Goldsmith, 2008). In Sub-Saharan Africa (SSA), soybean production has experienced substantial growth, increasing from approximately 20,000 hectares and 13,000 tonnes in the early 1970s to 1,500,000 hectares and 2,300,000 tonnes by 2016 (Khojely *et al.*, 2018). If cultivation had been implemented on the roughly 600 million hectares of arable land available in this region, production could have been significantly higher. Sub-Saharan Africa, approximately between 15° N and 35° S, this region is located south of the Sahara Desert and spans 21.2

million square kilometers, of which less than 10% is now under cultivation. Currently, South Africa, Nigeria, Zambia, and Uganda are the top soybean producers in the region (Khojely *et al.*, 2018).

2.4. Soybean Production in Ghana

In Ghana, soybeans are a relatively recent introduction to agriculture. Soybeans were introduced to the country in the early 20th century as a food crop to enhance the nutritional value of traditional diets (Mbanya, 2011). Initially grown for local consumption and rotated with maize because of their nitrogen-fixing capabilities, soybeans have recently garnered considerable attention as a crucial feed source for the growing livestock and aquaculture industries, as well as for human consumption (Dogbe *et al.*, 2013).

Consequently, smallholder farmers now regard soybeans as a potential new income source. Additionally, Ghana, along with other Sub-Saharan African countries, is promoting local soybean cultivation to decrease reliance on imported raw soybeans and soybean meal. The Ghanaian cedi experienced a notable devaluation of 40% in the third quarter of 2014, leading to increased costs for domestic consumers, including those in the poultry industry, for imported soy products. Furthermore, the unfulfilled domestic demand for soybeans limits exports to neighboring countries (MEDA, 2015). Therefore, enhancing local soybean production could serve as a strategic measure for policymakers seeking to reduce currency outflows and stimulate both local and national economic growth. With the high demand for soybeans and their potential to increase smallholder farmers' incomes, agricultural development initiatives and government efforts have intensified to promote soybeans and raise awareness in farming communities. This has resulted in increasing acceptance of soybean farming among smallholder farmers in Ghana (Dogbe *et al.*, 2013).

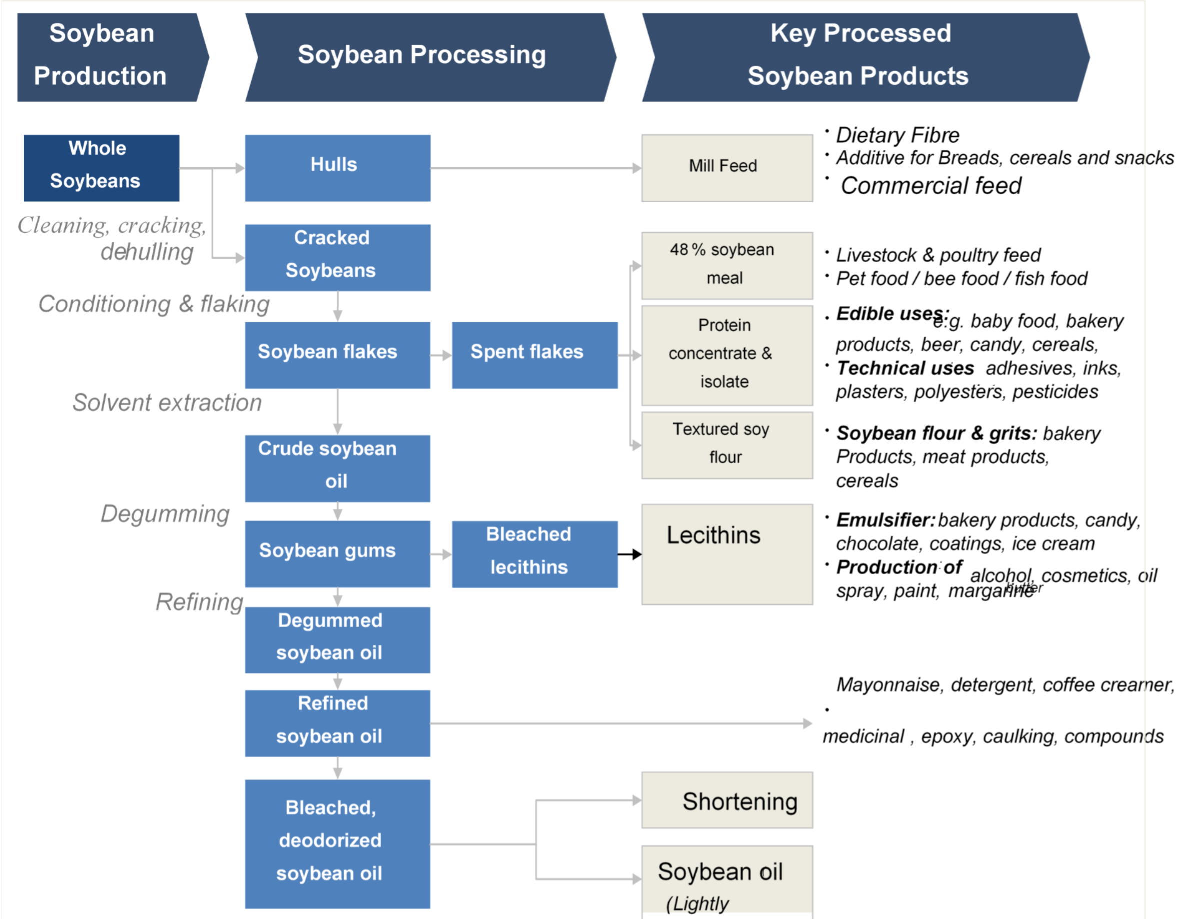
However, average soybean yields in the country are still significantly lower than global averages. The Northern Region comprises about 70% of Ghana's soybean acreage and contributes 77% of its total production, with average yields between 509 and 642 kg/ha. These yields represent only 25% of the global average of 2,310 kg/ha (Masuda & Goldsmith, 2009) and just 30% of the national average of 1,910 kg/ha (Dogbe *et al.*, 2013). The low yields are primarily due to a production environment characterized by minimal inputs and outputs. Research by Awuni and Reynolds (2016) indicates that improved agricultural practices and inputs could potentially quadruple the yields of existing soybean varieties. As noted by Mbanya (2011) and Dogbe *et al.* (2013), a limited number of smallholder farmers utilize rhizobium inoculants and other improved agricultural techniques, such as fertilizers, pesticides, and effective management practices like row planting and optimal plant density. A study conducted by Dogbe *et al*. (2013) found that only 2.5% of female farmers and no male farmers reported using inorganic fertilizers for soybean production. Additionally, many smallholder farmers in Ghana do not adopt effective weed control strategies, which adversely affects both production costs and yields. Due to inadequate management practices, farmers typically engage in three weeding sessions during the growing season: one two to three weeks after planting, another four to six weeks later, and a final session eight to ten weeks post-planting (Dogbe *et al.*, 2013). This low-input production scenario is largely a result of limited awareness and motivation among farmers, compounded by challenges regarding the cost and availability of necessary inputs. Dogbe *et al.* (2013) and Mbanya (2011) indicate that many farmers lack knowledge of better production methods, such as using rhizobium inoculants. Moreover, some farmers prioritize investing in technologies that improve yields of staple crops, which are more marketable or easier to consume at home. There is also a common belief among some smallholder farmers that soybeans, being nitrogen-fixing legumes, do not require fertilizers for optimal growth. In addition, the poor infrastructure for soybean seeds contributes to low yields. Most farmers depend on seeds saved from their own harvests rather than certified planting seeds (Mbanya, 2011). When they do seek certified seeds, options are scarce; in 2011, only one soybean variety was produced by commercial seed producers, whereas six maize varieties, four rice varieties, and three cowpea varieties were available (Tripp & Mensah-Bonsu, 2013). That year, certified seed producers yielded only 189 metric tons (MT) of soybeans, compared to 2,670 MT of maize and 2,367 MT of rice (Tripp & Mensah-Bonsu, 2013). Consequently, farmers struggle to find appropriate certified soybean seeds suited to their agro-ecological conditions and often face difficulties acquiring enough seeds for their production needs. This combination of accessibility issues, along with challenges related to cost, awareness, and farmers' preferences, contributes to the low-input, low-output scenario in soybean production in Ghana.

2.5. The Concept of Value Chain

The concept of the value chain has played a crucial role over the years in identifying and developing projects aimed at enhancing agricultural enterprise development (Vermeulen et al., 2008). As defined by Porter (1985), a value chain encompasses all processes involved in bringing an idea through various stages of production, transformation, and delivery to the end user, ultimately leading to the product's disposal after use (Zamora, 2016; Kuwornu et al., 2013). Value addition refers to the process of converting a product from its original state into one with greater value, achieved through value creation, advanced industrial innovation, or both (Mmasa, 2013). This process enhances a product regardless of whether the individual is the original producer. It includes elevating any product to the next level, increasing the value perceived by customers, and innovating to improve existing products or create new ones or new applications for them. Stakeholders in the value chain include input suppliers, manufacturers, processors, exporters, and buyers, all of whom perform essential functions to transition a product from its initial creation to its final use (Kaplinsky and Morris, 2000). The ongoing retail revolution is transforming how agricultural commodities are produced, sourced, and sold on a global scale. Rapid changes in today's dynamic markets have a significant impact on the competitiveness and long-term profitability of small-scale agricultural producers, affecting every segment of the value chain, from input suppliers to producers, processors, wholesalers, retailers, and consumers (Vermeulen *et al.,* 2008). Value addition is gradually replacing traditional business models, where a commodity is produced and sold directly to the market, by focusing on identifying consumer needs and designing products to meet those requirements (Coltrain *et al.*, 2000). The demand for value-added products is growing in response to the evolving global economy, with market factors creating more opportunities for product differentiation. This is driven by increasing consumer demands for convenience, nutrition, and health, along with processors' efforts to enhance output and technological advancements that enable production to meet demand (Royer, 1995). Value addition is believed to enhance the benefits for both participants in the value chain and the broader economy (Roy *et al.*, 2013; Ntale *et al.,* 2014). In the agricultural context, value addition involves processing agricultural products by combining various resources—such as ingredients, raw materials, tools, labor, knowledge, and skills—to elevate the product's value beyond its initial form (Boehijie *et al.,* 1999). According to Ja'afar-Furo *et al.* (2011), the idea of value addition in agriculture is increasingly recognized by both governmental and non-governmental organizations as an effective strategy for increasing revenue generation in rural areas, especially in developing economies. Lu and Dudensing (2015) emphasise that value-added agriculture is a critical tactic for rural development and agricultural entrepreneurship. Many value-added activities require investment, scalability, and specialized skills; however, simpler changes—such as cooling milk or drying fruit—can also increase value. Producers focused on value addition should aim to create products that fill market gaps or meet consumer demands. Rather than just launching a product and hoping it will be accepted, producers can utilize value-added strategies for business growth by gaining insights into the needs of their target markets and consumers (Boland, 2009). Sarma et al. (2016) describe value addition as any process that brings a raw product closer to a form that effectively meets consumer demands. This transformation allows the product to better align with customer preferences. The emphasis on enhancing the value of raw agricultural products has gained considerable attention as a strategy to improve farm profitability. Most agricultural raw materials have intrinsic value, and a variety of methods can be used to increase this value, including processing, distributing, cooking, churning, culturing, grinding, hulling, extracting, drying, smoking, sorting, cleaning, cooling, packaging, and processing. This practice is commonly referred to as food processing (Born and Bachmann, 2006). Latynskiy and Berger (2017) carried out a study in Uganda that evaluated how group certification affected smallholder coffee producers' incomes. The research discovered that participating households experienced a slight but positive impact. Nevertheless, because of the associated costs, it was found that certification added little value. The adoption of the value addition form and a rise in farmer group membership were suggested in order to improve the benefits associated with packaging and certification. Oluoch (2016) found that farmers' incomes rose with the level of value added to their raw sweet potato tubers. The study also revealed that marketing organizations held more negotiating power compared to individual farmers.

2.6. The Soybean Value Chain

Soybean is a versatile legume that can be the basis for various food products. It serves as a significant source of protein, which can be fed to animals either directly or indirectly. The soybean also produces a small quantity of oil as a byproduct, suitable for cooking purposes. Among the processed soybean products, soybean meal—primarily used as animal feed for poultry and pigs—is the most widely produced globally (Dei, 2011). This meal is created from soybean flakes that are extracted from the oil during mechanical or solvent-assisted processing. The high protein content of soybean meal sets it apart from other feed stocks, making it a very high-quality feedstock (Park *et al.,* 2017). Of the mass of soybeans, 15–18% are converted to oil. While soybeans are rarely grown with this as their primary goal, a tiny but increasing percentage of their oil is used as a feedstock for the production of biofuel. Soybeans are utilised to create food products for human consumption based on regional preferences. This practice is especially prevalent in East Asia, while in Africa, countries like Malawi view soy pieces as an appealing and affordable alternative to meat. Although various soybean products are available in industrialised nations like the US, similar offerings are generally lacking in the soybean industries of emerging markets. Below is a diagram illustrating the soybean value chain.



Source: Adapted from World Initiative for Soy in Human Health (WISHH)

Figure 2.1: Soybean Value Chain

2.7. Determinants of Smallholder Farmer Value Addition

Numerous factors significantly impact farmers' decisions regarding value addition in agriculture, including education, access to market information, farming experience, market distance, production quantity, and membership in farmer groups (Korir, 2018; Eze, 2022; Wangu *et al.*, 2020; Ejechi, 2023; Adeyonu *et al.*, 2016; Mhazo *et al.*, 2015; Amentae *et al.*, 2016; Thindisa, 2014; Orinda *et al.*, 2017). Extensive research has identified these influences on farmers' choices to enhance the value of their crop yields. For instance, Wangu *et al.* (2020) highlighted various socioeconomic factors, such as land size, farm income, number of crops grown, access to loans, and the age and educational level of household heads, that affect value addition decisions. Similarly, Thindisa (2014) pointed out that both internal and external factors, including socioeconomic conditions, institutional services, and cognitive skills such as education level and market experience, play a role in this process. Orinda *et al.* (2017) found that group participation, marketable surplus, distance to markets, availability of loans and extension services, and total production quantity significantly and positively influence value addition. They observed that farmers who collaborate in groups can share ideas and information, benefit from economies of scale, lower costs, and ensure coordinated production, marketing, and training. These factors collectively increase their chances of participating in value addition. The study indicated that farmers farther from markets tend to add value to their crops due to better prices in distant markets, the perishable nature of products like sweet potatoes, and the necessity of processing to reduce transportation costs. On the other hand, factors like household size, land size, and access to off-farm income had a negative effect on the adoption of value-adding activities. Larger households often consume a greater portion of their harvest, resulting in less available for sale or processing. Moreover, Sebatta *et al.* (2015) found that access to agricultural extension services, market distance, and quantity harvested positively influenced value-adding activities. However, their research showed a strong negative association between value addition and off-farm income, with no correlation found between value-adding activities and household size, availability of contracts, or credit facilities. In Ethiopia's Bacho and Dawo districts, Amentae *et al.* (2016) identified that farmers' decisions to add value were significantly affected by access to extension services, education level, farming experience, market prices of value-added products, and proximity to markets. Mapiye *et al.* (2007) emphasised the importance of research and extension services for South African communal Nguni cattle producers, noting that these services enable farmers to utilise modern inputs, increase awareness of value-adding activities, and access market information. Orinda (2013) identified factors such as household size, total production quantity, loan availability, land size, market distance, and group membership as influential in value addition participation. Additionally, Mhazo *et al.* (2015) suggested that small-scale processors in Zimbabwe could diversify their post-harvest activities if provided with market information and skills, leading to access to formal markets and greater profits. According to Adeyonu *et al.* (2016), household size, visits from extension agents, access to credit, membership in associations, and training all play significant roles in determining the level of value addition, with credit access, training, and harvested quantity notably influencing value addition decisions. Tadesse *et al.* (2017) identified factors affecting households' decisions to add value to milk, including age, education level of the household head, number of young children, labour force access, and longer shelf life. Ejechi (2023) highlighted key factors influencing value addition to sweet potatoes, such as gender, education level, agricultural status, farmer group membership, and access to financing. Eze *et al.* (2022) noted that processors' preferences for adding value to cashew products increased with age, educational level, income, processing experience, market access, market distance, government policies on cashew processing, and market facilities. Korir (2018) identified the total land size, cost per unit of potatoes, and group membership as the primary factors affecting value addition in Bomet County. Lastly, Mkandawire (2018) found that geographical factors, gender, number of firms, animal farming, and program participation significantly influenced the decision to engage in value addition.

2.8. The Concept of Food Security

Early definitions of food security primarily addressed global and national perspectives. For instance, the World Food Conference of the United Nations defined food security as "the availability, at all times, of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (FAO, 2008; Burchi & De Muro, 2016). While this definition addresses food availability at various levels—global, national, community, and household—the term "enough" remains unclear (Pinstrup-Andersen, 2009). It raises important questions about whether the available food meets economic demands, the prices at which it is accessible, and whether it fulfills nutritional and energy needs (Pinstrup-Andersen, 2009). At the national level, there is often a focus on the supply side, emphasizing the need to align food availability with the needs of the population. This perspective suggests that food production must exceed population growth to maintain balance, as advocated by the international community (Burchi & De Muro, 2016). However, this approach has its limitations; simply having food available does not ensure that everyone has access to it. Additionally, providing sufficient calories does not guarantee a healthy and nutritious diet (FAO, 2009; Pinstrup-Andersen, 2009). For food security to genuinely improve individual or family well-being, equitable distribution is essential, meaning all individuals must have access to food. Recognizing this issue, Pinstrup-Andersen redefined food security in the mid-1970s as "access by all people to enough food to live a healthy and productive life" (Pinstrup-Andersen, 2009). Subsequently, the FAO revised this definition to include nutritional value and dietary preferences. Originally focused on supply, the concept has evolved to encompass multiple dimensions of food security. This study adopts the definition established at the 1996 World Summit and reaffirmed in 2009 (Ecker & Breisinger, 2012), stating that food security exists when "all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food necessary to meet dietary needs and food preferences for a healthy and active life" (Pinstrup-Andersen, 2009). This comprehensive definition includes four key dimensions: availability, accessibility, utilization, and stability. Food availability pertains to the supply of sufficient food to meet per capita energy requirements, sourced from either local production or markets at the household level. Accessibility involves having the physical and economic means to acquire adequate quality and quantity of food for a healthy diet, with an emphasis on purchasing power. Utilization refers to individuals' ability to select nutritionally appropriate foods and the resources available for food preparation and storage. Lastly, stability necessitates a consistent food supply over time (Pinstrup-Andersen, 2009; Hendriks, 2016). To be classified as food secure, a household must fulfil all four dimensions. In the 1996 summit definition, the terms "safe" and "nutritious" emphasize the importance of food safety and nutritional quality, while "preferences" shift the focus from merely having sufficient food to ensuring access to preferred food options (Burchi & De Muro, 2016). This distinction highlights that even with equal access, individuals may experience different levels of food security based on their personal preferences (Pinstrup-Andersen, 2009). It is crucial to recognize that access to food and adequate nutrient intake are significantly shaped by intra-household dynamics, resource distribution, household preferences, and consideration of individual dietary needs. In this context, the roles of the household decision-maker and the individual responsible for meal preparation and child feeding are pivotal in shaping intra-household food security (Ecker & Breisinger, 2012). Additionally, gender equality and nutritional awareness among those making household decisions are essential for resource allocation, particularly for young children, as various health issues, such as stunted growth, are associated with lower levels of maternal education (Le-Anh & Nguyen-To, 2020).

2.9. Measuring Household Food Security (HFS)

Food security indicators are essential for objectively assessing the food security status of households. However, due to the complex nature of food security, measuring it through a single indicator is challenging (Maxwell *et al.,* 2014; Nkomoki *et al.*, 2019; Sandoval *et al.*, 2020; Vaitla *et al*., 2020). Common indicators used to evaluate household food security include availability, access, utilization, and stability, which can be divided into quantitative and qualitative measures (Jones *et al*., 2013; Kennedy *et al*., 2010; Leroy *et al*., 2015). Quantitative measures, such as the FAO index, household income and expenditure surveys, and anthropometric data, are often utilized at the household level. However, these methods can be challenging to implement, often requiring significant time and financial resources (Jones *et al*., 2013; Leroy *et al*., 2015; Napoli, De Muro, & Mazziotta, 2011). On the other hand, qualitative measures like the Household Hunger Scale (HHS), Household Dietary Diversity Scale (HDDS), and Food Consumption Score (FCS) have become more popular due to their ease of data collection (Jones *et al.*, 2013). To effectively evaluate food security, it is crucial to use a combination of measures and indicators that encompass all aspects of food security, including availability, access, utilization, and stability. Seven primary household-level indicators are commonly employed for this purpose: The Household Food Insecurity and Access Scale (HFIAS), Coping Strategies Index (CSI), Reduced Coping Strategies Index (rCSI), Household Hunger Scale (HHS), Household Dietary Diversity Scale (HDDS), Food Consumption Score (FCS), and self-assessment of food security (SAFS).

2.9.1 Household Food Insecurity and Access Scale (HFIAS)

The Household Food Insecurity Access Scale (HFIAS) was created between 2001 and 2006 as part of the USAID-funded Food and Nutrition Technical Assistance II project (FANTA), in partnership with institutions like Tufts and Cornell Universities. Its main goal was to develop a reliable tool for assessing food insecurity in developing nations, enabling cross-cultural comparisons (Coates *et al.*, 2007). The HFIAS focuses on evaluating household behaviors and psychological responses to food insecurity, such as decreasing meal sizes and compromising food quality when resources are limited. This methodology is grounded in the idea that there are consistent mental and physical responses to food insecurity that can be measured and summarized through a scale (Coates *et al.*, 2007). The scale includes nine questions about experiences related to food insecurity, along with another nine that inquire about the frequency of these experiences over the past thirty days. These questions address concerns such as anxiety over food availability, the quality of the food, and physical effects related to food insecurity. To derive an HFIAS score, researchers sum the response codes from the frequency questions, where a score of 0 means "no" and a score of 3 means "often." The total score ranges from 0 to 27, with higher scores indicating a greater severity of food insecurity faced by the household.

2.9.6 Household Dietary Diversity Score (HDDS)

The Household Dietary Diversity Score (HDDS) was established in 2006 as part of the Food and Nutrition Technical Assistance (FANTA) initiative, which focuses on enhancing food access (Swindale and Bilinsky, 2006). This metric evaluates the variety of food types consumed within a specific period, usually the last 24 hours. The HDDS is a significant indicator as it reflects both macronutrient and micronutrient diversity in a household's diet. It is also crucial for measuring nutrition security, as research has shown a strong link between dietary diversity and child growth (Headey & Ecker, 2013). Studies indicate a solid correlation between household dietary diversity, per capita intake, daily caloric availability, and various anthropometric indicators of nutritional health. Households that can afford a wider range of nutrient-dense and higher-cost foods typically exhibit better dietary diversity (Headey & Ecker, 2013). The HDDS assesses how many different food types (out of a total of eight) were consumed by the household in the previous week, serving as an indirect indicator of the household's socioeconomic status. Data for the HDDS is collected using a 24-hour recall method, which records the variety of food types prepared and consumed by the household. A series of yes-or-no questions are employed to gather information for the HDDS indicators. The HDDS is treated as a continuous variable, with its score calculated by summing the responses, resulting in a value between 0 and 9.

2.9.7 Self-Assessed Food Security (SAF)

The Self-Assessment of Food Security (SAF) is a subjective measure that can be readily influenced within programming contexts. It involves self-reported assessments of a household's current food security status and how their livelihood has changed over time. Despite its subjective nature, the SAF is valuable for understanding a household's awareness of food security issues (Maxwell *et al*., 2014). Tinonin *et al*. (2016) note that the SAF measure was developed by asking households how long they could sustain their food supplies from the previous production season. While using a combination of indicators can strengthen advocacy and intervention strategies, it’s important to recognize that these indicators may differ across various contexts (Maxwell *et al*., 2014). Research on this topic in West Africa is limited, with most studies focusing on three primary indicators: Household Dietary Diversity (HDD), Food Consumption Score (FCS), and Self-Assessment of Food Security (SAFS) (Butaumocho & Chitiyo, 2017; De Cock *et al.*, 2013; Faber et al., 2009; Gandure *et al*., 2010). Some indicators emphasize specific aspects of food security more than others; for example, both HDD and FCS mainly address the quality aspect of the access dimension, while SAFS also includes considerations related to stability (Maxwell *et al*., 2014). Therefore, it is essential to evaluate whether the factors influencing food security are consistent across different measurement approaches.

2.10. Effect of Value Addition on Household Income

Numerous studies have concurred that farmers can increase their earnings and diversify their sources of income through value addition. For instance, Golleti and Samman (1999) draw attention to the potential for post-harvest and value-added activities to reduce poverty in their study. They point out that improvements in processing and market chains, together with decreases in urban food prices and increases in rural income and employment, all contribute to these gains. In his research on the effects of value addition on household incomes, Ramirez (2001) found that participating in value-added activities can increase household income by as much as 350%. Similarly, Pravakar *et al.* (2010) noted that adding value to agricultural sales significantly boosts farmers' incomes. Wanyama *et al.* (2013)

also pointed out that the benefits of value addition on household income differ considerably between male- and female-headed households. Umeh (2013) highlighted that various cassava value-added products generate different income levels in the domestic market. Sebatta *et al.* (2015) conducted a break-even analysis to evaluate how value addition to potatoes influenced farmers' incomes in Uganda. Their results showed that farmers who engaged in value addition earned 40% more than those who did not. The study further revealed that the market prices for value-added seed potatoes were 30% higher than for non-value-added products, with value-added potato products reaching a maximum price of UGX 1,200 per kilogram, compared to only UGX 150 for non-value-added items. This indicates that value addition in potato farming is an effective strategy for improving farmer incomes. Oluoch (2016) assessed the impact of sweet potato value addition on farmers' incomes in Homabay County, Kenya, using a multiple regression model. The study concluded that greater value addition to raw tubers was associated with increased market income for farmers. In a related study, Korir (2018) found a significant difference (P = 0.028) in gross margins between those who added value and those who did not, with non-value adders losing approximately UGX 29,306 per acre, while value adders gained UGX 16,676 per acre. He also noted that value adders consistently earned more per unit area than their counterparts. Similarly, Mkandawire (2018) discovered that farmers engaged in value addition achieved better gross margins per unit of product compared to those who did not. Ettah and Okorie (2018) also reported that processing 1 kg of soybean into soymilk increased its value from ₦250 to ₦1,200, while soy flour's value rose from ₦250 to ₦1,000, underscoring the profitability of soybean processing. Alalade et al. (2019) reinforced this conclusion, stating that greater value addition by farmers led to improved income levels.

2.11. Value addition and food security linkage

Value addition refers to the enhancement of a commodity's utility by adjusting its time, place, and form to align with consumer preferences and tastes. This process converts perishable grains, fruits, and vegetables into stable products, enhancing food quality through various techniques such as physical processing, chemical changes, and fermentation. Methods of value addition include altering the product's form or color, extending the shelf life of perishable items, and ensuring that food is available year-round. Common preservation techniques encompass thermal processing, pickling, fermentation, freezing, and dehydration. By reducing food spoilage throughout the supply chain—from production to consumption—value addition is crucial for achieving food security through effective processing, packaging, marketing, and consumption strategies (Ngugi *et al.*, 2020). Additionally, processed foods increase product availability beyond their original production areas and seasons, thus stabilizing supplies and improving individual food security (IITA, 2015). Value addition also empowers households to maximize their economic potential (WFP, 2020). Furthermore, it reduces risks associated with food systems by ensuring a safe and nutritious food supply, addressing foodborne diseases linked to bacteria, viruses, parasites, and chemical contaminants. Overall, value addition enhances the value of agricultural products, promotes agricultural productivity, stabilizes food supply, and ensures that vulnerable groups—such as children, women, and the elderly—receive adequate nutrients, including essential micronutrients through food fortification (Aworh, 2020). According to Fagbemi and Oluwajuyitan (2020), value addition serves as a crucial driver of sustainable agribusiness, particularly in sub-Saharan Africa, where there is a strong demand for agricultural exports. Despite facing issues like youth unemployment, food insecurity, poverty, and rising insecurity, Nigeria has vast untapped agricultural resources, especially in the food sector. Ngugi *et al*. (2023) established a significant link between value addition in agricultural products and household food security, noting a confident and linear relationship between the two. Moreover, Ngugi *et al.* (2020) highlighted that value addition is the process of converting raw materials into high-quality finished products. Examples of this include making salsa from tomatoes, pesto from basil, and jams or jellies from berries, as well as pre-cut and packaged vegetables for convenient cooking. The potential for value addition presents substantial opportunities for national growth, employment, and household food security. However, empirical evidence linking value addition directly to food security remains limited.

2.12. Conceptual Framework

The conceptual framework of this study defines key concepts, establishes relationships among them, and highlights significant interactions based on the existing literature. It serves as the foundation for the research problem and helps understand the objectives of the study. Farmers decide whether to engage in soybean value addition based on expected benefits and influencing factors. Utility Maximization Theory supports this by explaining how farmers assess the economic gains of value addition against potential constraints. This study posits that a farmer's decision to add value to soybean production is influenced by three main factors: farm, socioeconomic, and institutional factors. Farm characteristics, such as farm size, soybean output, sources of labor, off-farm activities, farm expenditures, years of farming experience, and distance to markets play a critical role in determining a farmer's ability to process soybeans. Socioeconomic characteristics, including household size, age, education level, access to financial resources, credit access, and occupation, influence both participation in value addition and scale of engagement. Institutional factors such as access to extension services, membership in farmer groups, market accessibility, and land tenure security also impact farmers' decision-making processes. These factors shape the extent to which farmers participate in soybean value addition, ultimately affecting their household income and food security status.

To assess food security, this study employed the Food Insecurity Experience Scale (FIES), which consists of eight structured questions measuring food access constraints. A higher number of affirmative responses indicated greater food insecurity, whereas fewer responses suggested better food security. Additionally, the study utilized the Household Dietary Diversity Score (HDDS) and Household Food Consumption Score (FCS) to evaluate the variety, frequency, and nutritional quality of food intake. These metrics provide a comprehensive assessment of how soybean value addition influences household food security outcomes, ensuring a clear understanding of the relationship between value addition, income, and food security in Saboba District.

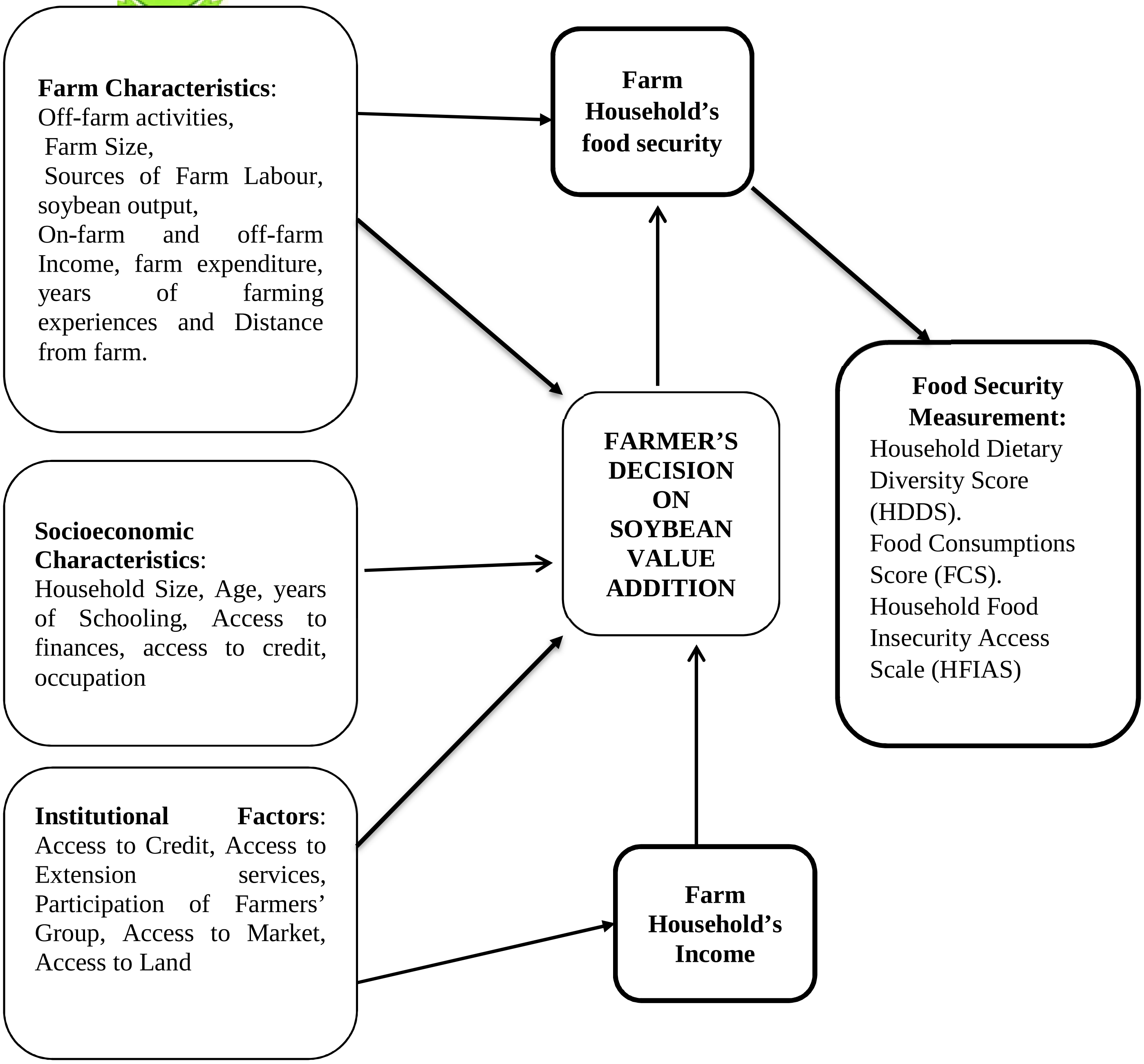


Figure 3.2: Conceptual Framework
Source: Researcher's Conceptualisation (2024)

2.13. Theoretical Framework

This study's theoretical underpinning is utility maximisation theory. Proponents of this theory include Bentham (1789), Mill (1861), and Crimmins and Long (2012). The theory posits that farmers' decisions to enhance the value of their production are influenced by the expected utility and returns, which should be greater when they add value to their products.

Consumers reciprocate this utility through their patronage. Farmers are inclined to engage in value addition only when they perceive that the net benefits outweigh the advantages of not doing so. Although utility cannot be measured directly, the decisions made by economic agents, such as consumers, offer valuable insights into it. Ultimately, value addition leads to increased sales and profit maximization, which in turn enhances farm incomes and bolsters food security. This theory is particularly pertinent to this study, as it emphasizes the primary motivation for farmers to enhance the value of soybeans: the expectation of profit. The theory can be mathematically represented as follows:

Let U_i *and* U_k represent a farmer's utility for two alternatives: adding value "i"and not adding value "k".. The linear random utility model for these two options can be expressed as:

$$U_i = \beta_i X_i + \varepsilon_i$$

$$U_k = \beta_k X_k + \varepsilon_k$$

Here, U_i *and* U_k represent the expected utility from the value-added and non-value-added options "i" and "k", respectively. The parameters β_i *and* β_k are the estimated coefficients, while ε_i *and* $\varepsilon_k$are stochastic error terms assumed to be independently and identically distributed.

If a farmer opts for choice "i", it implies that the expected utility of adding value to option iii exceeds that of option "k". This can be mathematically represented as follows:

$$U_i(\beta_i X_i + \varepsilon_i) > \; U_k = \beta_k X_k + \varepsilon_k$$

The chance that the processor will prefer to add value, i.e., the choice 'i' can be stated as:

$$P(Y = 1|X) = P(U_i > U_k)$$

$$P(\beta_i X_i + \varepsilon_i - \beta_k X_k + \varepsilon_k > 0|X)$$

$$P(\beta_i X_i - \beta_k X_k + \varepsilon_i - \varepsilon_K > 0|X)$$

$$P(\beta^* X_i + \varepsilon^* > 0|X = F(\beta^* X_i)$$

In this framework, "P" signifies the probability function, while U_i and U_k have been previously established. The terms ε_i and ε_k represent random stochastic error terms, and β is a vector of unknown parameters reflecting the net impact of predictor variables on the decision to add value. Furthermore, $F(\beta^* X_i)$ indicates the cumulative distribution function of the estimated $\beta^* X_i$, with the specific form of F depending on the distribution of the random error term. Based on this distribution, a variety of qualitative choice models can be derived (Greene, 2012). This theoretical framework is particularly pertinent to this study, as it corresponds with the dichotomous choice model utilized here. Probit regression was employed to explore the relationship between a dichotomous response variable and a set of predictor variables.

2.14. Research Gaps

The shift from traditional agriculture to agricultural value addition (agro-processing) aims to tackle post-harvest losses, food insecurity, and low incomes among smallholder farmers. While there is considerable evidence that value addition can decrease post-harvest losses and boost farm revenue, a direct link to food security for farming households remains unestablished. The following research gaps have been identified:

1. There is insufficient research on the effects of soybean value addition on food security in Ghana.
2. Information on the impact of value addition on smallholder farming in the Saboba area and Northern Region is limited.

3. Previous studies have focused on proxy measures of welfare, such as net farm income, crop income per acre, and consumption expenditure, rather than directly assessing the food security status of farmers.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter elaborates the methodology applied for the study, structured into the following sections: Study Area, Research Design, Target Population, Sampling Procedures and Sample Size, Data Collection Instruments, Pilot Testing of Instruments, Instrument Validity and Reliability, Data Collection Method, Data Analysis Techniques, and Ethical Considerations.

3.2. Study Area

This study was carried out in the Saboba district of Northern region. The Saboba District is bordered by several other districts: to the east lies the Tatale District, the Chereponi District is to the north, while the Gushiegu and Karaga Districts are situated to the west. To the southwest is the Yendi District, and the Zabzugu District is located to the south. The district also adjoins the River Oti, which acts as the international boundary between Ghana and the Republic of Togo. Spanning approximately 1,751.2 km².Saboba District is located between latitudes 24° and 25° North and longitudes 27° and 13° East. The area experiences two main seasons: a dry season from November to April and a rainy season from May to October, characterized by unpredictable rainfall patterns that can result in heavy thunderstorms and flooding during peak months. The local vegetation includes Guinea savanna, riverine forests, and various tree species. The district is rich in historical, scientific, and artistic attractions, such as the oxbow lake, human bones, sacred stones, and remnants of the Gold Coast Police. Agriculture serves as the main economic activity in the region, employing more than 70% of the workforce, with food crop farming being a key practice among the diverse ethnic groups. Other vital economic activities include trade, small-scale agro-based enterprises, and various income-generating endeavors. Most farmers are peasants with average landholdings of around two hectares. Key crops cultivated in the district include millet, sorghum, beans, maize, rice, and groundnuts, along with cassava, yam, and vegetables. Industrial crops like cotton and soybeans are also grown, and there are small-scale cashew plantations. Women predominantly engage in food processing, sewing, dressmaking, food selling, and brewing. Market days are bustling, with locals exchanging goods with traders from other districts and Togo. Main market centers include Saboba, Gbagbapong, Kpalba, Sambuli, and Wapuli. The district hosts a range of livestock, featuring high-quality cattle, sheep, and goats. Pig farming holds cultural significance, particularly for funerals, while poultry farming, including guinea fowls, turkeys, and chickens, occurs on a smaller scale. However, only a small portion of these ruminants is raised commercially (Ahiagbe *et al.*, 2021). As per the 2021 Population and Housing Census, the district has a population of 95,683, with 47,172 males and 48,511 females, showing that females outnumber males (GSS, 2021).

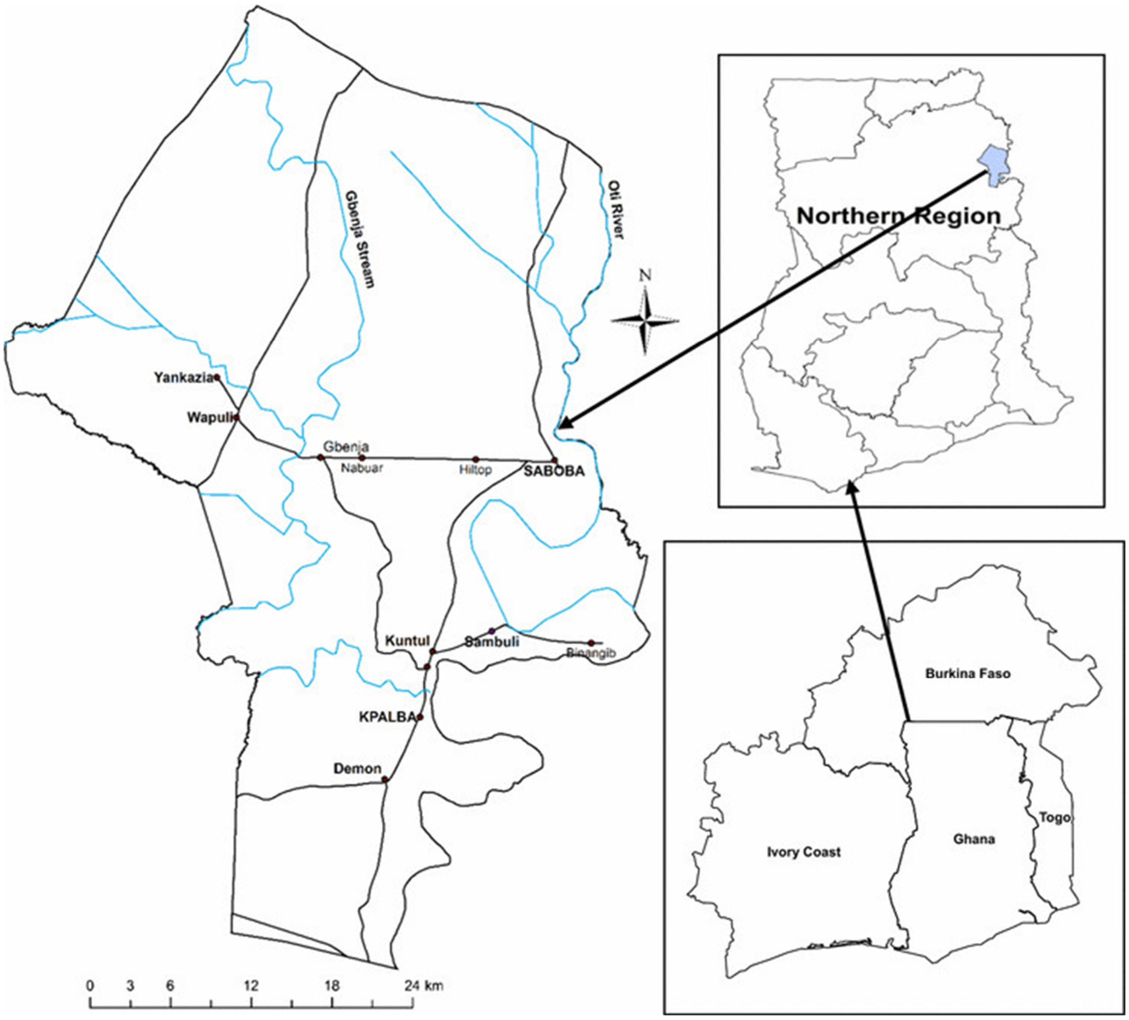


Figure 3.1: Map of Saboba District
Source: Map-of-Saboba-district.png (740×667)

3.3. Research Design

This study employed a cross-sectional descriptive survey design. According to Kombo and Tromp (2006), descriptive research aims to clarify the current situation by systematically gathering respondents' opinions or experiences on a specific topic. This type of research analyzes populations by selecting samples to identify patterns or trends. Hakim (2012) aptly compared the role of a research designer to that of an architect creating a building. This design aimed to collect quantitative data for inferential analysis and qualitative data for descriptive analysis. As a result, the design is suitable for this study since its goal is to gather comprehensive data through descriptions that facilitate the identification of components. Examining the connections between the variables already mentioned in the conceptual framework is another advantageous use of this design (Flick, 2015). The study primarily used primary data from soybean producers in the Saboba District through the use of semi-structured questionnaires

3.4. Target Population

The target population for this study consists of households in the Saboba District. Based on the 2021 population census, the district has a household population of 94,486 (GSS, 2021).

3.5. Sample Size

In this study, the sample size was determined using a mathematical formula. Specifically, Slovin's formula was employed to calculate the appropriate sample size from a target population of 94,486 households, as detailed below.

$$n = \frac{N}{1 + (N(e^2)}$$

Where:

$n =$ Sample size

$N =$ Population

$e =$ Margin of error (take 0.05)

Where:

$N = 94{,}486$

$e = 0.05$

$$n = \frac{94{,}486}{1 + 94{,}486\ (0.5^2)} = 398.439740 \cong 400$$

3.6. Sampling Technique

A two-stage sampling technique was employed to select respondents from the Saboba District, which comprises 254 communities. In the first stage, a simple random sampling method was used to select 20 communities from each district. A complete list of all communities was obtained from the Saboba District Assembly, and a lottery method was applied to ensure that each community had an equal chance of being chosen. This approach minimized selection bias and provided a fair representation of the different areas within the district.

In the second stage, purposive sampling was used to select 20 soybean processors from each of the 20 communities, resulting in 400 respondents. The selection process was guided by agricultural extension officers and community leaders who helped identify respondents based on predefined criteria, including active engagement in soybean processing, experience in the sector, and willingness to participate in the study. Selecting an equal number of respondents (20) from each community was made to ensure uniformity and allow for balanced comparisons across communities. However, this approach assumes a relatively even distribution of soybean processors across communities, which may not always reflect the actual variations in processing activities. Despite this limitation, the sampling strategy ensured a representative and relevant sample to assess the impact of soybean value addition on household income and food security.

3.6.1 Data Collection Procedure

Data collection occurred over three months, from January to March 2024, during which questionnaires were administered to the 20 respondents in each of the chosen communities, as detailed in Table 3.6 below.

Table 3.1: Table Showing distribution respondents across the selected communities.

District	Name of Community	No of 20 respondents Contacted
Saboba	Bungbal	20
	Biwaldo	20
	Demon	20
	Saboba	20
	Sambuli	20
	Jagrido	20
	Sanguli	20
	Nakpel Chekosi	20
	Nabuni	20
	Sambang	20
	Takpalb	20
	Kujooni	20
	Kuncha	20
	Sobiba	20
	Nalongni	20
	Olubaboi	20
	Shegbeni	20
	Nakpar	20
	Wapuli	20
	Yankazia	20
Total	**20**	400

Source: Researchers Construct 2024.

3.7. Data sources

Primary data was mainly used. This was gathered using a questionnaire. Supporting information was extracted from unpublished theses, published theses, policy documents on the topic, and relevant studies.

3.7.1. Research Instruments

In this study, questionnaires were employed as the instrument for the study. A questionnaire consists of a series of written questions with anticipated responses (Oso and Onen, 2009). The primary advantage of using questionnaires is their ability to capture variables such as respondents' opinions, attitudes, perceptions, and feelings, which are not always observable. The questionnaires contained mostly closed-ended questions, limiting the opportunity for the researcher to explore new perspectives, but these questions helped respondents focus on the relevant topics. According to Wang (2015), closed-ended or structured questions are generally easier to analyse, while open-ended or unstructured questions often yield more detailed responses from participants.

The questionnaire used in this study was structured into multiple sections to comprehensively capture relevant data on soybean producers, value-addition processes, and their impact on household income and food security. It comprises five key sections. The first section focused on the sociodemographic characteristics of the respondents, including age, gender, education level, household size, land ownership, and farming experience. The second section examined soybean production and value addition practices, covering farming methods, processing techniques, access to inputs, and value addition activities, such as processing soybeans into products such as soy milk, soy flour, and soy cake. The third section explores economic factors and household income, assessing how soybean value addition influences income levels, profitability, and market access, along with costs, revenues, and financial support programs. The fourth section assessed household food security and welfare by examining food availability, dietary diversity, and consumption patterns using food security indicators such as the Household Food Insecurity Access Scale (HFIAS). The final section addresses the challenges faced in soybean production and value addition, as well as farmers' perspectives on the necessary policy interventions, training needs, and institutional support. The questionnaire included both closed- and open-ended questions, allowing for structured data collection while also providing respondents with the opportunity to elaborate on key issues.

3.7.2. Method of data collection

Before data collection commenced, familiarization visits were made to the Saboba District, specifically targeting several of the selected communities for the study. Opinion leaders in the communities were also contacted for permission to meet with the head of the farm household. Opinion leaders were shown the researcher's student ID card to verify the authenticity of the research. The purpose of the study and the confidentiality of the respondents' responses were communicated to the respondents when they were visited in their various houses and on the farm. Following that, their cooperation was solicited. They were administered the questionnaire in English, Likpakpaln, Dagbani, or Anufo languages, depending on what was appropriate. Upon completion, the researcher expressed his gratitude for the respondent's patience and contribution.

3.7.3. Pilot Testing and Validity of Instruments

A pilot study was conducted to evaluate the clarity and consistency of the data collection instrument by assessing a dependent variable within a small sample. This pre-testing aimed to ensure that all items were well-defined and interpreted uniformly by respondents. The process involved refining questions for clarity and addressing any ambiguous or negative wording. During the pilot phase, both content and construct validity of the instruments were established. Participants for this pilot were purposefully selected from the Saboba District and were distinct from those in the main study. Some individuals completed the same questionnaires without prior notice to identify variations in response patterns between the two instances. This iterative approach is crucial in research, allowing for the identification and correction of unclear questions, and gathering valuable feedback to enhance the instrument's effectiveness. According to Creswell and Creswell (2017), validity pertains to the accuracy and significance of the conclusions drawn from research findings, reflecting how well a sample of test items represents the overall content. "Content validity" was assessed through expert review and respondent feedback. It refers to how accurately the data collected using an instrument represents a certain domain or concept. One of the primary goals of the pilot study was to ensure the validity of the questionnaire. Content validity was used to draw conclusions about a range of topics similar to those assessed based on test outcomes. The representativeness of the sample population was a key concern regarding content validity. Wang (2015) emphasizes that test items should encompass information and skills reflective of the broader body of knowledge. Expert feedback was sought to evaluate the representativeness and relevance of the questions, as well as to suggest structural improvements to the research methods. This input significantly contributed to enhancing the content validity of the data collected. The validity of the questionnaire was further assessed through consultations with supervisors, lecturers, and other professionals to ensure its suitability for the intended purpose.

3.9. Analytical Framework

3.9.1. Probit regression model

The probit model was used to examine the factors influencing farmers' decisions to increase the value of their soybean crops because of its effectiveness in estimating dichotomous variables. As noted by Nagler (2002), this model constrains estimated probabilities between 0 and 1, thereby addressing the limitation of constant impacts from independent variables across different expected values of the dependent variable. In this framework, the dependent variable (Y) assumes values of either 1 or 0, reflecting an underlying unobserved continuous variable (Y*) (Kuwornu *et al.*, 2012). The observed binary variable Y, in this study, represents the farmers' choice regarding soybean value addition, distinguishing between no value addition (AC = 0) and value addition (AC = 1). The strengths of the probit model include its reliance on maximum likelihood estimation, which effectively calculates coefficients while accommodating asymptotic error distributions (Nagler, 1994). This means that the distribution of the error term is regarded as plausible, leading to reasonable probabilities. The error term is assumed to follow a normal distribution, and the cumulative density function of this error is computed for each value of the independent variables to evaluate the likelihood of value addition occurring. Thus, the study aims to elucidate the factors that influence farmers' decisions to engage in soybean value addition, expressed as follows:

$$AC(Y)=f(X)$$

$$AC(Y)=(\sum_{i=1}^{n} \beta_i X_i)$$

$$AC(Y) = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \varepsilon_i$$

$$AC(Y)=\beta_0 + \beta_1 X_1 + \beta_2 X_2 + .. + \beta_n X_n + \varepsilon_i$$

where AC(Y) is a dichotomous dependent variable which is refers to 1 access and 0 to non-access. That is

Y = 1 if Y > 0 (soybean value addition)

Y = 0 if Y ≤ 0 (no soybean value addition)

β= represents unknown parameters to be estimated

X= Socioeconomic control variables and reasons for access

ε_i = Error term respectively.

The probability that a farmer engages in soybean value addition is given by:

$$P(AC = 1|X) = \Phi(\beta_0 + \sum_{i=1}^{n} \beta_i X_i)$$

Where Φ represents the cumulative distribution function of the standard normal distribution.

The estimated coefficients β_i provide insight into the marginal effects of the independent variables on the probability of soybean value addition. The model's significance will be assessed using likelihood ratio tests and pseudo R-squared values to determine its explanatory power.

3.9.2. Measuring the outcome variables (Food Security Status and Farm Income)

The study measures smallholder farmers' income through crop production gross margins, calculated by subtracting total variable costs from total revenue. Total revenue is derived by multiplying the overall quantity of soybeans produced by the unit price per bag. Variable costs include all inputs utilized in production, such as seeds, fertilizers, and herbicides. Food security is assessed using the Food Insecurity Experience Scale (FIES), which comprises eight questions that respondents answer with a straightforward "yes" or "no." A lower number of affirmative responses indicates improved food security, while a higher number of affirmative responses signifies greater food insecurity.

Table 3.2: Definition of Variables for Food Security and Farm Income

Variables	**Definition**	**Expected Sign**	**Justification**
Age of Household Head (Years)	Number of years of the farmer	±	Older farmers may have more experience but may be less likely to adopt new value addition techniques (Kuwornu *et al.*, 2012).
sex (1 = male, 0 = female)	Whether the respondent is male or female	+	Males may have better access to resources and markets, but women are more involved in food processing (Quaye, 2008).
Education Level (Years of Schooling)	Years of formal education completed	+	Higher education improves knowledge of value addition and market opportunities (Sebatta *et al.*, 2015).
Household Size (Number of Members)	Total number of people in the household	±	Larger households may have more labor for processing but higher consumption needs (Tadesse *et al.*, 2017).
Land Size (Acres)	Total farm size under cultivation	+	Larger farms may have surplus for value addition (Adeyonu *et al.*, 2016).
Access to Credit (1 = Yes, 0 = No)	Whether the farmer has access to financial support	+	Credit access enables investment in processing equipment (Ejechi, 2023).
Access to Extension Services (1 = Yes, 0 = No)	Whether the farmer receives extension services	+	Extension services provide knowledge on value addition techniques (Korir, 2018).
Membership in Farmer-Based Organization (1 = Yes, 0 = No)	Participation in a farmer group or cooperative	+	Group participation enhances market access and knowledge sharing (Orinda *et al.*, 2017).
Access to Processing Inputs (1 = Yes, 0 = No)	Availability of resources like processing machines, packaging materials	+	Adequate processing inputs encourage participation in value addition (Ngugi *et al.*, 2020).

Market Distance (Kilometers)	Distance to the nearest major market	-	Longer distances may discourage value addition due to high transport costs (Sebatta *et al.*, 2015).

Source: Researchers Construct 2024.

3.9.3. Endogenous Switching Regression Model

This section details the analytical framework and models used to evaluate the impact of soybean value addition on food security and farm income. The fundamental concept of choice in economics is based on the utility or satisfaction that a farmer (individual) stands to gain when he or she makes that decision and obtains the greatest gain from his or her choice. In this study, the decision made by farmers to add value to their soybean harvests is framed within the overarching goal of enhancing food security. This choice was analyzed using the Endogenous Switching Regression (ESR) approach. The ESR model evaluates the impact of a decision on the outcome variable while accounting for both observed and unobserved heterogeneity through the use of multiple selection and outcome models (Jaleta et al., 2015). This method allows for a more nuanced understanding of how different factors influence the decision to engage in value addition, providing insights into the causal relationships between the decision-making process and the resulting outcomes. By incorporating both the decision to add value and the subsequent effects on the outcome variable, the ESR approach helps to mitigate potential biases that may arise from unobserved factors influencing both the decision and the outcomes. The ESR Model presupposes that the groups engaged in value addition (treatment groups) are selected randomly, indicating that their decision to add value is not influenced by hidden factors. To estimate the selection model, the probit model—rooted in the random utility theory—is utilized. A significant portion of economic literature on decision-making relies on the expected utility theory, which articulates the unobservable utility derived from both value addition and non-value addition through observable variables (Khonje et al., 2015). The model is specified as follows:

$$P^* = \alpha Z_i + u_i$$

$$I_i = 1 \; if \; P^* > 0 \; and \; I_i = 0 \; if \; P^* \leq 0$$

In this context, $P*$ represents the latent variable in the selection equation, which cannot be directly observed. It can be modeled as a function of various observed factors related to the farm, institutions, and socioeconomic conditions. This binary variable takes a value of 1 when farmers choose to add value to their soybean harvests and 0 when they do not. Here, $Z_i$denotes the factors influencing the decision regarding value addition, while α\alphaα represents the vector of parameters that indicate both the magnitude and direction of each covariate's impact on the choice to enhance the value of soybeans. The error term u_i accounts for unobserved factors and measurement errors. Respondents are categorized into two regimes, as illustrated in the following two regression equations.

Soybean value addition: $Y_{1i} = \beta_1 X_i + \varepsilon_{1i}$, $if I_i = 1$

No soybean value addition: $Y_{2i} = \beta_2 X_i + \varepsilon_{2i} \quad if \; I_i = 0$

Assume that the error terms $\varepsilon_{1i}, \varepsilon_{2i} \; and \; u_i$have a trivariate normal distribution, with mean vector zero and covariance matrix (Lee et al., 1982),

$$\text{Cov}(ui,\varepsilon 1i,\varepsilon 2i) = \begin{bmatrix} \sigma_u^2 & . & . \\ \sigma_{\varepsilon 1u}^2 & \sigma_{\epsilon 1}^2 & . \\ \sigma_{\epsilon 2u}^2 & . & \sigma_{\epsilon 2}^2 \end{bmatrix}$$

Where $\sigma_u{}^2$ variance of the error term in the selection equation, $\sigma^2_{\varepsilon 1}$ and $\sigma^2_{\varepsilon 2}$ are variances of the error terms in the continuous equations. $\sigma^2_{\varepsilon 1u}$ and $\sigma^2_{\epsilon 2u}$ are covariance of ui and ε1i and ε2i respectively. Since Y_{1i} *and* Y_{2i} are not observed simultaneously a covariance of the corresponding error terms is not defined (Maddala, 1983). This structure of the error terms indicates that the error terms of the outcome equation and the error term of the selection equation are correlated which results in a non-zero expected value of ε_{1i} and ε_{2i} given u_i - error term of the selection equation (Abdulai & Huffman, 2014). Therefore, the expected values of the truncated error terms $(\varepsilon_1 \mid I = 1)$ and $(\varepsilon_2 \mid I = 0)$ are given below:

$(\varepsilon 1 \mid I = 1) = (\varepsilon_1 \mid u > -Z\alpha)$

$$= \sigma_{\varepsilon 1u} \frac{\varphi(\frac{Z\alpha}{\sigma})}{\Phi(\frac{Z\alpha}{\sigma})} \equiv \sigma_{\varepsilon 1u}\ \lambda_1 \qquad (10)$$

And, $(\varepsilon_2 \mid I = 0) = (\varepsilon_2 \mid u \leq -Z\alpha)$

$$= \sigma_{\varepsilon 2u} \frac{-\varphi(\frac{Z\alpha}{\sigma})}{1 - \Phi(\frac{Z\alpha}{\sigma})} \equiv \sigma_{\varepsilon 2u}\ \lambda_2 \qquad (11)$$

φ and Φ are the probability density and cumulative distribution functions of the standard normal distribution, respectively. The ratio of φ and Φ evaluated at Zα is referred to as the inverse Mills ratio λ_1 and λ_2 (selectivity terms). If the estimated covariance $\sigma^2_{\varepsilon 1u}$ and $\sigma^2_{\varepsilon 2u}$ are significantly different from 0 the decision to soybean value addition and the outcome variable (food security or farm income) are correlated. This implies endogenous switching and the presence of a sample selectivity bias (Maddala, 1996; Maddala & Nelson, 1975).

Where $\rho 1$ and $\rho 2$ are the correlation coefficients between the selection equation error term ui and the error terms of the outcome equations ε_1 *and* ε_2. Treatment effects were also estimated. The average Treatment impact on the Treated and Untreated (ATT and ATU) are calculated utilizing the findings for predicted values of the dependent variable for soybean value addition and no soybean value addition in actual and counterfactual situations:

$$E(Y_{1i} \mid I_i = 1, X_{1i}) = \beta_1 X_{1i} + \sigma_{\epsilon 1u}\rho_1 \frac{\varphi(Z\alpha)}{\Phi(Z\alpha)}$$

$$E(Y_{2i} \mid I_i = 0, X_{2i}) = \beta_1 X_{2i} - \sigma_{\epsilon 2u}\rho_1 \frac{\varphi(Z\alpha)}{\left(1 - \Phi(Z\alpha)\right)}$$

$$E(Y_{2i} \mid I_i = 1, X_{1i}) = \beta_2 X_{1i} + \sigma_{\epsilon 2u}\rho_2 \frac{\varphi(Z\alpha)}{\Phi(Z\alpha)}$$

$$E(Y_{1i} \mid I_i = 0, X_{2i}) = \beta_2 X_{2i} - \sigma_{\epsilon 1u}\rho_2 \frac{\varphi(Z\alpha)}{\left(1 - \Phi(Z\alpha)\right)}$$

The difference between the predicted values of the result variables from equations $E(Y_{1i} \mid I_i = 1, X_{1i}) = \beta_1 X_{1i} + \sigma_{\epsilon 1u}\rho_1 \frac{\varphi(Z\alpha)}{\Phi(Z\alpha)}$ and $E(Y_{2i} \mid I_i = 1, X_{1i}) = \beta_2 X_{1i} + \sigma_{\epsilon 2u}\rho_2 \frac{\varphi(Z\alpha)}{\Phi(Z\alpha)}$ is denoted by ATT. It is the difference between the anticipated value of the dependent variable for soybean value addition and the expected value if they did not add value soybean. ATU is the difference between equations $E(Y_{2i} \mid I_i = 0, X_{2i}) = \beta_1 X_{2i} - \sigma_{\epsilon 2u}\rho_1 \frac{\varphi(Z\alpha)}{\left(1 - \Phi(Z\alpha)\right)}$ and $E(Y_{1i} \mid I_i = 0, X_{2i}) = \beta_2 X_{2i} - \sigma_{\epsilon 1u}\rho_2 \frac{\varphi(Z\alpha)}{\left(1 - \Phi(Z\alpha)\right)}$, which estimates the difference in the expected value of the outcome variable for no soybean value addition and if they had added value to soybean.

Table 3.3: Definition of Variables for Food Security and Farm Income

Variables	Definition	Expected Sign	Justification
Age of Household Head (Years)	Number of years of the farmer	±	Older farmers may have more experience but may be less likely to adopt new value addition techniques (Asfaw et al., 2016).
Sex (1 = Male, 0 = Female)	Whether the respondent is male or female	+	Males may have better access to resources and markets, but women are more involved in food processing (Doss & Morris, 2001).
Education Level (Years of Schooling)	Years of formal education completed	+	Higher education improves knowledge of value addition and market opportunities (Ragasa & Mazunda, 2018).
Household Size (Number of Members)	Total number of people in the household	±	Larger households may have more labor for processing but higher consumption needs (Gebre et al., 2021).
Land Size (Acres)	Total farm size under cultivation	+	Larger farms may have surplus for value addition (Abdulai & Huffman, 2014).
Access to Credit (1 = Yes, 0 = No)	Whether the farmer has access to financial support	+	Credit access enables investment in processing equipment (Ali et al., 2019).
Access to Extension Services (1 = Yes, 0 = No)	Whether the farmer receives extension services	+	Extension services provide knowledge on value addition techniques (Maertens et al., 2020).
Membership in Farmer-Based Organization (1 = Yes, 0 = No)	Participation in a farmer group or cooperative	+	Group participation enhances market access and knowledge sharing (Verhofstadt & Maertens, 2015).
Access to Processing Inputs (1 = Yes, 0 = No)	Availability of resources like processing machines, packaging materials	+	Adequate processing inputs encourage participation in value addition (Ochieng et al., 2021).
Market Distance (Kilometers)	Distance to the nearest major market	-	Longer distances may discourage value addition due to high transport costs (Chamberlin & Jayne, 2013).

Source: Researchers Construct 2024.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.2 Descriptive statistics of institutional and demographic characteristics

Table 4.1 outlines the demographic and socioeconomic characteristics of the respondents. The average age of household heads in the sample is 49.33 years also they possess an average of 24 years of farming experience. The average household size is reported at 8 members, and household heads have completed an average of 5 years of formal education. The respondents' Food Insecurity Experience Scale (FIES) score averages 6.41 out of a maximum of 8, reflecting moderate food insecurity among the group. Additionally, 54 percent of the sampled farmers engage in some form of soybean value addition, indicating that the slightly majority process their produce. Notably, 91 percent of the respondents come from male-headed households, which aligns with the cultural norms of the region, where household leadership typically falls to the eldest son in the absence of the father. This gender dynamic may influence resource allocation and decision-making within these farming households.

In terms of participation in farmer-based organizations (FBOs), only 10 percent of the farmers reported membership. This low participation rate could restrict access to training, information, and various benefits associated with FBO involvement. On a positive note, most soybean farmers have access to extension services, which enhances their likelihood of receiving training in best agronomic practices for optimal yields. Additionally, land ownership is high among participants, with about 82 percent owning land, a favorable condition for soybean cultivation, as it indicates that 8 out of 10 surveyed farmers have land available for farming.

Table 4.1: Descriptive statistics of institutional and demographic characteristics

Variable	Mean	Std. dev.
Age	*49.33*	14.92
Edu	*5.43*	8.48
HH size	*8.40*	4.70
FARM experience	*23.62*	15.16
FIES	*6.41*	*2.48*
Value addition	*0.54*	0.50
Sex	*0.91*	0.32
FBO	*0.10*	0.33
Extension	*0.55*	0.50
Land ownership	*0.82*	0.41
Market access	*0.96*	0.24
Credit access	*0.72*	0.20
Tractor	*0.94*	0.26
Input access	*0.18*	0.41
Price Information access	*0.92*	0.30
Soya input support	*0.78*	0.48
Received training on value addition	0.37	0.18
Per capita	*817.10*	1,015.68

Source: *Author's Field Survey, 2024*

Additionally, approximately 96 percent of the farmers indicated they have access to markets, while over 72 percent reported having access to credit to support their production and value addition efforts. More than 94 percent of the farmers also have access to tractor services for their agricultural activities. In terms of access to information, 18 percent of the farmers reported having input price information from the various shop operators, while 92 percent indicated they had access to general price information from friends and the general community. Furthermore, over 78 percent of the farmers noted they received support for soybean production inputs, which is advantageous for enhancing both production and value addition. Regarding training, 37 percent of the farmers reported having received instruction specifically focused on soybean value addition. The analysis of per capita income revealed that the average income among households in the sample was GH₵817.00.

4.3 Soya bean value addition characteristics

4.3.1 Soya bean value addition

The study also evaluated the value addition characteristics of the respondents. According to the results presented in Table 4.2, 54 percent of the farmers in the sample engaged in value addition, which corresponds to 219 farmers. Out of these 219 farmers, 28 percent processed the soyabean to soya milk, about 65 percent produces Khebab, and about 45 and 32 percent of them processed the soya into dawadawa and tom brown/ porridge respectively. Also, further assessment revealed that 68 percent of the farmers who do value addition receive training on soya processing while about 39 percent of them indicating to be soya bean processing cooperative members. Furthermore, the results indicated that 93 percent of the farmers who process their soya also consume some of the processed products. However, only 11 percent of the them reported to have received financial aid for their value addition which is very low and could hinder farmers' involvement in value addition of soya bean.

Table 4.2: Soya bean value addition

Variable	**Yes**		**No**	
	F	%	F	%
Do you perform Soybean value addition	219	54.21	185	45.79
Type of value				
Soya milk	62	28.31	157	71.69
Soya khebab	143	65.30	76	34.70
Dawadawa	98	44.75	121	55.25
Tombrown/porridge	71	32.42	148	67.58
Have you received any value addition training	149	67.73	71	32.27
Processing cooperatives	86	39.27	133	60.73
Consume the value-added soya bean product	204	93.15	14	6.85
Received financial aid for value addition	25	11.42	194	88.58

Source: *Author's Field Survey, 2024*

4.3.2 Household members' involvement in the value-addition activities

The study also tried to understand the household members that participate in the soya bean value addition activities. According to the results in Table 4.3, most farmers reported that their spouses (females) are primarily involved in soybean value addition, with only 1 percent of male household heads participating in the processing activities. This is not surprising because women dominate the processing of soya bean into dawadawa and soya khebab across the markets in northern Ghana.

Table 4.3: Household members involved in value-addition activities

Which member of the household is involve value addition activities	**Freq.**	**Percent**
Household head female	20	9.13
Household head male	2	0.91
Spouse female	197	89.95
Total	219	100.00
Where do you perform your processing	**Freq.**	**Percent**
Home	208	94.98
processing center	11	5.02
Total	219	100.00

Source: *Author's Field Survey, 2024*

4.3.3 Quantity of soya bean processed

The study also examined the volume of soybean processed in the area. Table 4.4 reveals that, on average, 264 kg of soybeans are processed into soy milk, with quantities ranging from 0 kg to a maximum of 3,000 kg. For soy kebab, the average processed amount is 325 kg, also reaching a maximum of 3,000 kg. In contrast, the average quantities for dawadawa and tom brown/porridge are considerably lower, at 98 kg and 92 kg, respectively. This data suggests that most soybean processors in the study area predominantly concentrate on producing soy milk and kebab.

Table 4.4: Quantity of soya bean processed

Quantity processed	**Mean**	**Std. dev.**	**Min**	**Max**
Soya milk	263.7097	548.1758	0	3000
Soya khebab	325.3846	547.6939	0	3000
dawadawa	97.9235	267.3189	0	1500
Tombrown/porridge	91.59509	247.099	0	1000
% soya process from own production	**Mean**	**Std. dev.**	**Min**	**Max**
Soya milk	7.559748	19.67894	0	100
Soya khebab	9.608939	14.14226	0	100
dawadawa	34.53297	45.60794	0	100
Tombrown/porridge	28.82424	43.7738	0	100

Source: *Author's Field Survey, 2024*

Furthermore, the study looked at the proportion of the quantity processed that comes from the farmers own production. The results revealed that 8 percent of the soya bean processed into soya milk is from own production. About 10 percent of the soya khebab comes from own production with 35 and 29 percent of the soya processed into dawadawa and Tombrown/porridge being from own production. This finding is not unexpected, as households primarily consume soybean in the form of dawadawa, which is used as a spice, or Tombrown/porridge. Consequently, farmers may not feel the need to purchase soybeans from the market to fulfill these consumption requirements. However, khebab and soya milk are mostly produced for the market and may require major purchases to keep up production.

4.3.4 Structure of soya bean processing activities

Table 4.5 outlines the structure of soybean processing activities among the sampled processors. The findings indicate that 47 percent of the 219 processors engage in value addition independently, while 46 percent collaborate with family members. About 7 percent work in groups, and less than 1 percent utilize hired labor for value addition. This suggests that the soybean processing sector in the study area operates on a small scale and involves few participants. Regarding the marketing of processed products, a significant majority—78 percent—of the processors sell their products in local markets. Meanwhile, 21 percent sell directly to individuals, and only 1 percent utilize alternative sales channels beyond local markets and individual sales.

Table 4.5: Structure of soya bean processing activities

How do you perform your processing activities	Freq.	Percent
Alone	103	47.03
Together with hired labour	1	0.46
With a group	15	6.85
With family	100	45.66
Total	219	100.00
How do you market your value addition	**Freq.**	**Percent**
Individuals	45	20.64
Local market	171	78.44
Others	3	1.38
Total	219	100.00

Source: *Author's Field Survey, 2024*

4.4 Determinants of soyabean value addition among farm households in Saboba (Probit model)

The probit results displayed in Table 4.6 illustrate the factors influencing farmers' participation in soybean value addition in the Saboba District. The results showed a Likelihood Ratio (LR) chi2(18) = 65.77 with a probability (Prob > chi2 = 0.0000), Log likelihood = -243.35779 Pseudo R2 = 0.1190 implying the explanatory variables fits the model. Table 4.6 presents both coefficients and marginal effects; however, the discussion focuses on the marginal effects, as coefficients only indicate the direction of the explanatory variables' influence on value addition participation without quantifying the magnitude of the effect. Out of the 17 variables analyzed in the probit model, 12 exhibited statistical significance at various levels. Sex was positively correlated with soybean value addition, significant at the 1 percent level, indicating that males have a 0.026 higher probability of participating in value addition compared to females, which challenges prior assumptions that women primarily engage in post-harvest activities. This is due to men's greater access to capital, processing equipment, and market networks, while cultural and labor constraints limit women's engagement in commercialized value addition. Previous research, such as Agoh *et al.* (2020), found that female groups typically handle tasks like cleaning and packaging, leading to the expectation of greater female involvement in soybean processing.

Additionally, the age of the household head was negatively associated with soybean value addition; each additional year in age resulted in a 0.003 decrease in the likelihood of engaging in value addition. The results suggest a non-linear relationship between age and soybean value addition. Younger farmers are more likely to engage in value addition due to their openness to innovation and willingness to adopt new processing techniques. However, as age increases, participation peaks and then declines, possibly due to physical constraints and reduced willingness to engage in labor-intensive processing. The significance of the age-squared variable confirms this inverted U-shaped relationship. (Falola *et al.,* 2013).

Educational attainment positively influenced soybean value addition, with each additional year of education increasing the likelihood of participation. This aligns with findings from Paltassingh and Goyari (2018), which suggest that more educated farmers are more open to adopting new technologies. Education also enhances the ability to comprehend information and navigate uncertainties (Gao *et al.,* 2020).

Household size showed a positive correlation with soybean value addition at the 1 percent significance level, suggesting that larger households are more inclined to engage in value addition due to the labor demands of both production and processing. This finding corroborates conclusions by Amentae *et al.* (2015) and Tadesse *et al.* (2018), who noted that larger households tend to be more involved in value addition.

Membership in farmer-based organizations (FBOs) also positively impacted value addition, with significance at the 1 percent level. Being part of an FBO increased the likelihood of engaging in soybean value addition by 0.165, as FBO members typically have greater access to information and are familiar with modern processing techniques. Group membership facilitates collaboration in production, marketing, and training, which helps reduce information asymmetry and lowers transaction costs (Pingali *et al.,* 2019).

Conversely, access to extension services was negatively associated with soybean value addition at the 1 percent significance level, suggesting that farmers receiving these services were less likely to engage in value addition. This unexpected finding may be due to the focus of extension services on production rather than processing, with most training emphasizing improved cultivation techniques, input use, and yield enhancement rather than post-harvest value addition. Additionally, extension officers may have limited expertise or resources to promote processing technologies, leading farmers to prioritize raw soybean sales over value-added activities. This contrasts with Falola *et al.* (2016), who found a positive relationship between extension access and value addition.

Table 4.6: Determinants of soyabean value addition among farm households in Saboba District (Probit model)

	Coefficients	**Marginal Effects**
VARIABLES	Value Addition	dy/dx
Sex hh	0.074***	0.026***
	(0.008)	(0.003)
Age	-0.009***	-0.003***
	(0.001)	(0.000)
Education in years	0.016***	0.005
	(0.003)	(0.001)
HH size	0.093***	0.032***
	(0.019)	(0.006)
Farm experience	0.011	0.004
	(0.007)	(0.002)
FBO	0.478***	0.165***
	(0.078)	(0.028)

Extension	-0.448***	-0.154***
	(0.052)	(0.018)
Land ownership	-0.313*	-0.108*
	(0.161)	(0.055)
Market access	-0.474	-0.164
	(0.318)	(0.111)
Credit access	-0.045	-0.016
	(0.054)	(0.019)
Tractor access	0.360***	0.125***
	(0.111)	(0.039)
Input access	0.325***	0.112***
	(0.038)	(0.013)
Price Information	-0.0357	-0.012
	(0.224)	(0.077)
Received training on value addition	0.327**	0.113**
	(0.159)	(0.055)
Constant	0.446***	
	(0.113)	
Observations	401	

Source: *Author's Field Survey, 2024* *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4.6 reveals that land ownership negatively and significantly influenced respondents' value addition activities. This finding indicates that farmers who own land are more likely to engage in soybean value addition compared to those without land. This can be attributed to landowners generally having larger plots designated for soybean cultivation, leading to increased output. Consequently, this greater production enhances the availability of raw soybeans for processing at a lower cost than purchasing from the market.

Furthermore, access to tractor services and agricultural inputs were both positively and significantly associated with farmers' participation in soybean value addition. Specifically, access to tractor services increased the likelihood of engaging in value addition by 0.125, while access to agricultural inputs raised this probability by 0.112, controlling for other factors. This makes intuitive sense, as farmers with access to tractors can produce soybeans in larger quantities, resulting in a more substantial supply available for processing.

Additionally, farmers who received training in soybean value addition demonstrated a positive and significant relationship with value addition activities. This suggests that those who underwent training are more likely to engage in value addition compared to their counterparts who did not. This aligns with findings from Melembe et al. (2021), which indicated that agribusinesses that have access to value addition training are more inclined to participate in both milling and post-slaughter value addition activities.

4.5 Effect of soyabean value addition on household per capita income (ESR)

Table 4.7, Columns 2 and 3 detail the effects of soybean value addition on the per capita income of farm households in the Saboba District. The positive "rho" values for both value addition participants and non-participants indicate that unobserved factors influencing the decision to engage in value addition also affect per capita income. This suggests that factors such as entrepreneurial skills, market access, and financial capacity may simultaneously drive both value addition and income levels. The likelihood ratio test for joint independence produced significant results at the 5 percent level, leading to the rejection of the null hypothesis that the three equations could be estimated separately. The "rho" value was positive for both value addition participants and non-participants, with significance only for non-participants at the 1 percent level, indicating selectivity bias in the findings. Both groups, those engaged in value addition and those not, exhibited significantly higher per capita incomes compared to the average farmer in the area.

The results further demonstrate that the sex of the household head significantly influences per capita income for both participants and non-participants at the 1 percent level. Interestingly, sex had a negative relationship with the per capita income of participants but a positive relationship for non-participants. This suggests that male-headed households participating in soybean value addition may earn less compared to male non-participants. A possible explanation is that male participants may incur higher processing costs or face lower market prices for value-added products, whereas male non-participants might benefit from bulk sales of raw soybeans at stable prices. Additionally, male non-participants may earn more because they allocate more resources to large-scale soybean cultivation and bulk sales, which provide stable returns. In contrast, male participants in value addition may face higher processing costs, limited market access, or lower profit margins on processed products, which could explain their relatively lower earnings.

Age was found to negatively impact the per capita income of both groups, indicating that older farmers generally earn less than their younger counterparts. This could be linked to older farmers being less physically capable and less likely to utilize modern tools and platforms, like social media, which younger farmers might leverage to enhance sales and access valuable information.

Educational attainment significantly affected per capita income, showing a positive impact for participants and a negative impact for non-participants. Each additional year of education increased per capita income for those engaged in value addition but decreased income for those who were not. This suggests that education equips farmers with the knowledge and skills necessary for processing, marketing, and value addition, thereby improving their earnings. However, for non-participants, higher education may lead to diversification into non-farm activities, reducing their reliance on farming and ultimately lowering their income from soybean cultivation.

Household size also exhibited a positive relationship with per capita income for both groups, suggesting that larger households tend to have higher incomes, regardless of their participation in value addition. Although larger households may face resource constraints, they could also benefit from greater labor availability for farming and processing activities, especially if they have a higher proportion of working-age individuals. The effect was positive for both participants and non-participants, but the impact was higher for participants, suggesting that households engaged in value addition leverage their larger labor force more effectively in processing activities, thereby increasing their income.

Farm experience positively influenced the per capita income of both groups, being significant for participants. Increased farm experience correlates with higher income, as experienced farmers likely possess a better understanding of agronomic practices and have established connections with suppliers and markets.

Membership in farmer-based organizations (FBOs) was associated with higher per capita income for both groups, although it was only significant for non-participants. This suggests that FBO members tend to earn more than non-members, benefiting from collective resources for training, processing, and marketing, which enhances their bargaining power and income.

Land ownership was positively related to the per capita income of participants but negatively for non-participants, with significance observed only for non-participants. This unexpected result may indicate that non-participants who own land experience lower incomes than non-landowners, perhaps due to producing large quantities without adding value.

Market access also displayed a significant relationship with per capita income for both groups, being negatively associated with participants' income but positively for non-participants. This suggests that those with market access earn less when engaging in soybean value addition, while they benefit more from market access when not participating. This negative relationship for participants suggests that while market access generally enhances earnings, farmers engaged in value addition may face higher competition, lower profit margins, or increased transaction costs in more accessible markets. In contrast, non-participants may benefit from stable prices in bulk sales, leading to the observed differences in income impact.

Table 4.7: Effects of soyabean value addition on household per capita income (ESR)

1	2	3	4
VARIABLES	Inhperinc_1	Inhperinc_0	Value Addition
Sex	-0.0974***	0.169***	0.0931***
	(0.000583)	(0.0137)	(0.0121)
Age	-0.0140***	-0.0145***	-0.0342***
	(0.00470)	(0.00192)	(0.00157)
Education in years	0.0122***	-0.00471***	-0.0119***
	(0.00277)	(0.000513)	(0.00295)
HH size	0.202**	0.623***	0.497***
	(0.0806)	(0.0192)	(0.0565)
Farm experience	0.321***	0.0293	-0.486
	(0.109)	(0.0354)	(0.304)
FBO	0.0967	0.178***	-0.492***
	(0.0801)	(0.0173)	(0.0441)
Extension	-0.0363	0.000209	-0.317*
	(0.157)	(0.0711)	(0.166)
Land ownership	0.0285	-0.184**	-0.0397
	(0.0489)	(0.0929)	(0.0599)
Market access	-0.115*	0.136***	0.351***
	(0.0698)	(0.0243)	(0.0472)
Credit access	0.0703	-0.175***	0.267***
	(0.0815)	(0.0644)	(0.0631)
Tractor access	0.00195	0.0262***	-0.00902***
	(0.00237)	(0.00253)	(0.00116)
Input access	0.0367***	0.0453***	0.0143***
	(0.00421)	(6.38e-05)	(0.00318)
Price Information	-0.0839***	-0.0421***	0.0906***
	(0.00287)	(0.00980)	(0.0179)

Received training on value addition			0.347**
			(0.167)
Constant	6.232***	6.978***	0.397***
	(0.118)	(0.624)	(0.0831)
lns1			-0.357***
			(0.0294)
lns2			-0.180***
			(0.0552)
r1			0.103
			(0.116)
r2			0.419***
			(0.0361)
Observations	401	401	401
Wald test of indep. eqns. :chi2(1) = 4.18 Prob > chi2 = 0.0409 Wald chi2(18) =163.34 Log likelihood = -680.32458 Prob > chi2 = 0.0000			

Source: *Author's Field Survey, 2024*

Also, credit access was positive to participants per capita income and negative to non-participants per capita income but only significant to non-participants per capita income. This finding implies that farmers with access to credit who choose not to engage in soybean value addition tend to have lower per capita incomes than those without credit access. This could suggest that credit access may be used more effectively by farmers who participate in value addition, allowing them to invest in processing and enhance their income potential. Conversely, those who do not engage in value addition may not be leveraging their credit access as effectively, resulting in lower income levels. This is consistent with expectations because credit comes with high interest rates, thus, farmers who are unable to add value to the soyabean they produce may earn less from their production thus, farmers who did not access credit earning the same amount as their counterparts who accessed credit would be better off. Moreover, access to inputs and tractor services positively influences the per capita income of both participants and non-participants, with significance at the 1 percent level. This suggests that farmers who have access to these resources experience an increase in their per capita income, regardless of whether they engage in soybean value addition or not. This finding highlights the importance of resource availability in enhancing overall income levels for farmers. This is plausible because input and tractor service access are expected to translate to higher farm output and by implication higher per capita household income.

Access to price information was found to have a negative and significant effect on the per capita income of both participants and non-participants in soybean value addition. This indicates that farmers with access to price information, regardless of their participation in value addition, tend to have lower income compared to those who do not receive such information. This finding is unexpected and suggests that having access to price information may not necessarily translate into higher income for these farmers. This is inconsistent to expectations because we expected that farmers who have access to price information can better plan as to when to sell and the quantity keep. Thus, would most likely have higher income from both production and value addition. However, the finding is explainable because per capita income depends on the amount earned and the household size. Thus, farmers who have prices information may sell at good prices but if their household size is big enough to erode their income, they would have low per capita income compared to their counterparts who may not have access but have smaller household size.

4.6 Effect of soyabean value addition on household per capita income

Table 4.8 shows that farmers engaged in soybean value addition (cell "a") have a per capita income of 6.797 units, while those not involved in value addition (cell "b") have a per capita income of 5.468 units. Cell "c" presents the counterfactual for participants in soybean value addition, indicating that if they had chosen not to participate, their per capita income would have been 6.231 units. Conversely, cell "d" illustrates the counterfactual for non-participants, revealing that if they had participated, their per capita income would have been 6.001 units.

The estimated treatment effect indicates that participants expected per capita income is higher than that of non-participants by 1.329 units (a-b). Furthermore, if those participating in soybean value addition had opted out, they would have experienced a loss of per capita income by 0.566 units (a-c), which is statistically significant at the 1 percent level. This suggests that participants would lose approximately 9.08 percent of their income if they stopped value addition. Conversely, if non-participating farmers had decided to engage in soybean value addition, they would have seen an increase in their per capita income by 0.533 units, also significant at the 1 percent level. This indicates that non-participants could enhance their income by about 9.75 percent if they participated in value addition.

Table 4.8: Treatment and Heterogeneity effect of soyabean value addition on per capita income

	Yes	**No**	**Treatment**	**%Change**	**Heterogeneity Effect**
YES	6.797 (a)	6.231 (c)	ATT = 0.566	9.08	
NO	6.001 (d)	5.468 (b)	ATU = 0.533	9.75	0.033***
Ha	0.796	0.763	0.033		

Source: *Author's Field Survey, 2024*

The heterogeneity effects indicated that if non-participants in soybean value addition decided to engage in it, their per capita income would increase by 9.75 percent. Conversely, if participating households opted out of value addition, their per capita income would decrease by 9.08 percent. Overall, the positive transitional heterogeneity of 0.033 suggests that the impact of soybean value addition on household per capita income is significantly more beneficial for those who participate than for those who do not. This finding underscores the positive influence of soybean value addition on household incomes. These results are consistent with earlier studies, such as Umeh (2013), which highlighted the positive effects of cassava value addition on household income. Similarly, Lawal et al. (2011) found notable income disparities between farmers who added value to their cashew nuts and apples compared to those who did not. Additional empirical research by Janvry and Sadoulet (2002), Diagne *et al.* (2009), Wanyama *et al.* (2013), and Winters *et al.* (1998) also supports the notion that adopting agricultural technologies positively impacts household income.

4.7 Effect of soybean value addition on household food insecurity (ESR)

Table 4.9 (columns 2 and 3) investigates the effect of soybean value addition on food insecurity among farm households in the Saboba District. The likelihood ratio test for joint independence yielded significant results at the 5 percent level, leading to the rejection of the null hypothesis and confirming that the three equations cannot be estimated separately. The positive and significant "rho" values for both participants and non-participants indicate the presence of selectivity bias. This suggests that both groups face significant food insecurity compared to a random farmer in the area. Regarding gender, the results reveal a significant but contrasting effect: male-headed households engaged in soybean value addition experience higher levels of food insecurity, while non-participating male-headed households report lower food insecurity levels. This discrepancy highlights the complex relationship between value addition and food security, suggesting that while engaging in value-added activities may initially seem beneficial, it may also be linked to greater food insecurity for male-headed households.

This outcome contradicts prior expectations and the literature (Sekhampu, 2013), as male-headed households typically have better access to resources and earnings, which should improve food security. However, it may be that women manage household resources more effectively and prioritize food needs, especially since they are often directly involved in food preparation. Age appears to have a positive and significant coefficient for participants in soybean value addition, suggesting that older farmers face greater food insecurity when participating in value addition. This finding contradicts expectations, as older farmers are generally assumed to have more experience and higher earnings, which would enhance their food security. Nevertheless, health challenges and declining physical strength among older farmers could divert resources toward healthcare, ultimately affecting their ability to secure food for their households.

Education shows a negative coefficient for food insecurity in both participants and non-participants, being significant for non-participants. This implies that increasing years of education correlates with decreased food insecurity. This aligns with expectations, as higher education often leads to better job opportunities, higher earnings, and enhanced agronomic knowledge, ultimately helping farmers improve food security. Household size has a negative and significant coefficient for non-participant food insecurity, suggesting that larger household sizes lead to reduced food insecurity. This finding is contrary to expectations, as larger households typically imply more mouths to feed, which should increase food insecurity. However, the composition of the household matters; if a household consists primarily of working-age individuals rather than dependents, they may be better positioned to achieve food security. Larger households can also provide more labor for farming activities, potentially increasing food production and reducing food insecurity. This result aligns with Olounlade *et al.* (2020), who reported a positive relationship between household size and food security, but deviates from Aidoo et al. (2013).

Table 4.9: Determinants and effect of soyabean value addition on household food insecurity (ESR)

Variables	(1) FIES_1	(2) FIES_0	(3) Value Addition
Sex HH	1.315**	-1.044*	0.0569
	(0.545)	(0.630)	(0.271)
Age	0.0383***	-0.00511	-0.0106
	(0.0141)	(0.0205)	(0.00728)
Education in years	-0.0156	-0.0864***	0.0130
	(0.0212)	(0.0192)	(0.00902)
Household size	0.00583	-0.126*	0.124***
	(0.0535)	(0.0676)	(0.0246)
Farm Experience	0.0204	0.0416	0.0153*
	(0.0165)	(0.0254)	(0.00866)
Extension	0.246	1.437***	-0.531***
	(0.327)	(0.386)	(0.185)
Land Ownership	-0.404	0.319	-0.292
	(0.506)	(0.489)	(0.229)
Market access	-0.996	-0.346	-0.384
	(0.729)	(1.322)	(0.429)
Credit access	-0.342**	1.742***	0.00109
	(0.159)	(0.439)	(0.107)
Input Access	0.656	-0.312	0.318
	(0.410)	(0.480)	(0.210)
	(0.0736)	(0.0704)	(0.0317)
FBO	0.978**	-0.0160	0.420
	(0.487)	(0.608)	(0.285)
Tractor	1.034	-0.890	0.345
	(0.778)	(0.820)	(0.369)
Price Information	-0.127	-0.256	0.0910

	(0.632)	(0.705)	(0.317)
Training			0.440*
			(0.251)
Constant	3.685	-1.874	0.0616
	(2.883)	(4.552)	(1.510)
			0.728***
Is1			(0.0629)
			0.722***
Is2			(0.0692)
			0.375*
r1			(0.221)
			-0.378*
r2			(0.218)
Observations	401	401	401
Wald test of indep. eqns. :	chi2(1) = 4.92	Prob > chi2 = 0.0265	

Source: *Author's Field Survey, 2024*

Access to extension services positively affects the food insecurity status of both participating and non-participating households, with significant effects observed only for non-participants. This finding suggests that access to extension services may actually contribute to increased food insecurity among households that do not engage in soybean value addition, which is contrary to expectations. Generally, it is believed that farmers who receive extension services should benefit from enhanced food security due to the training, guidance, and information provided by extension agents. Such support is expected to lead to improved farm output, increased income, and ultimately better food security. However, the unexpected positive relationship found in this study raises questions about the effectiveness or relevance of the extension services for non-participating farmers. More investigation is needed to explore this issue further, including whether the extension services align with the specific needs of non-participants or if other factors are contributing to the increase in food insecurity in these households.

In addition, credit access was significant but negative to participants' food insecurity a positive food insecurity. This implies that having access to credit reduces food insecurity for participant but increases food insecurity for non-participants of soyabean value addition. This is understandable because credit can be both good for enhancing household food security and could also push households into food insecurity. When credit is put into productive use it is expected to generate revenue enough to offset its cost and provide surplus for the borrower. However, when credit is channeled into consumption farmers may have to settle it from sales of food produce for household food needs and therefore would be likely to have higher food insecurity.

Regarding FBO membership and food insecurity, the findings in Table 4.9 indicate that FBO membership positively correlates with food insecurity among participants in soybean value addition, while it negatively correlates with food insecurity for non-participants. This suggests that farmers who are FBO members and engage in soybean value addition experience higher levels of food insecurity, whereas those who do not participate in value addition enjoy lower food insecurity compared to non-members. This outcome contradicts expectations, as FBO members are anticipated to have better access to vital information related to production, processing, marketing, and overall household welfare, including food security. Consequently, it would be expected that this exposure would enable them to improve their food security status.

4.8 Effect of soybean value addition on household food security

As shown in Table 4.10, farmers engaged in soybean value addition (cell “a”) have a Food Insecurity Experience Scale (FIES) score of 6.863 units. In contrast, farm households that do not participate in soybean value addition (cell “b”) have a FIES score of 6.690 units. Cell “c” illustrates the counterfactual for participants; had they opted out of soybean value addition, their FIES score would have been 7.667 units. Meanwhile, cell “d” represents the counterfactual for non-participants, indicating that if they had chosen to engage in soybean value addition, their FIES score would have been 6.072 units. The estimated treatment effect reveals that the expected FIES score for participants is lower than that of non-participants by 0.791 units (a-b). If those who currently participate in soybean value addition had chosen not to participate, they would have experienced a reduction in their FIES score by 0.618 units (a-c), which is statistically significant at the 1 percent level. This finding suggests that if a soybean value addition participant had decided to withdraw from the program, they would have faced a 10.49 percent decline in their FIES score. Similarly, if non-participating farmers had decided to engage in soybean value addition, they would have seen a reduction in their FIES score by 0.618 units, significant at the 1 percent level, indicating a potential 9.24 percent decrease in their food insecurity experience.

Table 4.10: Treatment, and Heterogeneity effect of soyabean value addition on food security (expected food insecurity (FIES))

	Yes	**No**	**Treatment**	**%Change**	**Heterogeneity Effect**
YES	6.863 (a)	7.667 (c)	ATT= -0.804	10.49	-0.186
NO	6.072 (d)	6.690 (b)	ATU= -0.618	9.24	
Ha	0.791	0.977	-0.186		

Source: *Author's Field Survey, 2024*

The heterogeneity effects indicate that if a non-participant in soybean value addition chose to participate, their Food Insecurity Experience Scale (FIES) would decrease by 9.24 percent. Conversely, if a participating household decided to withdraw from soybean value addition, their FIES would increase by 10.49 percent. Overall, the negative transitional heterogeneity of -0.186 suggests that the impact of soybean value addition on food security is significantly more favorable for those who participate than for those who do not. This means that soybean value addition negatively affects food insecurity, implying a positive relationship with food security.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The analysis revealed that the average age of household heads in the sample is 49.33 years, indicating that those engaged in soybean production tend to be older. Farmers reported an average of 24 years of farm experience, suggesting substantial expertise in soybean cultivation. The average household size was found to be 8 members, with household heads having completed an average of 5 years of formal education. The Food Insecurity Experience Scale (FIES) score averaged 6.41 out of a possible 8, highlighting moderate food insecurity among respondents. Notably, 54 percent of the sampled farmers were involved in soybean value addition. The demographic composition showed that 91 percent of the respondents came from male-headed households, and only 10 percent reported being members of farmer-based organizations (FBOs).

Majority of soybean farmers had access to extension services, with a high land ownership rate of 82 percent—indicating that 8 out of every 10 farmers owned land, which is a positive factor for soybean production. Additionally, approximately 96 percent reported having market access, while over 72 percent indicated access to credit to support their production and value addition activities. Access to tractor services was reported by over 94 percent, with 18 percent having access to agricultural inputs and 92 percent reporting access to price information. Furthermore, 37 percent of farmers indicated that they received training on soybean value addition.

In terms of income, the average household per capita income in the sample was GH₵817. The study also examined the processing quantities of soybeans, finding that, on average, 264 kg were processed into soy milk, with a maximum of 3,000 kg. For soya khebab, the average processed quantity was 325 kg, also reaching up to 3,000 kg. In contrast, the average quantities for dawadawa and tom brown/porridge were significantly lower, at 98 kg and 92 kg, respectively. This indicates that most soybean processors in the area primarily focus on producing soy milk and khebab.

The probit model identified key determinants influencing participation in soybean value addition, including training in soybean value addition, access to inputs, access to tractor services, land ownership, access to extension services, FBO membership, household size, age, and gender.

The endogenous switching model further indicated that participation in soybean value addition positively correlates with household per capita income while negatively correlating with food insecurity among farm households.

5.2 Conclusion

With regards to the findings of this study, it was established that receipt of training on soyabean value addition, input access, tractor access, land ownership, extension access, FBO membership, household size, age and gender were the key determinants of farmers participating in soyabean value addition in Saboba district. Except for age, extension access and land ownership which were negative, all other significant variables were positive to farmers' participation in soybean value addition. The study also concludes that soyabean value addition is positively related to household per capita income. The study further concludes that soyabean value addition is a negative function of household food insecurity. In other words, soyabean value addition is a positive function of household food security.

5.3 Recommendation

In line with the main objectives of this study, the following recommendations are made based on the key findings:

1. Enhancing Household Per Capita Income through Soybean Value Addition:

Given the positive impact of soybean value addition on farm household income, it is recommended that the Ministry of Food and Agriculture (MoFA) and the Ministry of Finance (MoF), in collaboration with the Savannah Agricultural Research Institute (SARI) and the Council for Scientific and Industrial Research (CSIR), promote value addition initiatives. This could include providing subsidies for soybean processing equipment, technical training, and market linkages for soybean farmers.

NGOs such as the Alliance for a Green Revolution in Africa (AGRA) and USAID should support training programs and financial assistance for smallholder farmers engaged in soybean value addition, ensuring that value-added products become more competitive in the market.

2. Improving Household Food Security through Value Addition:

Since the study found that households engaged in soybean value addition experienced improved food security, the Ghana School Feeding Programme (GSFP) and World Food Programme (WFP) should incorporate soybean-based products into school feeding programs. This will create a stable market for value-added soybean products while improving nutrition among schoolchildren.

The National Buffer Stock Company (NAFCO) should ensure that value-added soybean products are included in national food reserves, stabilizing food availability in times of crisis.

3. Strengthening Education and Capacity Building for Farmers:

Since education was found to positively influence participation in soybean value addition, it is recommended that MoFA, SARI, and CSIR invest in farmer education programs. These should include literacy training, workshops on processing techniques, and business management skills.

Development partners such as FAO, WFP, and USAID should fund training programs tailored to farmers with little or no formal education, ensuring they gain the necessary skills to engage in value addition and market their products effectively.

4. Expanding Research to Other Districts:

While this study focused on the Saboba District, future research should extend to other districts in the Northern Region and beyond. The Ghana Statistical Service (GSS) and agricultural research institutions should collaborate to conduct larger-scale studies on soybean value addition and its impact on food security and income across multiple regions. Universities and research institutions such as the University for Development Studies (UDS) and Kwame Nkrumah University of Science and Technology (KNUST) should undertake studies that examine the long-term benefits and sustainability of soybean value addition in Ghana's agricultural sector.

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APPENDIX

Effect of Soybean Value Addition on Farm Household Income and Food Security in the Saboba District

Questionnaire

Questionnaire ID:________________________ Enumerator code:_________________

Community_________________________ Date___________________________

Introduction and Consent

My name is…………… and I am an enumerator collecting data on behalf of Mr. Anthony Bilandam. Mr Bilandam is an MPhil Candidate at the University for Development Studies, Nyankpala and is undertaking a research on "Soybean Value addition effect on Farm household Income and Food Security in the Saboba District". The responses are strictly for academic purposes and will be treated to the best of our capabilities with the highest level of confidentiality and respondents will remain anonymous. Thank you.

A. Household Demographic information

A1. Name of Respondent: _______________________________________

A2. Gender of respondent: 1.Male □ 2.Female □

A3. Is respondent the household head? 1.Yes □ 2.No □

A4. Gender of Household head Male 1. □ 2.Female □

A5. Age of Household head_______________

A6. Number of years of Household head schooling _______________

A7. Marital status of Household head: 1.Married □ 2.Single □ 3.Divorced □ 4.Widow(er) □

A8. Religion of Household head? 1.Islam □ 2.Christian □ 3.Traditional □ 4.other □

A9. Number of household members: _______________

A10. Age and sex composition of household members

Age	Male	Female	Total
< 15 years			
16-35 years			
36-65 years			
65+ years			

A11. Main occupation of Household head 1. farming □ 2. civil servant □ 3.trading □ 4.other □ specify_______________

A12. How many years have you been farming? _______________

A13.Who makes decisions on food purchases and consumption? 1.Male (head) □ 2.Female (spouse) □ 3.Female (head) □

A14.Do you have any other source of income? 1.Yes □ 2.No □

If yes, what are the other sources? ,,

A15. Household farm size in Acres___________________________

A16.Do you own the land? 1.Yes □ 2.No □

Crops usually grown …………………………………………………….

A17.Are you a member of any FBO? 1.Yes □ 2.No □

A18.Name of the FBO________________________________

A19.How long have you been a member of the FBO? __________________

A20.Do you get access to extension? 1.Yes □ 2.No □

A21.How often do you get extension visits? ___1.Weekly □ 2.Bi-weekly □ 3.Monthly□

A22.Source of extension? 1.MOFA□ 2.FBO□ 3.others□, Specify__________________________

A23.Do you get access to credit? 1.Yes □ 2.No □

A24.If no why? 1.not needed□ 2.not available□ 3.no collateral□ 4.high interest□

A25.Source of credit: 1.Family□ 2.Rural Banks □ 3.credit union□ 4.FBO□ 5.Friends□ 6.commercial banks□

A26.What was the credit used for?

____

A27.Do you participate in training/workshop on farming? 1.Yes □ 2.No □

A28.Source of the training___________________________

A29.Was the training beneficial? 1.Yes □ 2.No □

A30.Do you get access to market for your produce? 1.Yes □ 2.No □

A31.Do you get access to tractor service? 1.Yes □ 2.No □

B. CROP PRODUCTION

B1. How long have you been farming Soybean? _______________

B2. What is the main purpose of production?1. Commercial □ 2.Family consumption □

3.Security □ other________

B3. Do you get input support for your Soybean cultivation? 1.Yes □ 2.No □

B4. Is soybean your major crop produced? 1.Yes □ 2.No □

B5. Which of the following inputs do you use in your Soybean Cultivation?

input	**Qty.**	**Unit cost**	**Total cost**
Farm size(acre)			
Family labor			
Hired labor			
fertilizer			
Seeds(improved)			
Seeds(Local)			
Other inputs			
Other Agrochemicals			
Land size for other crops			

B6. Do you own the land on which you cultivate your soybean? 1.Yes □ 2.No □

B7. Do you cultivate on irrigated land? 1.Yes □ 2.No □

B8. Do you cultivate during the dry season? 1.Yes □ 2.No □

B9. How long does it take you to travel to the following places?

Home to farm ________miles________ hours by foot________ hours by bicycle

Home to input shop ________miles________ hours by foot________ hours by bicycle

Home to market ________miles________ hours by foot________ hours by bicycle

B10. Have you received any form of training on Soybean cultivation? 1.Yes □ 2.No □

B11.what output did you get from your soybean cultivation from your last production cycle

Year	Land/Size	Name of Variety	Output	price
2022				
2023				

B12. How do you sell your soybean?

1.Farm gate □ 2.Retailers □ 3.Aggregators □ 4.Processors □ 5.Others specify ________________

B13. Do you get price information for your soybean cultivation? 1. Yes □ 2.No □

B14. Do you get input support for soybean cultivation? 1.Yes □ 2.No □

C.SOYBEAN VALUE ADDITION

C1. Do you perform Soybean value addition (processing) activities 1.Yes □ 2.No □

C2.What percentage of your soybean yield do you process? ______

C3.what type of value addition do you perform?

Value addition activity	Tick
Soymilk	
Soy Khebab (Tofu)	
Dawadawa	
Tombrown (porridge)	

C4.Have you received any kind of training on soybean value addition? 1.Yes □ 2.No □

C5.which member of the household is in charge of soybean value addition activities?

1.Household head(Male) □ 2.Household head(Female) □ 3.Spouse(Female) □ 4.Spouse(Male) □

C6. Where do you perform your processing activities? 1.Home□ 2.Processing center□ 3.Others specify ________________

C7. How do you perform your processing activities? 1.Alone □ 2.with family□ 3.with a group□ 4.together with hired labour□

C8.On the average, how much money do you make from the sales of your soybean value added products

Value addition activity	**amount**
Soymilk	
Soy Khebab (Tofu)	
Dawadawa	
Tombrown (porridge)	

C9. Are you part of a processing cooperative? 1.Yes □ 2.No □

C10. Have you received any training on soybean value addition? 1.Yes □ 2.No □

C11. Do you consume any of the value added soybean products with your household? 1.Yes □ 2.No □

C12. What percentage of your soybean value added product do you consume with your household?

Value addition activity	Percentage
Soymilk	
Soy Khebab (Tofu)	
Dawadawa	
Tombrown (porridge)	

C13. How do you market your value added soybean products?

1. Local market □ 2.Retailers□ 3.individuals □ 4.Others specify _________________

C14. Where do you acquire soybean for your value addition from?

1. Local market □ 2.Retailers□ 3.individuals □ 4.Others specify _________________

C15. On the average, how much do you spend on value added activities?

Value addition activity	Amount
Soymilk	
Soy Khebab (Tofu)	
Dawadawa	
Tombrown (porridge)	

C16. Do you get financial support for you soybean value addition activities? 1.Yes □ 2.No □

C17. What is the major reason why you engage in soybean value addition activities

____

____

____

____

C18. If you do not perform soybean value addition activities, what are the reasons

____

____

____

____

C19. How long have you been performing soybean value addition activities for?__________

D. HOUSEHOLD WELFARE MEASUREMENTS

D1. Food expenditure

Item	Quantity/week	Amount/Week(GHs)	Amount/Season(GHs)
Beans			
Bread			
Rice			
Fruits and vegetables			
Fish/egg/poultry/meat			
Sugar/salt			
Oil/butter			
Spices			
Soft drinks/Alcohol			
Milk			

D2. Non-food expenditure

Item	Amount/month(GHs)			
Health care				
Transport /fuel				
Utility (electric bills/airtime)				
Clothing				
Education				
Social events				
entertainment				
Remittances/gifts				
rent				
other				
Proportion (%) of income spent on	**Food**	**Health**	**Clothing**	**Education**

D3. Household assets

Asset	**tick**	**number**	**Condition**	**value**
Television				
Radio				
Mobile phone				
Bicycle				
Motorbike				
Tricycle				
Boats				
Personal computers/laptops				
Knapsack sprayer				
Hoe				

Cutlass				
Donkey cart				
tractor				

D4. Household income source

Number of income earners		Amount(GHs)
Farm income(last 12 months)	Crop sales	
	Livestock sales	
Off-farm income	Value added soybean sales	
	Government work	
	Remittance	
	Others	

SECTION E: HOUSEHOLD FOOD SECURITY

E1 Household Consumption Score

I would like to ask you about all the different foods that your household members have eaten in the ***last 7 days****. Could you please tell me* ***how many days*** *in the past week your household has eaten the following foods? (for each food, ask what the primary source of each food item eaten that week was, as well as the second main source of food, if any)*

Food item	DAYS eaten in past week (0-7 days)	Sources of food (enter source code)	
		primary	**secondary**
3.1 – Maize			
3.2 – Rice			
3.3 – Bread/wheat			
3.4 – Tubers			
3.5 – Groundnuts & Pulses			
3.6 – Fish (eaten as a main food)			
3.7 – Fish powder (used for flavor only)			
3.8 – Red meat (sheep/goat/beef)			
3.9 – White meat (poultry)			
3.10 – Vegetable oil, fats			
3.11 – Eggs			
3.12 – Milk and dairy products (main food)			
3.13 – Milk in tea in small amounts			
3.14 – Vegetables (including leaves)			
3.15 – Fruits			
3.16 – Sweets, sugar			

Food source codes:

Purchase =1 Own production =2 Traded goods/services, barter =3

Borrowed = 4 Received as gift= 5 Food aid =6 Other (specify) =7

E2 Coping Strategies Index (CSI)

In the past 7 days, if there have been times when you did not have enough food or money to buy food, how many days has your household had to:	Frequency: Number of days out of the past seven: (Use numbers 0 – 7 to answer number of days; Use NA for not applicable)
1. Rely on less preferred and less expensive foods?	
2. Borrow food, or rely on help from a friend or relative?	
3. Purchase food on credit?	
4. Gather wild food, hunt, or harvest immature crops?	
5. Consume seed stock held for next season?	
6. Send household members to eat elsewhere?	
7. Send household members to beg?	
8. Limit portion size at mealtimes?	
9. Restrict consumption by adults in order for small children to eat?	
10. Feed working members of HH at the expense of non-working members?	
11. Reduce number of meals eaten in a day?	
12. Skip entire days without eating?	

E3 **Food Insecurity Experience Scale**

FOOD INSECURITY EXPERIENCE SCALE Household Referenced Now I would like to ask you some questions about food. During the last 12 MONTHS, was there a time when:	
Q1. You or others in your household worried about not having enough food to eat because of a lack of money or other resources?	0 No 1 Yes
Q2. Still thinking about the last 12 MONTHS, was there a time when you or others in your household were	0 No 1 Yes

unable to eat healthy and nutritious food because of a lack of money or other resources?	
Q3. Was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources?	0 No 1 Yes
Q4. Was there a time when you or others in your household had to skip a meal because there was not enough money or r resources to get food?	0 No 1 Yes
Q5. Still thinking about the last 12 MONTHS, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources?	0 No 1 Yes
Q6. Was there a time when your household ran out of food because of a lack of money or other resources?	0 No 1 Yes
Q7. Was there a time when you or others in your household were hungry but did not eat because there was not enough money or other resources for food?	0 No 1 Yes
Q8. Was there a time when you or others in your household went without eating for a whole day because of a lack of money or other resources?	0 No 1 Yes