

**ASSESSMENT OF THE MARKET FOR POULTRY BY-PRODUCTS AND THEIR
CONTRIBUTION TO POULTRY FARMERS' REVENUE IN GHANA**

BY

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DECLARATION

I, Etriakor Kofi Gbordzoe, the author of this thesis, “**ASSESSMENT OF THE MARKET FOR POULTRY BY-PRODUCTS AND THEIR CONTRIBUTION TO POULTRY FARMERS’ REVENUE IN GHANA**” do hereby declare that, with the exception of the properly listed references, all work done for this thesis was done by me at the Department of Agricultural Economics and Agribusiness, University of Ghana, Legon.



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DEDICATION

This thesis is dedicated to my parent, Rev. Dr. & Mrs. Gbordzoe and my siblings for their undaunted support, love and encouragement throughout my studies.



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ABSTRACT

The study set out to assess the market for the poultry by-products and their contribution to poultry farmers' revenue in the Ashanti and Bono regions of Ghana. The study identified poultry by-products being commercialized by poultry farmers in the study area and estimated how much in revenue the by-products are contributing to their total revenue from poultry production. The study analyzed the factors influencing the revenue proportion contributed from the by-product. The study finally, identified and ranked constraints poultry farmers encounter in marketing their poultry by-products. The study employs descriptive statistics and a diagram to assess the nature of the poultry by-products market, and uses a Tobit model to analyse the factors that influence the proportion of revenue contributed from poultry by-products. A Kendall's Coefficient of Concordance (W) was used to measure the level of agreement between the identified constraints. Data was collected from 120 poultry farms located in the Bono and Ashanti regions. The findings revealed that, the poultry by-product market in the Ashanti and Bono regions has only one poultry by-product (poultry dropping) being commercialized of which Côte d'Ivoire is the largest end user. Côte d'Ivoire consumes about 7000 metric tons of poultry droppings annually representing 75% of the total annual production. The findings indicated that the average price for which poultry dropping is sold per 80Kg is GHS 6.00. The results also revealed that, the average revenue accrued by a poultry farmer from the sale of poultry droppings annually is GHS 6,730.00, with standard deviation of GHS 8,338.00. This constitutes less than 1% of their annual revenue from poultry production. Analysis from the Tobit regression model indicate that ownership, litter size, membership of PFA and number of spent layers sold are variables that influence the proportion of revenue contributed from poultry droppings. The four most prevalent constraints among respondents in the study area, in order of magnitude, are low prices for droppings, lack of processing and storage facilities for poultry dropping, seasonal demand, and buyers' distance. Government should support the development of value chains that would purchase, process and sell poultry dropping and other poultry by-products to expand the market under the circular economy framework.

TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
ABSTRACT.....	v
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF ACRONYMS	xii
CHAPTER ONE	1
INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	6
1.3 Research Objectives	9
1.4 Justification of the Study	9
1.5 Organization of the Study	11
CHAPTER TWO	13
LITERATURE REVIEW	13
2.1 Introduction	13
2.2 Agricultural Markets and Marketing.....	13
2.3 Agricultural Marketing Channels.....	15
2.3.1 Definition of Agricultural Marketing Channels	15
2.3.2 Determinants of Agricultural Marketing Channels	15
2.4 Overview of Poultry Sector in Ghana	17
2.4.1 Nature of the Poultry Sector	17
2.4.2 Poultry Production Trends.....	17
2.5 Agricultural By-products.....	20
2.5.1 Overview of Agricultural By-products.....	20
2.5.2 Benefits of Agricultural By-products	22
2.6 By-product from Poultry Production	23

2.6.1 Overview of Poultry By-products.....	23
2.6.2 Prospects for Products	23
2.7 Empirical Studies On Poultry By-products	25
2.8 Farm Income	27
2.8.1 Farm Income Generation	27
2.8.2 Poultry Production as an Income Generation Activity	29
2.8.3 Agricultural Income Diversification.....	30
2.8.4 By-product Based Income Diversification	32
2.9. Theoretical Frameworks Underpinning the Study	33
2.9.1 The Production Theory	33
2.9.2 Circular Economy Framework and Theory of By-product Synergy	35
2.10 Economic Tools for the Study.....	37
2.10.1 Tobit Model (Censored Regression Model)	37
2.10.2 Kendall's Coefficient of Concordance	41
2.11 Conclusion.....	42
CHAPTER THREE	44
METHODOLOGY	44
3.1 Introduction	44
3.2 Conceptual Framework	44
3.3 Theoretical Framework	46
3.3.1 Theory of By-product Synergy.....	46
3.4 Analytical Framework.....	47
3.4.1 Method of Analysis	47
3.4.2 Software for Data Analysis.....	57
3.5 Data Description.....	58
3.5.1 Study Area	58
3.5.2 Sampling Technique and Sample Size	61
3.5.3 Method of Data Collection	62
3.5.4 Research Design	63
CHAPTER FOUR.....	64
RESULTS AND DISCUSSIONS.....	64

4.1 Introduction	64
4.2 Socio-economic Characteristics	64
4.2.1 Gender of Respondents.....	64
4.2.2 Education Level of Respondents	65
4.2.3 Age of Respondents.....	65
4.2.4 Litter Size	67
4.2.5 Ownership.....	67
4.2.6 PFA Membership.....	68
4.2.7 Access to Veterinary Service.....	68
4.3 Nature of Poultry By-product Market	69
4.3.1 Availability of poultry by-products	69
4.3.2 Mapping of Actors in the Poultry By-product Market	70
4.3.2 Distribution of Poultry By-product to Marketing Channels	74
4.4 Contribution of Poultry Droppings to Poultry Farmers' Revenue	77
4.4.1 Respondents' Rank on How Beneficial the sale of Poultry Dropping is.....	80
4.5 Determinants of Revenue Proportion Contributed by Poultry Droppings	82
4.5.1 Ownership.....	83
4.5.2 Quantity of Poultry Dropping Sold	83
4.5.3 Member of Poultry Farmers' Association (PFA)	85
4.5.4 Litter Size	86
4.5.5 Number of Spent Layers Sold	87
4.5.6 Price of Poultry Dropping.....	87
4.6 Constraints Faced by Respondents in the Poultry By-product Market	88
4.6.1 Low Price.....	89
4.6.3 Seasonal Demand	91
4.6.4 Distance from Buyer.....	92
4.6.5 Lack of Market Information	92
4.6.6 Access to Credit.....	93
4.6.7 Poor Road Network	94
CHAPTER FIVE	95
SUMMARY, CONCLUSION AND RECOMMENDATIONS.....	95
5.1 Introduction	95

5.2 Summary and Major Findings.....	95
5.3 Conclusions	97
5.4 Recommendations	99
REFERENCES	104
APPENDIX 1: Questionnaire	121
APPENDIX 2: Determinant of Poultry Farmer’s Choice of Channel for Selling Droppings	128
APPENDIX 3: Proportion of Revenue Contributed by Poultry Dropping (By Region)	129
APPENDIX 4: Variance Inflation Factor for Independent Variables in the Tobit Regression Model	130



TABLE	LIST OF TABLES	PAGE
Table 2.1: Domestic Chicken Supply Against Imported (2000-2016)		20
Table 3.1: Description, Measurement and A Priori Expectation of Variables		52
Table 3.2: Distribution of Sample Size.....		62
Table 4.1: Socio-economic Characteristics of Respondents.....		66
Table 4.2: Total Quantity of Poultry By-product Forms Sold.....		69
Table 4.3: Distribution of Poultry By-product to Channels.....		75
Table 4.7: Determinants of Revenue Proportion Contributed by Poultry Droppings.....		84
Table 4.8: Ranking of Constraint in the Poultry Dropping Market		90



TABLE	LIST OF FIGURES	PAGE
Figure 2.1: National Poultry Production.....		19
Figure 3.1: Conceptual Framework of Overview of the Poultry By-products		45
Figure 3.2: Map of the Study Area		60
Figure 4.1: Channels of Marketing Poultry Droppings		74
Figure 4.2: Benefits of Poultry Droppings.....		82



LIST OF ACRONYMS

CAGR	Compound Annual Growth Rate
CI	Commercializing Indices
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
IFDC	International Fertilizer Development Centre
Kg	Kilograms
MFA	Ministry of Foreign Affairs
MoFA	Ministry of Food and Agriculture
Mt	Metric Tonnes
PFA	Poultry Farmers' Association
PMR	Persistence Market Research
ROI	Return on Investment
SME	Small and Medium Scale Enterprise
SSA	Sub-Saharan Africa
TMR	Transparency Market Research
UNEP	United Nations Environmental Program

CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture continues to play an essential role in contributing to socio-economic development in several countries of which Ghana is no exception (Abban *et al.*, 2021). Ghana's economy is based on agriculture, as it is a developing and emerging country. In 2017, the agriculture sector in Ghana produced around 19% of the country's GDP and employed 34% of the labor force (Ferreira *et al.*, 2022). Although sector performance has declined over time, it nevertheless contributes significantly to achieving national and international policy objectives ((Ferreira *et al.*, 2022). Agriculture is the primary source of food, employment, and livelihood for most rural people (Assa, 2012). “In 2019, the agricultural sector contributed to about 20% of Ghana’s gross domestic product (GDP)”. The GDP growth rate in Ghana in 2018 was 8.4%, while that of agriculture was 6.3% indicating the level of importance of the agricultural sector (Nyamekye *et al.*, 2021). The GDP growth rate also suggests that the general economic growth and development of Ghana depends on how well the agricultural sector is performing (Nyamekye *et al.*, 2021). This is because the sector provides food, raw materials, and foreign exchange, which propels industrialization.

Livestock production is an essential subsidiary of the agricultural sector of most developing countries, which is a source of income for most smallholder farming households and most rural folks in entirety (Anang *et al.*, 2013). Examples of predominant livestock productions in Ghana include cattle, goat, sheep, poultry, pig, rabbit and grasscutter. Poultry production has gained reputation among all other commercial livestock activities, with enormous prospect for rapid economic growth (Anang *et al.*, 2013) . Poultry production in rural areas is an important

agricultural activity for most communities in Africa, providing animal protein in the form of meat and eggs as well as being a reliable source of income (Awuni, 2002). A study by Rajendran & Mohanty (2003) revealed that poultry production has become a leading agricultural occupation because, it guarantees quick returns and involves minimal space and investment.

According to Assa (2012), poultry production is the fastest growing subsector of the global meat production sector. Global consumption of poultry product has been on the rise with the global economies like United States of America, China, and Brazil leading in per capita consumption (Lasekan *et al.*, 2013). In the last decade, global poultry production has increased drastically due to the world population growth and the high demand for poultry products (Ayoo *et al.*, 2019). With the large production ongoing globally, tons of organic by-product are generated in the form of excreta (dropping), viscera (internal organs), feet, heads, bones, blood and feathers (Zhu *et al.*, 2010), which brought about development processes such as rendering, composting, chemical, microbial and thermal microbial treatment of poultry and other animal wastes (Salminen & Rintala, 2002). In developing countries, the use of some poultry by-products like the dropping and feathers is not a new development (Onibokun & Kumuyi, 1999). It has being a tradition technique farmers have used to provide plants with required nutrients and improve soil quality (Onibokun & Kumuyi, 1999). The global market for chicken manure is expected to rise at a Compound Annual Growth Rate (CAGR) of 10% to 12% between 2021 and 2031 because of its high content of nitrogen, phosphorus and potassium (Persistence Market Research, 2021). One of the principal drivers for chicken manure industry is the growing demand for organic farming, organic products and the increased growth of agro-based industries globally. Chicken manure is considered as a rich source of nitrogen, which is a widely used fertilizer nutrient after potassium and phosphorus (Boateng *et al.*, 2009). The desire of governmental bodies to manage waste also serves as a driving

factor in increasing the demand for chicken manure and as a result, most governments globally are introducing diverse initiatives to encourage the usage of poultry manure as organic fertilizers by engaging in organic farming (Kumar, 2012). The changing way of life of the people; increase in household gardening (vegetables, flowers, shrubs, trees), rapid urbanization, infrastructure development in terms of public parks and jogging tracks, fuel the global poultry manure market (Cofie *et al.*, 2006).

Currently the global poultry manure market is being dominated by Asia pacific and is expected to expand its market size owing to the massive growth in agro-industries and the increase agricultural activities with North America closely behind them in the market (Transparency Market Research, 2020). The United States is expected to witness significant demand growth owing to the reputation of organic foods among consumers. Currently, some of the key players in global manufacturing and supplying of poultry manure fertilizer include Kreher Family Farms, Italtollina, Komeco, Olmix Group, Farm Choice, Stutzman Environmental Products, Rocky Point, Fertagon, Apple Agro, Fabon Agro, Samruddhi Green Crop Care Pvt Limited, Asis Agrochemical Industries and Gen-Ee Corporation SDN BHD. These manufacturers usually process the poultry manure fertilizer into the form of pellets, powder or liquid which are targeted at mainly residential gardeners, commercial gardeners and commercial crop producers for use on their field crops, fruit and vegetable fields, trees and shrubs and flowers amongst others. These manufacturers are focused on the production and supply of high-quality organic fertilizers from poultry manure and expanding their capacity by inducing strategic partnerships with local players in different countries to gain more geographical presence and market share.

In developing countries, especially in Africa and Asia, where smallholder livestock production is predominant, livestock farmers have often failed to achieve their production target as a result of

their inability to supply adequate feed to their livestock (Banda & Tanganyika, 2021). High livestock feed cost is restraining them to supply adequate feed to their livestock (Lawrence *et al.*, 2008). Hence, the potential of using by-products such as poultry feather in the compound feed drastically reduces the feed costs and therefore creating sufficient feedstocks at a global level. The global poultry feather meal market in 2021 was worth USD 359.5 million and is estimated to reach USD 820 million by the year 2027 (Transparency Market Research, 2020). The global poultry feather meal market is therefore expected to experience a CAGR of around 8.8%, mainly due to the traction gained by the costs of feed ingredients in recent years in developing countries. While feathers are often considered a by-product of poultry production, some producers raise poultry specifically for their feathers (Ockerman & Basu, 2014). Poultry feathers are used in a myriad of products such as pillow stuffing, diapers, plastics, boas, feather fans, masks, costume accessories, and flowers. Aside animal nutrition and decorative products, poultry feathers can also be used in manufacturing organic fertilizers, which is known as feather meal fertilizers (Thyagarajan *et al.*, 2013). Feather meal fertilizers are prevalently replacing synthetic liquid fertilizers used in horticultural and gardening applications (Transparency Market Research, 2020). The feather meal possess the needed amount of nitrogen for the growth of plants. Currently, North America has the largest market share of the poultry feather meal globally and is expected to continue to lead the world market. Europe is second placed, occupying a substantial portion of the global market for poultry feather meal. The Asian feather meal industries are booming recently especially in production and processing, having the poultry population of more than 14.6 billion (Transparency Market Research, 2020). Thus, the poultry feed meal is currently their source of low utility protein in the region (Ockerman & Basu, 2014).

Poultry by-products can be utilized as an income-generating activity globally and in the African region. There are several concerns at the global level that make the utilization of poultry by-products for income generation a viable option (Mishra *et al.*, 2015). Firstly, cross-country demand studies have shown that income elasticities of demand for food items, including meat products, tend to decline as per capita income increases (Zhou *et al.*, 2020). This implies that as people's incomes rise, their demand for meat products, such as poultry, may decrease. Therefore, finding alternative uses for poultry by-products, such as generating income through value-added products or by-products, can help sustain the poultry industry and ensure economic viability.

In the African region, there are specific concerns related to the poultry value chain that make the utilization of poultry by-products for income generation important. One of these concerns is the governance structure of the poultry value chain. A study analyzing the governance structures in the poultry value chains in Botswana, South Africa, Zambia, and Zimbabwe found that the governance structure is a factor that determines entry into and success in a global value chain (Ncube, 2018). By utilizing poultry by-products for income generation, stakeholders in the poultry value chain can enhance their participation and success in the global market. Additionally, there are environmental sustainability concerns associated with poultry supply chains. Designing reverse logistical loops in poultry supply chains can contribute to environmental sustainability (Shamsuddoha *et al.*, 2021).

By utilizing poultry by-products for income generation, such as through the production of biochar or other sustainable products, the poultry industry can reduce waste and contribute to a more sustainable and circular economy. Furthermore, socio-demographic factors play a role in the income generated from poultry farming. A study conducted in a rural area of Ciamis Regency found that socio-demographic factors, such as gender and social class, influence the income

generated from poultry production (Setiana *et al.*, 2020). This suggests that utilizing poultry by-products for income generation can be particularly beneficial for certain socio-demographic groups, providing them with additional income opportunities.

In conclusion, globally and in the African region, there are concerns related to income elasticities of demand for meat products, governance structures in the poultry value chain, environmental sustainability, and socio-demographic factors that make the utilization of poultry by-products for income generation a relevant and important activity. By finding alternative uses for poultry by-products, stakeholders in the poultry industry can address these concerns and ensure the economic viability and sustainability of the industry.

1.2 Problem Statement

Commercial poultry production in Ghana has been experiencing a massive decline despite being a vibrant industry which supplied about 80% of poultry meats and eggs in the country within 1980s-1990s and 2000 to 2007 (Randon & Ashitey, 2011). Currently, the local producers of poultry tend to face intense level of competition from the imported chicken whose prices are about 30%- 40% cheaper (Ahiale *et al.*, 2019). Poultry farmers in Ghana insisted the government end the importation of chicken meat since local production is being undermined (Kusi *et al.*, 2015). Aning (2006) also reported that Ghana's decline in poultry production is associated with higher cost of labor, feed, day-old chick, and other variable input costs. Yevu & Onumah (2021) have also reported that feed cost and labour cost reduce profit levels of poultry producers in Ghana. These high costs are compelling most poultry farmers in Ghana to exploit additional streams of revenue.

First and foremost, poultry farmers in Ghana have been able to ascertain the growing demand for organic fertilizers and have offered the poultry dropping as an alternative to inorganic fertilizers

for crop farmers (Drechsel *et al.*, 2000; Martey, 2018). Inorganic fertilizer supplies fall as a result of price hikes, causing a national scramble for farmer (IFDC, 2021). Inorganic fertilizers (nitrogen, phosphorus, and potassium) have been responsible for the triplication of global grain production and has aided the greatest human population growth the world has witnessed (Bourne *et al.*, 2002). International Fertilizer Development Centre (IFDC) indicates that official inorganic fertilizer imports by Ghana have reduced from about 618,638 Metric tons (Mt) to 239,062 Mt representing a 61% reduction from 2020 to 2021 alone (IFDC, 2021). The reason for the low imports volumes include price hikes and the preference of the international fertilizer suppliers for more lucrative markets who make payment upfront (IFDC, 2021). In the short supply, farmers, fertilizer companies, and governments organizations in Ghana are scrambling to prevent an obvious inevitable fall in crop yields as about 85% of the Ghanaian market is driven by subsidy (COCOBOD and Planting for Food and Jobs), and have not being able to secure intended volumes of the inorganic fertilizer in 2021 and 2022. The price for inorganic fertilizer has more than doubled (APRI, 2022). Crops farmers in Ghana have no other substantial solution to address the looming shortage and hike in prices of inorganic fertilizer than to switch to using poultry droppings and other readily available forms of organic fertilizers. Nkansa *et al.* (2020) have revealed that some poultry producers in Ghana sell off poultry by-products to organic fertilizer manufacturing companies, vegetable farmers, tree crop farmers, commercial parks and garden developers amongst others as currently there is a growing demand for organic foods and produce (Dubey & Dubey, 2010). The use of organic fertilizers has being shown to significantly increase productivity and crop revenue by 1.43 and US\$132 respectively (Martey, 2018).

Nkansa *et al.* (2020) indicates that whiles majority of poultry farms in Ghana sell their poultry by-products about 30% of them still dispose their by-product off into forest in their localities. This

practice often builds up cost of production as a poultry farmer is required to bear labor and transportation costs involved in moving poultry by-products from farm to dumping sites. This phenomenon can be attributed to poultry producers' lack of sufficient information on the nature of the poultry by-product market in Ghana. In addition, improper poultry by-product disposal can contribute to climate change. One way is through the release of greenhouse gases, such as methane and carbon dioxide. When poultry by-products decompose, it produces methane, which is a potent greenhouse gas that is approximately 28 times more effective at trapping heat in the atmosphere than carbon dioxide.

These present local poultry producers with myriad of opportunities to cut down their cost of production and diversify revenue sources in poultry production while managing waste which has been for years, an issue of major concern (Nwakaire *et al.*, 2016). Unfortunately, there is inadequate knowledge on the poultry by-product market in Ghana, how the markets have evolved, who the key actors in the market are and how they operate. Also, there is absence of knowledge on where the demand and supply is concentrated, what quantity of poultry by-product is distributed to available channels in the market, how much in revenue poultry by-product contributes to a poultry farmer, how the market players add value to the by-product, how the key players store the by-product prior to sale and who the regulatory bodies involved in the market are. To make the sale of poultry by-product easy to expand beyond subsistence level and more rewarding to local poultry producers while meeting demand and solving waste management issues concurrently, it is necessary to bridge the knowledge gap to help identify the right policy frameworks and technologies to improve markets for poultry by-product. These are vital issues whose investigation can be useful for the formulation of policies to strengthen and improve the poultry by-product market. The above gap makes the following questions relevant;

- i. What is the nature of the market for poultry by-products in the Ghana ?
- ii. What proportion does poultry by-products contribute to a poultry farmer's revenue in Ghana and what factors influence the proportion?
- iii. What are the constraints poultry farmers encounter in the poultry by-products market in Ghana?

1.3 Research Objectives

The main objective of the study is to assess the markets for poultry by-products in Ghana. Specifically, the study seeks to:

- i. Identify and describe the role of actors in the market for poultry by-product.
- ii. Estimate the proportion of revenue contributed by poultry by-products to a farmer's revenue and its determinants.
- iii. Identify and rank constraints poultry farmers encounter in the poultry by-product market.

1.4 Justification of the Study

Ghana's poultry industry plays an important role in ensuring food security and contributing to economic growth. However, while research into primary poultry products such as chicken meat and eggs is well documented, there is still a significant gap in knowledge about the country's poultry by-product market. Poultry by-products include various non-food components, including droppings, feathers, blood and viscera which have a significant economic and environmental value if used appropriately. Thus, the aim of this study is to conduct a comprehensive assessment of the poultry by-product market in Ghana, with a special focus on market characteristics, revenue

contribution, determinants of the revenue contribution and constraints faced by poultry farmers within the poultry by-product market.

Understanding the nature of the poultry by-product market is key for all stakeholders in the poultry industry. Poultry farmers can benefit significantly from a comprehensive analysis of the market, as it would enable them to identify lucrative outlets for by-products, diversify income sources, and reduce waste in their operations (Ayoo *et al.*, 2019). For traders and processors, insights into the market dynamics would inform investment decisions and value-addition processes. Policymakers can utilize the study's findings to formulate targeted policies that promote sustainable utilization of poultry by-products, thereby minimizing environmental pollution while maximizing economic gains. Additionally, consumers will benefit from the knowledge that poultry by-products are efficiently managed, ensuring quality and safety throughout the entire poultry value chain.

Estimating the proportion of revenue contributed by poultry by-products is essential for poultry farmers to gain a comprehensive understanding of financial viability of commercializing poultry by-products. This information will enable them to optimize resource allocation, prioritize investments, and strategize their poultry value chain management. Furthermore, identifying the determinants influencing the revenue contribution from by-products will empower farmers to adopt appropriate management practices to increase their revenue from poultry by-products, such as waste reduction strategies and value-adding techniques. Provided with this knowledge, farmers can enhance the economic sustainability of their poultry by-product operations and attract more investments to the sector. The government can also leverage this information to design targeted support programs that encourage efficient by-product utilization, ultimately improving the incomes of poultry farmers and enhancing the overall welfare of the poultry industry.

Identifying the challenges faced by poultry farmers in the by-product market is crucial for developing effective solutions that address these issues (Shabani *et al.*, 2013). By ranking these constraints in order of magnitude, stakeholders can prioritize interventions based on their potential impact on farmer livelihoods and the poultry industry as a whole. Policymakers can design suitable initiatives that improve market infrastructure, access to information, and value chain linkages, creating a conducive business environment for poultry farmers. Processors and traders, armed with insights into the specific hurdles faced by farmers, can provide targeted support and establish mutually beneficial partnerships. A more efficient and profitable poultry by-product market will benefit the entire poultry value chain, driving overall growth and prosperity in the agricultural sector.

In conclusion, the proposed study to assess the poultry by-product markets in Ghana is of utmost importance for various stakeholders in the poultry industry. Bridging the knowledge gaps surrounding the market characteristics, revenue contribution, determinants, and constraints faced by poultry farmers will empower them with vital market insights, ultimately leading to the adoption of sustainable and profitable practices (Batista *et al.*, 2015). Policymakers, industry players, and farmers alike will benefit from evidence-based decision-making, resulting in improved livelihoods, environmental sustainability, and overall growth of Ghana's poultry by-product sector. With the findings of this study, stakeholders can collaborate to implement targeted interventions that enhance the poultry by-product market and contribute to the broader development of the agricultural sector in Ghana.

1.5 Organization of the Study

The thesis is divided into five chapters. Following the chapter one, the rest of the study is structured as follows. Existing body of knowledge significant to the study is reviewed in Chapter two. The

second chapter presents a brief description of agricultural markets and marketing, poultry production trends in Ghana, the poultry by-product market and its prospects. The methodology of the study is presented in Chapter three. This includes a discussion on the conceptual and theoretical frameworks. It also discusses the method of data analysis, study area and sampling technique. The results analysis and discussions for each study objective are presented in the fourth chapter. The summary of findings, conclusion and policy implications of the study are presented in Chapter five.



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of existing literature in relation to markets for poultry by-product and their contribution to poultry farmers' revenue in Ghana. The chapter begins with the description of agricultural markets and marketing, agricultural marketing channels. This chapter further describes the nature of poultry industry in Ghana, production and consumption trends. In conclusion, this chapter reviews studies on the agricultural by-products, poultry by-products, their markets and prospects.

2.2 Agricultural Markets and Marketing

The commercial world has the general concept of what a market constitutes as a place or environment where selling and buying occurs. This seems to satisfy the definitional requirements of descriptive studies, which are concerned physical facilities, institutional processes and the product characteristics (Khanna *et al.*, 2005). In general, this concept is insufficient from the viewpoint of economics (Khanna *et al.*, 2005). In the modern day economics concept, market is defined as a space or sphere where the forces of supply and demand are at play to determine or alter price, as ownership of a given quantity of good or service is transferred where certain institutional and physical arrangements may be evident. Agricultural markets are a very essential component of every economy around the globe at national, regional and global levels although they mostly constitute a lesser part of gross domestic product (GDP) of most developed nations (Rezitis *et al.*, 2013). Agricultural markets encompass the entire food system ranging from input supply to farm production, harvest, processing, packing and packaging, transportation, and all the way up to final consumer (Myers *et al.*, 2010). Myers *et al.* (2010) further stated that activities that

occur in the agricultural market happen over a space and time, linked by interregional trade and storage. (Degaga, 2020), also explained agricultural market from the viewpoint of being a potential agent of change, stating that they provide a way to apportion resources ensuring the highest production value and maximum satisfaction of consumers. Agricultural markets possess the ability to stimulate growth through the promotion of technological innovation and increasing demand and supply (Degaga, 2020; Scarborough & Kydd, 1992). Agricultural markets also play a central role in the management of risks related with demand and supply shocks by aiding in regulating net export flows resulting in the reduction of the price variability encountered by both producer and consumers (Barrett & Mutambatsere, 2008).

Agricultural marketing was defined by the United National Commission on Agriculture as a process that begins with the choice to produce a marketable farm product and involves all aspects of the marketing structure or system, both financially and institutionally based on the market structure and economic considerations that are at hand (Kamble, 2019). A different definition for agricultural marketing which does not include the input side of agriculture, explains agricultural marketing as a composition of all the operations and agencies in a market involved in the movement of farm produced food (raw materials and its products or by-products) from the farms to the final consumer (Bressler, 1952; Tavva & Anantharaman, 2019). Yadav (2010) also described agricultural marketing as a chain of services involved in moving an agricultural product or commodity from a point of production to a point of consumption. This is a definition numerous organisations and governments have recognized as it describes their activities in the agricultural commodity market. However, Yadav's definition omits two vital elements of marketing which include customer orientation and inbuilt sustainability. Vargo & Lusch (2014) provided an alternative definition which overcomes the issues in Yadav's definition describing agricultural

marketing as a management orientation centering all activities of the organisation on satisfying customer needs and wants, thereby helping achieve the organization's long-term objectives.

2.3 Agricultural Marketing Channels

2.3.1 Definition of Agricultural Marketing Channels

Agriculture Marketing Channels are defined as interdependent organisations involved in the distribution of agriculture produce, products and services. According to Coughlan *et al.* (2006), earlier definitions of marketing channels were primarily concerned with the specific activities that channel actors like distributors, wholesalers, and retailers carried out on behalf of the producers to make the produce, products, and services available to the final consumers. Gundlach *et al.* (2006) also added that, previous definitions focused on the function perspective of agricultural marketing channels which were largely concerned with planning, organizing, directing and controlling the efforts put in by the various channel members in order to minimize transaction costs and leverage specific functions (Coughlan *et al.*, 2006). Currently, marketing channels have been viewed from the consumer perspective, where every member of the channel is considered to add value in one way or the other to the consumer (Gundlach *et al.*, 2006).

2.3.2 Determinants of Agricultural Marketing Channels

The selection of a marketing channel is a vital decision making process which when made by farmers, has significant impacts on their farm profitability by creating unique value chains and input costs, potentially helping farmers to maximize profit while minimizing risks (Lee *et al.*, 2020). There are many agricultural marketing channels and are dependent on the kind of commodity (Davis *et al.*, 2017). According to Davis *et al.* (2017), the factors responsible for the variation in marketing channels include; distance between the producer and the consumer, training

producer has undergone, market characteristics (i.e. local or distant market), strength of marketing agencies, and perishability of the produce or product. Davis *et al.* (2017) also stated that, weight and bulkiness, market information, produce quantity, membership in producer marketing groups and access to extension services also influence farmers' choice of marketing channel.

Study by Srinivas *et al.* (2014) revealed that producers' choice of marketing channels was influenced by elements like price, mode of payment, speed of payment, and amount produced. Farmers' choice of marketing channel is influenced by payment methods, particularly speed of payment (Ogunleye & Oladeji, 2007). They argue that farmers only provide their produce to marketing channels that would pay them on the spot and that farmers typically sell their produce in response to personal emergencies. This is meant to imply that if a marketing channel offers a producer a high price but is unable to pay them immediately, the producer will search for an alternate outlet where, sometimes even at a lower price, they feel they can be paid immediately. Farmers' preference for particular market outlets depend on the different price arrangements and payment agreements they make with commodity buyers (Niemi *et al.*, 2016). Udimal (2015) studied factors influencing the choice of marketing outlets by soybeans farmers in the Saboba District of the Northern Region. A multinomial logistic model was used to analyse the effects of economic and non-economic factors on the producers' choice of marketing outlets. The study revealed that; age, gender, marital status, educational attainment, cooperative membership, experience, and contractual agreement were the factors that influenced farmer's choice of marketing outlets. The study also revealed means of transportation as a key determinant of marketing outlets. Lack of transport services limit the farmers' ability to explore other marketing outlets operating in distance locations. This compels them to sell their produce at farm gate.

Therefore, the farmer must select the channel that offers the most profit margin and hence takes into account a number of considerations when making this decision.

2.4 Overview of Poultry Sector in Ghana

2.4.1 Nature of the Poultry Sector

Most businesses owned in Ghana especially commercial poultry businesses are referred to as Small and Medium scale Enterprises (SME's) and are mostly privately owned (Kusi *et al.*, 2015). Commercial production of poultry in Ghana is categorized into large-scale production, medium-scale production, and small-scale production based on the available number of birds an enterprise keeps. A poultry enterprise is classified to be operating on small-scale with 50-500 birds while between 500-10,000 birds is classified as medium scale production and above 10,000 birds is referred to as large-scale production (Mensah-Bonsu *et al.*, 2019). The poultry sector in Ghana is highly gender-segregated implying, men and women cluster at different stages of the poultry value chain (Mensah-Bonsu *et al.*, 2019). Men dominate the production level of the value chain while the women dominate the processing levels of the value chain. Mensah-Bonsu *et al.* (2019) also reported that value addition and returns on investment (ROI) is higher for producers in both the layer and broiler productions respectively. Layer production is generally preferred industry-wide due to better prices producers receive for their product as there is no competition with the imported table eggs (Nti, 2018).

2.4.2 Poultry Production Trends

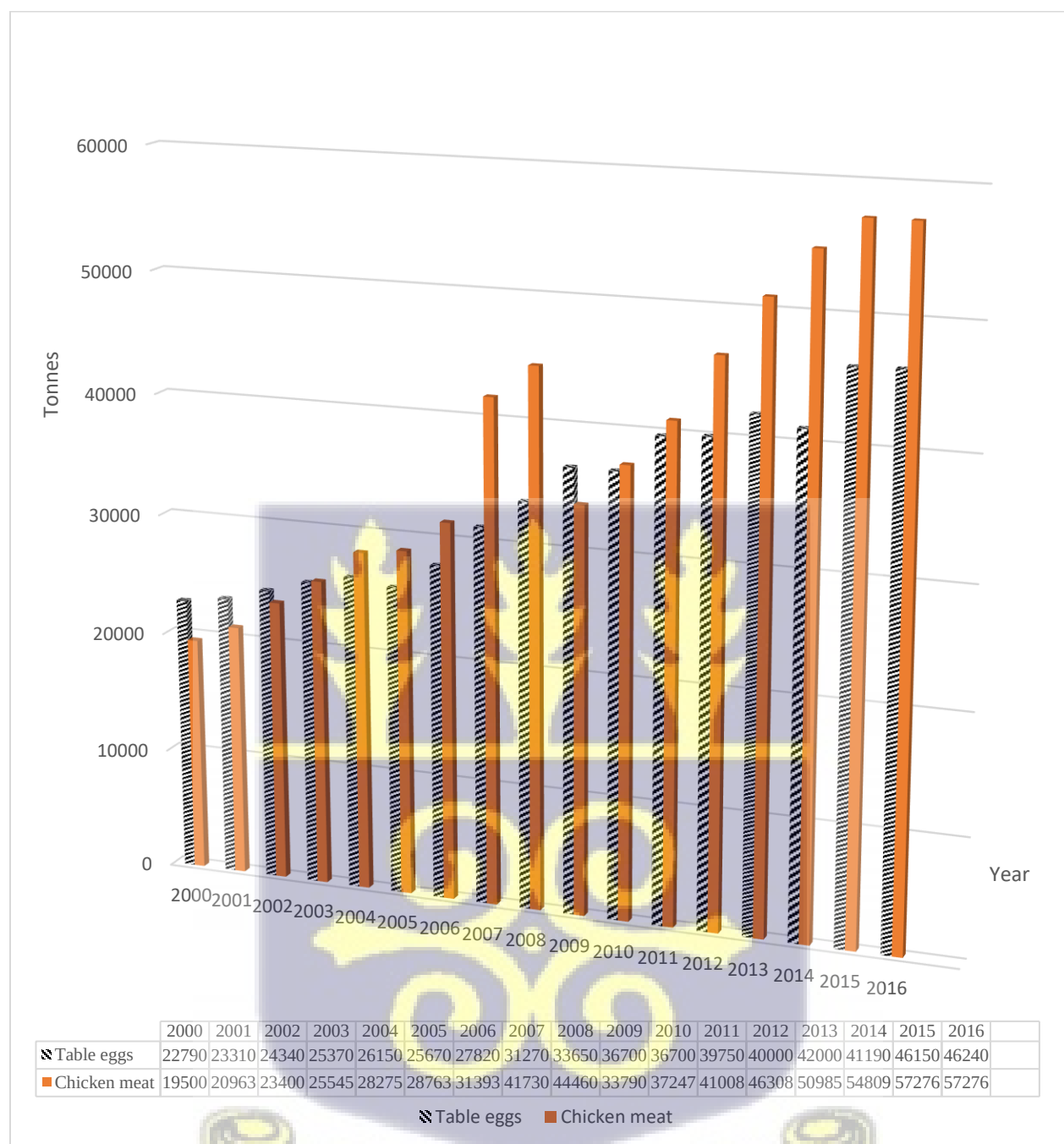
In the 1960s, the government of Ghana identified the poultry subsector of the livestock sector as huge potential for bridging the supply gap in animal protein and unemployment and went ahead to establish an integrated poultry project (FAO, 2014). Although initial growth was slow as a result

of inconsistent supply of day-old chick and other inputs such as feed and vaccines, poultry disease outbreaks, the government of Ghana in the 1970s removed customs duties on poultry inputs and made provision for veterinary services as part of their support toward the development of the poultry industry (Kusi *et al.*, 2015). The poultry industry in Ghana began to grow very fast in the 1980's to 1990's emerging into a vibrant industry in Ghana supplying about 95% of chicken meat and eggs until the sector's abrupt decline from between 2000 and 2010 (Flake & Ashitey, 2008). This led to losing about 80% of the market supply (Kusi *et al.*, 2015). Kusi *et al.* (2015) described the nature of the poultry sector in Ghana as a private entity with minimal support from the government where the main industry players are left to figure out unfriendly marketing systems, mostly emanating from foreign businesses.

Over a decade, the demand for broiler has been increasing (Netherlands Enterprise Agency, 2019). Meanwhile, the local supply of broiler meat has remained stagnant, permitting imports to fill the gap (Netherlands Enterprise Agency, 2019). Ghana's import of frozen chicken has shot significantly from 13,865 tonnes from 2000 to over 68,000 tonnes in 2013 as reported by the Netherlands Enterprise Agency in 2020 (Table 2.1). In 2020, poultry meat imports quantity for Ghana was estimated to be 287,930 tonnes (Knoema, 2021). Poultry meat imports quantity of Ghana increased from 421 tonnes in 1971 to 287,930 tonnes in 2020 growing at an average annual rate of 49.86% (Knoema, 2021). Ghana imported 254 million dollars in poultry meat making it the 24th largest importer of Poultry Meat in the world while Poultry Meat was the 6th most imported product in Ghana (Knoema, 2021).



Figure 2.1: National Poultry Production



Source: FAOSTAT (2017)

Table 2.1: Domestic Chicken supply against imported (2000-2016)

Year	Domestic (tonnes)	Imported (tonnes)	Total (tonnes)	Value of Imported in (000' USD)
2000	19,500	13,865	33,365	10,656
2001	20,963	11,278	32,241	8,303
2002	23,400	24,782	48,182	17,120
2003	25,545	54,238	79,783	24,111
2004	28,275	44,851	73,126	34,657
2005	28,763	49,916	78,679	67,304
2006	31,393	51,403	82,896	41,673
2007	41,730	75,373	117,103	61,936
2008	44,460	71,731	116,191	78,473
2009	33,790	109,179	112,627	72,745
2010	37,247	155,056	146,426	104,746
2011	41,008	154,366	196,064	175,401
2012	46,308	154,366	200,674	185,996
2013	50,985	168,235	219,220	197,392
2014	54,809	135,356	190,165	167,298
2015	57,276	115,335	172,611	115,731
2016	57,276	93,108	150,384	103,899

Source: FAOSTAT (2016)

2.5 Agricultural By-products

2.5.1 Overview of Agricultural By-products

Agricultural by-products are considered very valuable resources that can be gainfully harnessed to develop products of economic value which can improve the efficiency of farms, increase farm revenues, and encourage rural economic development (Ayoo *et al.*, 2019). The use of agricultural by-products is deemed very crucial. In many countries the disposal of agricultural by-product is costly and can have lethal impacts on the environment (Zhu *et al.*, 2010). The United Nations Environmental Program (UNEP) in 2009 estimated that, the amount of biomass generated globally is about 140 billion metric tonnes each year (Zhu *et al.*, 2010). (Shabani *et al.*, 2013) indicated that even though agricultural by-products are abundant in supply, their degree of utilization has being low and that this has restricted the realization of the benefit that could be derived from their utilization. attributed the low level of utilization and non-realization of the benefits of agricultural

by-products to challenges in gathering and hauling these by-products for value addition. Ayoo *et al.* (2019) however suggested that, for social, economic, and environmental reasons, innovative approaches need to be propagated to address the challenges to intensify the utilization of agricultural by-products believing that instigating these approaches can contribute positively in the direction of the reducing environmental pollution, protecting natural resources, increasing economic value and over-all revenue of farmers. In some countries, inventive approaches have been developed for extracting beneficial products from nutrient-rich agricultural by-products and also manufacturing their goods for which considerable market demand exists (Jayathilakan *et al.*, 2012). Examples of agricultural by-products include; straws from rice, wheat and corn can be used as a growth media (substrate) for growing mushrooms and some leafy vegetables in places where the soil is poor in supporting their growth. Also poultry and cattle manure can be used to manufacture organic fertilizers or can be used in conjunction with other agricultural by-products in the preparation of composts which helps in the improvement of the soil structure when applied to the soil. Feathers from poultry production can also be processed together with feed as a protein component for fishes and livestock.

The demand for Value-added products which are manufactured from agricultural by-products is high and growing and its' global market is expected to catapult from \$388 billion in 2013 reaching over \$700 billion in 2018 (Hinai *et al.*, 2022). Countries which possess good technological abilities will be able to efficiently transform agricultural by-products into value added products that would meet consumer preference. Meanwhile, projections have indicated an increase in revenue to about \$867.7 billion by 2025 at a compound annual growth rate of 8.1% for the period of 2020-2025.

2.5.2 Benefits of Agricultural By-products

There are a wide variety of benefits that can be obtained from processing and commercializing agricultural by-products and these include ;

Revenue generation and rural Economic development; Golden *et al.* (2015) indicated that, the U.S. biobased product industry contributed a total value of US\$369 billion to the U.S. economy in 2013. However, Ayoo *et al.* (2019) has reported that there has been no direct evaluation of how much revenue is accrued from the commercialization of agricultural by-products only. By-products from the production of corn, rice, sorghum, pineapples, bananas, and coconuts amongst other, are good and inexpensive sources of biofibers that are appropriate for various industrial applications such as the manufacturing of composites, textiles, pulp and paper (Ayoo *et al.*, 2019). The establishment and utilization of industries for such value addition to generate useful consumer products generate revenues and also provide employment opportunities. The increased and continuous use of agricultural by-products can offer a sustainable basis for individuals, small and medium industries in rural areas to stimulate rural economic development.

Improvement of Environmental Quality; disposing agricultural by-products without utilization releases carbon dioxide and other harmful gases into the atmosphere which intensifies the risks of climate change and poses significant threat to the health of humans (Ayoo *et al.*, 2019). According to FAO (2014), about one-third of the land surface is being used for agriculture. Hence, a significant amount of waste from the agricultural sector is produced each year (Sommer *et al.*, 2015). This confirms report by Zhu *et al.* (2010) indicating that due to the large production of poultry globally, tons of organic by-product are generated in the form of viscera (internal organs), feet, heads, bones, blood and feathers. The fundamental issue is not only producing enough food in a profitable way but also doing it in a sustainable manner which guarantees minimal impact on

the environment (Seidavi *et al.*, 2019). Therefore harnessing agricultural by-products as manure, bio-fertilizers, raw materials for energy production amongst others improve the quality of the environment.

2.6 By-product from Poultry Production

2.6.1 Overview of Poultry By-products

The increase in poultry production worldwide has led to higher generation in the quantity of poultry waste and until date, these waste materials are limited in use and usually end up in landfills (McGauran *et al.*, 2021). Solid wastes obtained from poultry production and processing include the feathers, viscera (internal organs), blood, bones, and residual meat. Solid wastes from poultry production are one of the most important biomass solid wastes in the world (Zhu *et al.*, 2010). Seidavi *et al.* (2019) suggested that, poultry industry players, mainly the producers and processors create these biomass wastes (excreta, feathers, eggshells, blood, bones, and internal organ) the most. These biomass solid wastes are made up of proteins. They consist of a variety of amino acid, which can be converted to very useful by-products such as blood meals, bone meal, organic fertilizers, gelatin, pillow filling, and biofuels amongst others. With the accelerated increase in waste generation from poultry production, utilization of this waste is key to adding value to the poultry production process through minimization of waste ending up in landfills and additional revenue generation (Odetoye *et al.*, 2021).

2.6.2 Prospects for Products

Poultry by-products have extraordinary importance in both developed and developing countries and present great prospects and opportunities for most poultry industry producers and processors (Seidavi *et al.*, 2019). Some of these include;

Excreta; There are bulky volumes of poultry excreta produced in the world which are creating environmental problems (Zhu *et al.*, 2010). Meanwhile, majority of soils especially in Sub-Saharan Africa (SSA) are significantly degraded and need of restoration to enhance sustainable food production (Omotayo & Chukwuka, 2009). This is a harder problem given that, the population is projected to increase with a corresponding increase in demand for food. Several studies have reported on different uses of poultry manure/ excreta and the results have proven that not only is poultry manure very useful, but it is more potential to be a commodity of higher economic value (Seidavi *et al.*, 2019). Abelha *et al.* (2003) reported that, more than 90% of poultry excreta are used for agricultural purposes in the form of organic fertilizers. Currently, poultry excreta is used in feeding livestock and fish (Seidavi *et al.*, 2019). Further studies by Seidavi *et al.* (2019) also have shown that, dried poultry excreta can be used in feeding cattle where about 30% of the dried poultry excreta is mixed with 30% cereal, 14.5% beet pulp, 25% straw and about 0.5% vitamin or trace mineral mix. A few countries such as India, China, and some African countries also produce biogas for household and institutions consumption using poultry excreta (Abelha *et al.*, 2003).

Poultry excreta has a high content of nitrogen containing about 18%-30% uric acid, 12-17% Ammonia, and about 2%-4% creatin (Martey, 2018). Therefore, its nutritive value is higher for use in livestock feeding or as a fertilizer. Martey (2018) has indicated that there is also very high demand for poultry droppings by organic fertilizer manufacturing companies as his studies on “welfare effect on organic fertilizer use in Ghana” has shown that the use of organic fertilizer significantly increases productivity and crop revenue by 1.43 and US\$132 respectively.

Feathers, Viscera, Head & Feet; Feathers from chicken constitute about 91% protein (keratin), 1% fat, and 8% water. The keratin proteins are binded by a more disulfide bond (S-S) indicating a strong covalent bond presence which stabilizes the protein structure making it difficult to break

(Saravanan & Dhurai, 2012). The amino acid component of chicken feathers also indicate high levels of serine, cystine, glutamine, and proline. Seidavi *et al.* (2019) has reported that chicken feathers can be transformed into feather powder which can be used as a protein and amino acid components in feed preparation for livestock. The breakdown of chicken feathers to a powdery state can be done using hydrothermal breakdown which utilizes high pressures under high temperature in their breakdown. However, Tiwary & Gupta (2012) have reported that this method makes the by-product more digestible but usually leads to the denaturing and loss of vital amino acids such as lysine, tyrosine, tryptophan, and methionine. Nitrogen fertilizers can also be produced using feathers from chicken through enzymic hydrolysis (Choi & Nelson, 1996). Chinta *et al.* (2013) has also indicated that chicken feathers can be used in the production of pillow stuffings, plastics and non-wooven textiles at relatively low cost. Thyagarajan *et al.* (2013) reported that an estimated 0.9- 1.3 million tons of chicken feathers are burnt, buried, or ground to be used as feed for livestock or as organic fertilizers during processing. Heads, blood, and viscera of chicken are good source of nitrogen whiles containing about 12% fat and can be processed together as feed for livestock or organic fertilizer (Singh & Singh, 2010). These can equally be used in the production of biodiesel for energy generation.

Egg shells; Chicken Egg shells are composed of nearly 98.2%, 0.9%, 0.9% calcium carbonate, magnesium, and phosphate correspondingly. The calcium content in egg shell are more than calcium contents in lime and coral (Seidavi *et al.*, 2019). Egg shell can be used to produce calcium based organic fertilizers, cosmetic product, animal feed, amongst others.

2.7 Empirical Studies On Poultry By-products

Lasekan *et al.* (2013) examined the potential of chicken by-products as sources of useful biological resources. This research aimed to explore and discuss the various potential applications and value-

added uses of by-products generated from chicken processing plants. The study focused on investigating methods to utilize these by-products, which include heads, legs, bones, viscera, and feathers, for beneficial purposes. Specifically, the research aimed to uncover ways to convert these by-products into protein hydrolysates, enzymes, and polyunsaturated fatty acids. The goal was to identify alternative methods to effectively utilize these biological components from by-products, rather than merely discarding or using them as livestock feed, fertilizers, or pet foods. The study also addressed the environmental and resource challenges associated with inappropriate disposal of these wastes. Furthermore, the research discussed the functional and bioactive properties of protein hydrolysates derived from chicken by-products and their potential applications in various fields. Additionally, the study examined the production methods, microbiological safety, and future prospects of utilizing these by-products in innovative ways.

Chuang *et al.* (2021) also investigated utilization of high-fiber agricultural by-products as potential feed additives to enhance animal performance and health. The study highlights the importance of considering factors like anti-nutritional elements and mycotoxin contamination when using these by-products. The solubility and fermentability of fiber significantly affect its availability. Contrary to previous beliefs, recent research indicates that dietary fiber and other functional compounds like polyphenols and flavonoids can contribute to improved health, antioxidant capacity, and microbiota stability in animals. High-fiber agricultural by-products offer an economical source of fiber that can potentially reduce animal feeding costs. The study emphasizes the need for a comprehensive evaluation of different fiber compositions' effects on animals, urging animal producers to consider using high-fiber agricultural by-products as both animal feed and feed additives.

Mishra *et al.* (2015) investigated the efficient utilization of poultry by-products for economic sustainability. This paper addresses the growing demand for various poultry products in India, driven by factors such as affordability, nutritional value, and societal acceptance. However, the increased production of poultry meat and products has led to significant waste generation, pollution, health concerns, and microbial contamination. Poultry by-products offer a range of potential uses, including as energy sources, livestock feed, fertilizers, soil amendments, collagen, gelatin, and calcium sources. Proper processing can convert these by-products into valuable materials, such as poultry meal and hydrolyzed feather meal, contributing to higher-value products. Despite the benefits, improper handling of poultry industry waste not only results in lost revenue but also poses hazards. This paper reviews the various applications of poultry by-products, aiming to promote sustainability in the poultry industry and meet future consumer demands. The review emphasizes the need to manage waste effectively while maximizing the value of poultry by-products in an evolving poultry market in India.

2.8 Farm Income

2.8.1 Farm Income Generation

Farm income generation is a vital component of agricultural sustainability and rural development. The ability to generate sufficient income from farming activities not only ensures the livelihoods of farmers but also contributes significantly to national economic growth. Several factors have been identified as influencing the financial performance and income generation of farmers. These include agricultural productivity, market access and prices, land tenure and ownership, government policies and support and finally climate and environmental factors. A study by Mishra *et al.* (2009) investigated the factors affecting the financial performance of new and beginning farmers. The study found that farm, operator, and household characteristics, as well as farm type

and regional location, significantly influenced the financial performance of farmers. The study also highlighted the importance of management strategies such as increasing the number of decision-makers, engaging in value-added farming, and having a written business plan in improving financial performance.

Another study by Serra *et al.* (2004) examined the determinants of investments in non-farm assets by farm households. The study emphasized the influence of farm income variability on off-farm investments, suggesting that farmers' preferences and risk management strategies should be considered when analyzing non-farm investments. Contract farming has also been studied as a potential factor in farm income generation. Hoang (2021) reviewed empirical studies on the impact of contract farming on farmers' income in the food value chains. The majority of studies showed a significant positive impact of contract farming on income, highlighting its potential to improve farmers' financial situation.

In addition to these factors, the involvement of farmers in non-farm income-generating activities has been explored. Ovwigho (2014) investigated the factors influencing the involvement of farm families in non-farm income-generating activities. The study found that demographic characteristics such as farm size, level of education, and household size significantly influenced the number of non-farm income-generating activities engaged in by farm families. The study also highlighted the relationship between involvement in non-farm income-generating activities and factors such as soil degradation, oil spillage, and income inequality.

The literature suggests that various factors, including farm and operator characteristics, management strategies, income variability, contract farming, and involvement in non-farm activities, play significant roles in farm income generation. Understanding these factors can help

policymakers and farmers develop strategies to improve financial performance and income generation in the agricultural sector.

2.8.2 Poultry Production as an Income Generation Activity

Poultry production as an income generation activity has gained significant importance in the agricultural sector due to its potential to provide a steady and profitable source of income, particularly in smallholder farming systems. Several studies have explored the role of poultry production in income generation and its impact on household nutrition and food security.

Kuivanen *et al.* (2016) conducted a case study in the Northern Region of Ghana to characterize the diversity of smallholder farming systems and identify constraints and opportunities for innovation. They identified six types of farming systems, with Types 1 and 2 being relatively resource-endowed and oriented towards non-farm activities and crop sales, respectively. Types 3 and 4 were moderately resource-endowed and derived income primarily from on-farm activities. Types 5 and 6 were resource-constrained, with production oriented towards subsistence. This study highlights the different levels of resource endowment and income generation strategies among smallholder farmers engaged in poultry production.

Poultry production has been found to have a positive impact on income diversification. A study by Sonaiya (2007) demonstrated that poultry farming played a significant role in diversifying income sources for rural households. The study highlighted that income from poultry production complemented income from other agricultural activities, providing a more stable and diversified income base. Another study by Benni *et al.* (2012) examined the economic benefits of poultry production. The study revealed that poultry farming contributed to increased household income, employment generation, and improved livelihoods. It also highlighted the potential for value

addition through the processing and marketing of poultry products, which further enhanced income generation opportunities.

The literature suggests that poultry production can be a viable income generation activity for smallholder farmers. However, the success and profitability of poultry production depend on various factors, including resource endowment, integration with other farming activities, household size, labor availability, and resource constraints. Understanding the diversity of smallholder farming systems and the specific opportunities and constraints associated with poultry production can inform targeted interventions and innovations to support farmers in improving their income generation through poultry production.

2.8.3 Agricultural Income Diversification

Income diversification in agriculture refers to the practice of generating revenue from multiple sources beyond traditional farming activities. It is a strategy that has gained significant attention in the literature as a means to enhance rural livelihoods, improve resilience, and foster sustainable agricultural development. It has been extensively studied in the literature, with several studies examining the factors influencing diversification strategies and the impact on household income and poverty reduction. Winters *et al.* (2002) conducted a study in rural Mexico to explore the relationship between assets, activities, and income generation. The study found that the asset position of households significantly influenced their participation in income-generating activities and the returns from those activities. Additionally, the study highlighted the role of social and public capital in income-generating activities, with the influence varying depending on the type of capital and the specific activity.

Bellemare (2018) examined the effects of participation in contract farming on income from various sources. The study found that while participation in contract farming had positive spillovers on income from agricultural sources other than livestock and contract farming, it was negatively associated with income from labor markets and nonfarm businesses. This suggests that participating households may shift away from non-agricultural activities, potentially impacting structural transformation narratives.

In Zambia, Bigstenn & Tengstam (2011) investigated smallholder diversification and income growth. The study revealed that education opened up opportunities for well-paid non-agricultural activities, while land shortage led to distress diversification into agricultural wage work. The study also found that the poor were more likely to rely on income from their own farms, indicating the importance of diversification as a means to improve income.

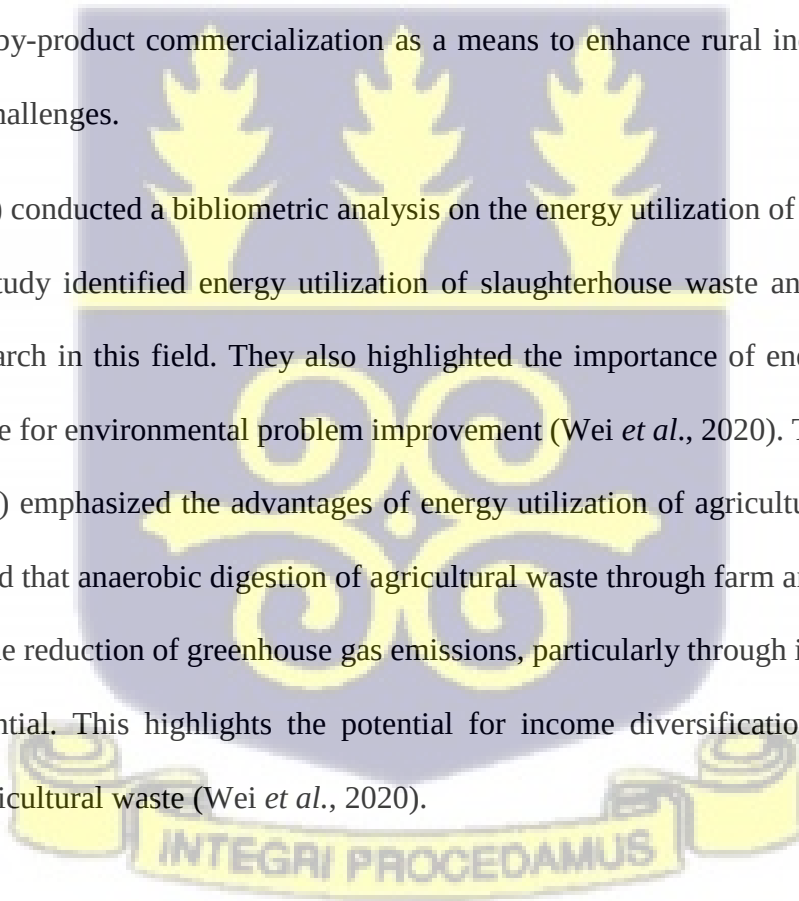
Mat *et al.* (2012) examined the impact of non-farm income on poverty and income inequality among agricultural households in rural Kedah, Malaysia. The study highlighted that agricultural income was the main source of income for rural households. However, encouraging non-farm income activities, particularly value-added activities, was identified as a policy implication to raise income and reduce poverty among agricultural households.

The literature suggests that income diversification in agriculture can contribute to income growth, poverty reduction, and improved livelihoods. Factors such as assets, social and public capital, education, land availability, and access to markets and finance play significant roles in shaping diversification strategies and outcomes. However, these and other studies have failed to

2.8.4 By-product Based Income Diversification

The literature on income diversification in agriculture has indeed provided valuable insights into its role in enhancing rural livelihoods, improving resilience, and fostering sustainable agricultural development. Several studies have explored the factors influencing diversification strategies and the impact on household income and poverty reduction. However, one area that has received limited attention in the literature is income diversification through by-product commercialization. By-products generated via agricultural activities can be a valuable and often underutilized resource. Commercializing these by-products can create additional income streams for farmers, thereby contributing to income diversification. Unfortunately, only few studies have delved into the potential of by-product commercialization as a means to enhance rural income and address energy-related challenges.

Wei *et al.* (2020) conducted a bibliometric analysis on the energy utilization of agricultural waste in China. The study identified energy utilization of slaughterhouse waste and cow manure as frontiers of research in this field. They also highlighted the importance of energy utilization of agricultural waste for environmental problem improvement (Wei *et al.*, 2020). The same study by Wei *et al.* (2020) emphasized the advantages of energy utilization of agricultural waste in rural areas. They found that anaerobic digestion of agricultural waste through farm anaerobic digestion can strengthen the reduction of greenhouse gas emissions, particularly through increased methane production potential. This highlights the potential for income diversification through energy utilization of agricultural waste (Wei *et al.*, 2020).



2.9. Theoretical Frameworks Underpinning the Study

2.9.1 The Production Theory

The production theory is a fundamental concept in economics that explains the relationship between inputs (factors of production) and outputs (goods or services) in the production process. Production theory, in the context of poultry byproducts, revolves around understanding the relationships between various inputs, processes, and outputs involved in the generation and utilization of these byproducts. It seeks to elucidate how factors such as the quantity of poultry droppings sold, the price at which they are sold, affiliation to poultry farmers' associations, and other variables interact to influence the proportion of revenue derived from poultry byproducts.

The theory suggests that the production of poultry byproducts involves a combination of inputs, including the quantity of droppings generated, processing methods employed, and market conditions. These inputs collectively contribute to the final outcomes, such as revenue proportions and overall economic viability. Production theory emphasizes the need for efficient utilization of resources and optimal decision-making to achieve desirable outcomes in the poultry byproduct market. Solow (1957) laid the foundation for the aggregate production function theory, which describes the relationship between inputs and outputs at the macroeconomic level. This theory has been widely applied in various sectors, including poultry production.

Endacott *et al.* (2021) conducted a farm survey in Nigeria to assess poultry production and revenue generation. They found that live spent layers, eggs, and used beddings were the most frequently sold products for revenue. This study provides empirical evidence of the production function theory in the poultry industry. Furthermore, the revenue contribution of poultry by-products is influenced by various factors, including disease control, biosecurity measures, and market participation. Hafez & Attia, (2020) highlighted the challenges faced by the poultry industry,

including disease control and public health hazards. They emphasized the importance of considering economic, ethical, and social dimensions in the production of poultry by-products.

Biswas *et al.* (2017) conducted a study on biosecurity and circulation of avian influenza virus in live-bird markets. Their findings demonstrated the significance of biosecurity measures in preventing the spread of diseases and ensuring the safety of poultry products. Moreover, market participation and integration with other agricultural activities can contribute to the revenue of poultry farmers. Habiyaemye *et al.* (2021) analyzed the economic profitability of integrated vegetable-poultry production systems in Tanzania. They found that the integrated system was more profitable than vegetable farming alone, highlighting the potential revenue contribution of diversifying agricultural activities.

Onyeneke *et al.*, (2020) examined the impact of poultry farmers' participation in modern food retail markets on household dietary diversity in Nigeria. Their study showed that participating in modern food retail markets improved poultry farmers' dietary diversity, indicating the potential for increased revenue through market integration. Understanding the cost structure and profit levels in the poultry industry is essential for assessing revenue contribution. (Oladeebo & Ojo, 2012) conducted an economic appraisal of small and medium-scale poultry egg production in Nigeria. Their study examined the factors that determine the revenue of poultry egg farmers and found that profit levels varied across different scale levels. This research provides insights into the economic aspects of poultry production and its revenue contribution.

In conclusion, the production function theory is a crucial framework for understanding the relationship between factors of production and revenue contribution in the poultry industry. The literature review highlights the importance of disease control, biosecurity measures, market participation, and cost structure in assessing the market for poultry by-products and their revenue

contribution to poultry farmers' overall revenue. By considering these factors, policymakers and stakeholders can make informed decisions to promote sustainable and profitable poultry production.

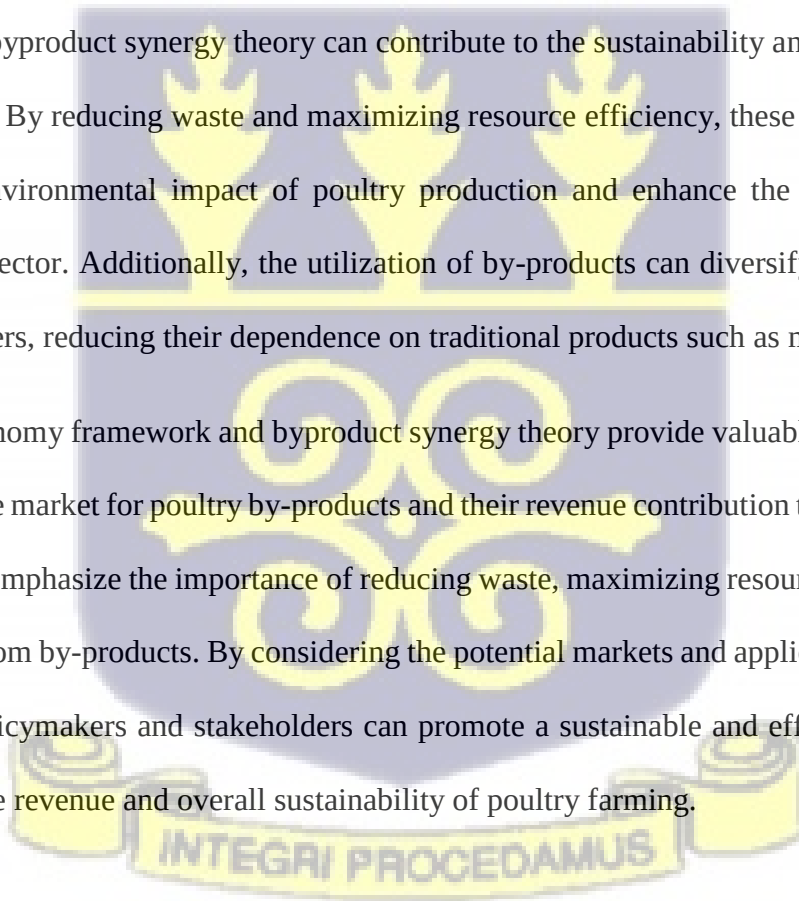
2.9.2 Circular Economy Framework and Theory of By-product Synergy

The concept of the circular economy and the theory of byproduct synergy play a crucial role in understanding the revenue contribution of poultry by-products in the context of a sustainable and efficient market. The circular economy framework emphasizes the importance of reducing waste and maximizing resource efficiency, while the byproduct synergy theory focuses on the potential value creation through the utilization of by-products. This literature review explores the linkages between these theories and their implications for the assessment of the market for poultry by-products and their revenue contribution to poultry farmers.

The circular economy framework provides a holistic approach to resource management and waste reduction. Geissdoerfer *et al.* (2017) define the circular economy as a new sustainability paradigm that aims to decouple economic growth from resource consumption. They highlight the importance of closing the loop of material flows and promoting the reuse, recycling, and remanufacturing of products. In the context of poultry farming, the circular economy framework encourages the identification and utilization of by-products to minimize waste and maximize resource efficiency. Byproduct synergy theory complements the circular economy framework by focusing on the potential value creation through the utilization of by-products. According to this theory, by-products from one process can serve as inputs for another process, creating a symbiotic relationship between different industries or sectors. In the context of poultry farming, byproduct synergy theory suggests that the by-products generated, such as feathers, blood, and offal, can be utilized in various ways to generate additional revenue streams. For example, feathers can be processed into

feather meal for use in animal feed or as a raw material for the production of bio-based products. The revenue contribution of poultry by-products can be assessed by considering the potential markets and applications for these by-products. Kirchherr *et al.* (2017) conducted an analysis of 114 definitions of the circular economy and found that economic prosperity is considered the main aim, followed by environmental quality. This implies that the revenue contribution of poultry by-products can be significant, as they can be transformed into valuable products or inputs for other industries. For instance, blood can be processed into blood meal, which is a valuable source of protein for animal feed. Similarly, viscera (internal organs) can be used for the production of pet food or as a source of bioenergy through anaerobic digestion. Furthermore, the circular economy framework and byproduct synergy theory can contribute to the sustainability and resilience of the poultry industry. By reducing waste and maximizing resource efficiency, these concepts can help minimize the environmental impact of poultry production and enhance the overall economic viability of the sector. Additionally, the utilization of by-products can diversify revenue streams for poultry farmers, reducing their dependence on traditional products such as meat and eggs.

The circular economy framework and byproduct synergy theory provide valuable insights into the assessment of the market for poultry by-products and their revenue contribution to poultry farmers. These concepts emphasize the importance of reducing waste, maximizing resource efficiency, and creating value from by-products. By considering the potential markets and applications for poultry by-products, policymakers and stakeholders can promote a sustainable and efficient market that contributes to the revenue and overall sustainability of poultry farming.



2.10 Economic Tools for the Study

2.10.1 Tobit Model (Censored Regression Model)

The Tobit model, also known as the censored regression model, was first introduced by James Tobin in 1958. The model is used to analyze data in which the dependent variable is censored at some threshold. This can occur in a variety of situations, such as when revenue data is only available for individuals earning above a certain amount, or when response times in a study are only recorded for individuals who respond within a certain period. The Tobit model assumes that the data is censored at random, and that the underlying relationship between the independent and dependent variables is linear. The model can be estimated using maximum likelihood techniques, and the estimated coefficients can be used to make predictions about the population from which the sample was drawn. The Tobit model has been widely used in economics to analyze labor market data, where it is often used to study the relationship between wages and various individual characteristics, such as education and experience. It has also been used in finance to analyze stock returns, and in marketing to study consumer choice behavior.

In recent years, several extensions of the Tobit model have been developed to address issues such as non-random censoring, non-linear relationships, and multiple thresholds. Some of the key references in literature on the Tobit model are Tobin, Amemiya and Wooldridge. They present a comprehensive introduction and cover various models estimation. Tobit model is a useful tool for analyzing censored data, and it has been widely used in a variety of fields, including economics, finance, and marketing. However, it is important to be aware of its assumptions and to check if those assumptions are met in the data.

Tobin (1958) first introduced the Tobit model, also known as the censored regression model, in his paper "Estimation of Relationships for Limited Dependent Variables." In the paper, Tobin

stated that the problem of limited dependent variables is one that arises in many branches of economics and other social sciences. He explained that, these variables are often censored in a way that makes it impossible to use traditional regression techniques to estimate the relationships of interest. Tobin then presented a method for estimating the relationships between such limited dependent variables and independent variables, which he calls "a probability model of demand for a durable good." He described the model and showed that it can be estimated using maximum likelihood techniques. Tobin demonstrates that the estimated coefficients can be used to make predictions about the population from which the sample was drawn. Tobin also discussed the assumptions of the model, as well as its limitations. He emphasized that the model assumes that the censoring is random and that the underlying relationship between the independent and dependent variables is linear.

Greene (2003) has also written extensively on econometric methods, including the Tobit model. In his widely used textbook "Econometric Analysis", Greene provided a detailed discussion of the Tobit model and its extensions. He covered the assumptions of the model and the maximum likelihood estimation method. He also provided examples of how the model can be used to analyze data and how to interpret the results. Greene also mentioned various extensions of the Tobit model to account for issues such as non-random censoring, non-linear relationships, and multiple thresholds. He also showed how the estimation can be performed using Bayesian method or using GMM methods. Greene also discussed the limitations of the Tobit model, such as the assumption of linearity, and the problems that can arise when these assumptions are not met. He suggests alternative models, such as the semi-parametric models, that can be used to analyze data when the assumptions of the Tobit model do not hold. Overall, Greene provided a comprehensive overview of the Tobit model, its assumptions, limitations and alternative methods. He also provided

examples and applications to demonstrate how the model can be used in practice and for interpreting the results.

Wooldridge (2010) is an econometrician who has written extensively on econometric methods, including the Tobit model. In his book "Econometric Analysis of Cross Section and Panel Data", Wooldridge provided a comprehensive introduction to the Tobit model, its assumptions, estimation methods, and interpretation of the results. He provided detailed explanations and examples of how the model can be used to analyze data in various fields, such as economics, finance, and marketing. Wooldridge also covered various extensions of the Tobit model to account for issues such as non-random censoring, non-linear relationships, and multiple thresholds. He further discussed the estimation methods, such as the maximum likelihood method and the Generalized Method of Moments (GMM) estimation. Wooldridge highlighted the limitations of the Tobit model, such as the assumptions of linearity and random censoring, and suggested alternative methods that can be used when these assumptions are not met. He emphasized on the importance of checking the assumptions of the model and discussed the diagnostic tests that can be used for this purpose.

Ichimura (1993) in his paper "Semiparametric Least Squares (SLS) and Weighted SLS Estimation of Single-Index Models", Ichimura presented a semiparametric method for estimating the Tobit model that relaxes the linearity assumption. He proposed the use of a single-index model, which allows for a non-linear relationship between the independent variables and the latent variable. The estimation procedure is based on the SLS (Semi-parametric Least Squares) method. He also provides the asymptotic properties and the performance of the method.

Ichimura's method allows for a more flexible form of the relationship between the dependent variable and the independent variables, and it has been widely used in applied research. His work on the Tobit model has been influential and widely cited in the literature. Ichimura's paper is

considered a major contribution to the literature on the Tobit model, as it provides a useful method for analyzing censored data when the linearity assumption of the standard Tobit model is not met. It also provides a way to estimate the model when there are no strong assumptions on the functional form of the relationship and open a way for more flexible forms of the model.

Muricho *et al.* (2017) used Tobit regression to examine the factors that affect the profitability of smallholder farmers in Ethiopia. The authors found that factors such as farm size, access to credit, and access to extension services were positively associated with profitability, while age and family size were negatively associated with profitability.

Michels & Musshoff, (2022) used a Tobit regression model to examine the adoption of mobile phone in agriculture. The study highlights the usefulness of the Tobit model in analyzing censored data. Smartphones are well-suited for applications in agriculture because of their mobility, high data processing power, access to agricultural apps, and compatibility with precision agriculture technologies. The study aims to comprehend the timing of when a certain technology is adopted and identifying the specific characteristics of early and late adopters to aid in the anticipation and fostering of the diffusion process. The results indicate that significant factors influencing the timing of smartphone adoption in agriculture include farmers' gender, risk attitude, and farm location.

Another Study by Mazibuko & Antwi (2019) used the Tobit Regresion Model to examine socio-economic factors influencing smallholder farmers agricultural infrastructure availability, accessibility and satisfaction. The study aimed to identify the factors that influence smallholder farmers' access to agricultural infrastructure and their satisfaction with the available infrastructure. The Tobit regression model was used to analyze the data, and the results showed that the main factors influencing agricultural infrastructure availability, accessibility, and satisfaction among

smallholder farmers were education level, farm size, and access to credit. The study provides insights into the factors that influence smallholder farmers' access to agricultural infrastructure and highlights the usefulness of the Tobit regression model in analyzing censored data.

A study by Guo *et al.* (2022) used Tobit regression to analyze the factors that affect the adoption of conservation tillage by farmers in China. The authors found that factors such as education level, farm size, and access to extension services were positively associated with adoption, while distance to market and off-farm revenue were negatively associated with adoption.

2.10.2 Kendall's Coefficient of Concordance

The Kendall Coefficient of Concordance is a statistical tool employed to evaluate the degree of agreement or concordance among multiple participants when they rank various items. This metric aids in ascertaining whether a consensus exists in the order of opinions and furnishes a quantifiable gauge of the agreement level. The utilization of the Kendall Coefficient of Concordance is driven by the requirement for an unbiased and structured method to analyze ranking data gathered from numerous respondents. Through the application of the Kendall Coefficient of Concordance, we can appraise the overall concurrence or divergence in how respondents rank the constraints.

In a study by Mensah *et al.* (2017), the Kendall's Coefficient of Concordance was employed in evaluating the constraints to development of agricultural insurance for cashew crop farmers in Brong-Ahafo Region of Ghana. The study aimed to identify and analyze the perceived constraints to developing agricultural insurance for cashew crop farmers. Kendall's coefficient of concordance was used in the study to test the agreement of the rankers (respondents) among the constraints identified. This statistical measure assesses the degree of agreement among multiple rankers or raters. Using the Kendall's coefficient of concordance, the study can evaluate the level of

consensus or disagreement among the respondents regarding the identified constraints to agricultural insurance development.

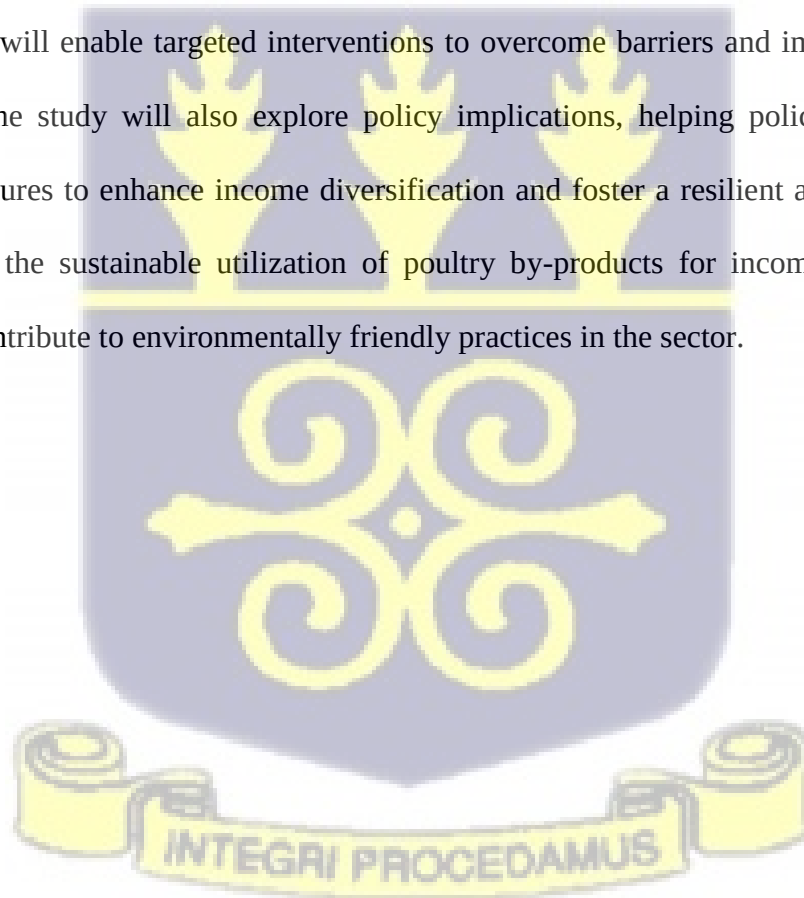
In another study by Steinke *et al.*, (2017), the Kendall's Coefficient of Concordance was employed to assess the accuracy of farmer-generated data in an agricultural citizen science methodology. The study aimed to test whether farmer-generated data in agricultural citizen science methodologies are accurate enough to generate valid statements about the research topic. It focused on evaluating the reliability of data collected by farmers through an agricultural citizen science approach. Kendall's W was employed as a measure of reliability in this study. Kendall's W is a statistical measure that assesses the degree of agreement among multiple rankers or raters. In the context of this study, Kendall's W was used to measure the agreement or concordance among farmers' rankings of plant vigor. The results of the study provide insights into the accuracy and reliability of farmer-generated data in the agricultural citizen science methodology. By using Kendall's W, the study quantified the level of agreement among farmers' rankings on plant vigor, indicating the reliability of the data collected through this approach.

Azumah *et al.* (2018) used the Kendall's Coefficient of Concordance to assess the perceived effectiveness of agricultural technology transfer methods. The study identified the most effective technology transfer methods for rice farmers in Northern Ghana and to assess the level of agreement among the respondents. Kendall's W was used in the study to test the agreement of the rankers (respondents) on their perceived effectiveness of the technology transfer methods.

2.11 Conclusion

The study on the assessment of the market for poultry by-products and their contribution to poultry farmers' revenue in Ghana aims to fill critical literature gaps related to income diversification

within the poultry sector. Existing research lacks comprehensive information on the nature of the poultry by-product market in Ghana and the revenue it generates for farmers. Quantifying the proportion of revenue from poultry by-products and analyzing its determinants is not extensively explored. Additionally, little is known about the constraints faced by farmers in this market. The study will provide a detailed analysis of the poultry by-product market in Ghana, including its structure, marketing channels, and key players. By quantifying the revenue contribution of poultry by-products to farmers' income, it will shed light on its significance for livelihoods. Understanding the factors influencing revenue diversification will be a crucial step in driving policy interventions and promoting sustainable agricultural practices. Identifying and ranking the constraints faced by poultry farmers will enable targeted interventions to overcome barriers and improve the market environment. The study will also explore policy implications, helping policymakers develop supportive measures to enhance income diversification and foster a resilient agricultural sector. By considering the sustainable utilization of poultry by-products for income generation, the research will contribute to environmentally friendly practices in the sector.



CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter consists of four sections. The first section (section 3.2) presents the conceptual of the study. The second section (section 3.3) also presents the theoretical frameworks of the study. The thirds section (section 3.4) presents the method of analysis used in the study, which entails models for analyzing the various objectives. The final section (section 3.5) presents study area and sampling techniques used.

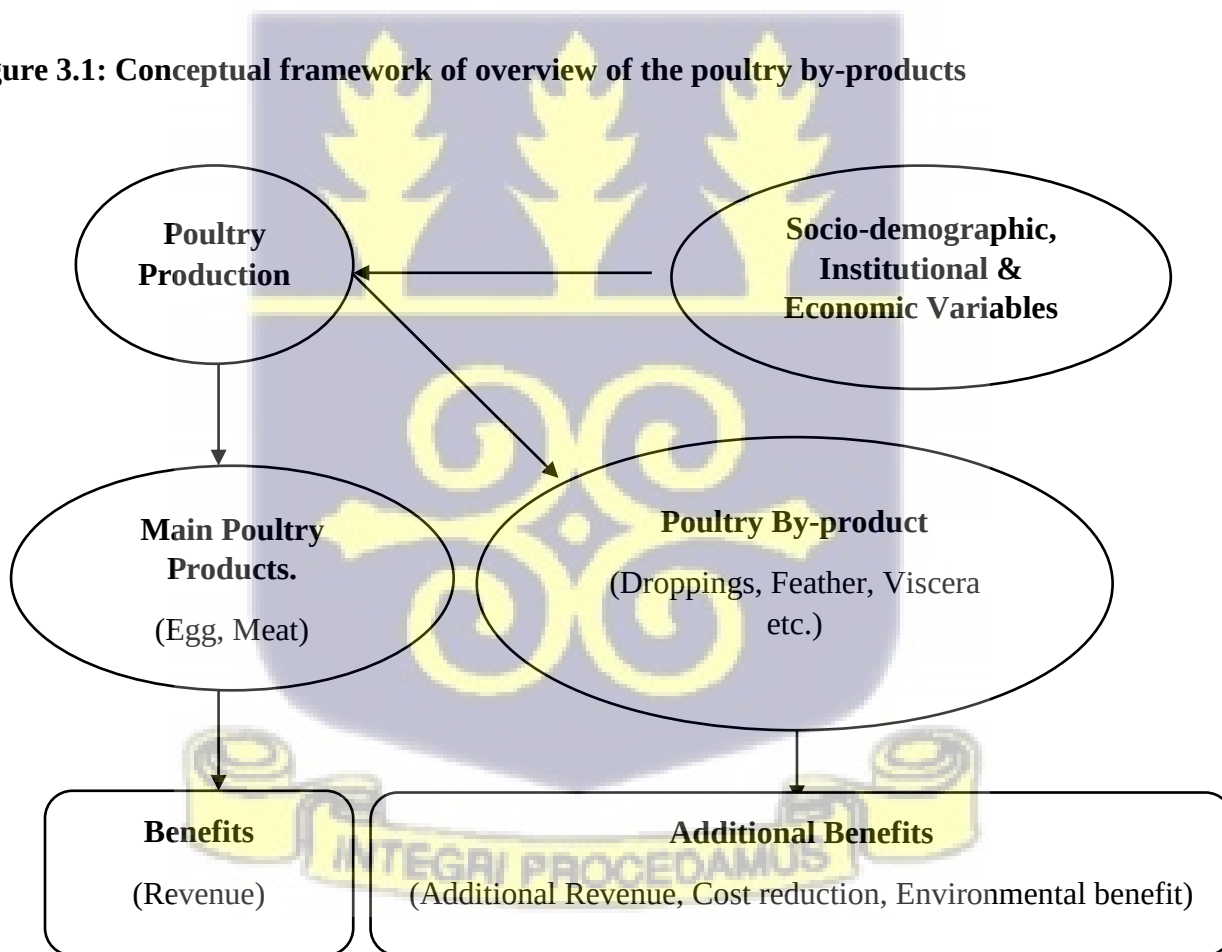
3.2 Conceptual Framework

The conceptual framework employed for the study is presented in Figure 3.1. The underpinning conceptual framework for the study is that poultry farmers conceive poultry production as less rewarding in recent times. Therefore, they would seek additional avenues for livelihood dependence. As a result, diversifying into the commercialization of poultry by-product is proposed to cut the cost incurred for the disposal of poultry by-product and increase their revenue. From Figure 3.1, it is evident that the main products from poultry production are meat and egg, where poultry producers channel most of their energy and investments.

Through the production of the main products, the by-products are created. These poultry by-product are available in many forms including the dropping (manure), feather, viscera, head, feet, and blood. The demand for any form of these by-products is based on preference and purpose for use. The dropping can serve as a source of nutrient to crop and animal farmers. In addition, the bone, blood, head, viscera and feathers contain good amount of protein hydrolysate and keratin hydrolysate, which is used in feed preparation for livestock and pets (Lasekan *et al.*, 2013). The

sale of poultry by-products result in reduction of cost accrued in poultry production as farmers would not have to incur the costs for the disposal of by-products. Furthermore, the sale of poultry by-products generates additional revenue for the poultry farmer while maintaining environmental friendliness. However, farmers' decision and readiness to diversify into commercializing poultry by-products can significantly be determined by their socio-demographic, economic and institutional characteristics. Some socio-demographic features conceptualized to influence diversification into commercializing poultry by-products as an additional source of revenue include age, sex, education, experience in poultry production and selling poultry by-products, litter size, Poultry Farmers' Association membership and access to veterinary service.

Figure 3.1: Conceptual framework of overview of the poultry by-products



Source: Author's own construct (2022)

3.3 Theoretical Framework

3.3.1 Theory of By-product Synergy

The theory of by-product synergy refers to the idea that by-products from one process can be used as inputs in another process, creating additional revenue streams and reducing waste (Zhou *et al.*, 2020). This theory is predicated on the notion that by-products that are ordinarily regarded as waste can be used in a way that generates economic value, benefits the environment, and decreases waste. By identifying a process's by-products and finding out how to use them as inputs in another process, by-product synergy can be achieved (Batista *et al.*, 2015). For instance, in the agricultural sector, crop waste can be used as livestock feed, lowering the demand for additional resources and generating a second source of revenue. The theory of by-product synergy is also related to the concept of circular economy, which seeks to minimize waste and pollution by maintaining products, components, and materials at their highest utility and value at all times, is related to the theory of by-product synergy. By identifying and utilizing by-products in this way, businesses and organizations can create value from what would otherwise be considered waste, and support sustainable development.

By-product synergy can also reduce the environmental impact of a process by reducing the need for new resources, lowering energy consumption and reducing waste. It can also improve the overall efficiency of a process or industry by making better use of existing resources and creating new revenue streams.

Overall, the theory of by-product synergy is a powerful tool for creating additional revenue streams, reducing waste, and increasing the overall efficiency of a process or industry. By identifying and utilizing by-products in this way, businesses and organizations can create value

from what would otherwise be considered waste, and support sustainable development (Zhou *et al.*, 2020).

3.4 Analytical Framework

3.4.1 Method of Analysis

i. Identify and describe the role of actors in the market for poultry by-product.

To identify and describe the poultry by-product market, the study solicited information from respondents on available poultry by-products being sold within market and channels of marketing poultry by-products. Information on their preferred channels of marketing and volumes of poultry by-product supplied to the preferred channels within the market was also obtained. SPSS version 26 was used to analyse the responses using descriptive statistics. The results were presented using descriptive and inferential statistics such as averages, percentages and frequencies. A flow chart diagram was used to depict the nature of the marketing channel in the study area for better understanding of how distribution of poultry by-product to various channels within the market occurs.

ii. Estimating the proportion of revenue contributed by poultry by-products to a farmer's revenue and its determinants

Data on the quantity and selling price was collected on all main products (eggs, meat, and spent layers) which generated on-farm revenue to the poultry farmer. This was used to estimate the revenue farmer accrued through the sale of their products within a production cycle (72 weeks). In order to estimate the revenue from the sale of the by-product, information on the total quantity and average selling price per unit for poultry by-product was also solicited from poultry farmers. Revenue generated from the sale of egg is given as;

$$R_e = Q_e \times P_e \dots\dots\dots (1)$$

Where R_e = revenue generated from the sale of eggs

Q_e = Number of crates of eggs sold

P_e = Price of egg per crate

Revenue generated from the sale of processed meat is given as;

$$R_m = Q_m \times P_m \dots\dots\dots (2)$$

Where R_m = Revenue generated from the sale of processed meat

Q_m = Quantity of processed meat sold

P_m = Price of processed meat per unit

Revenue generated from the sale of spent layers is given as;

$$R_s = Q_s \times P_s \dots\dots\dots (3)$$

Where R_s = Revenue generated from the sale of spent layers

Q_s = Number of spent layers sold

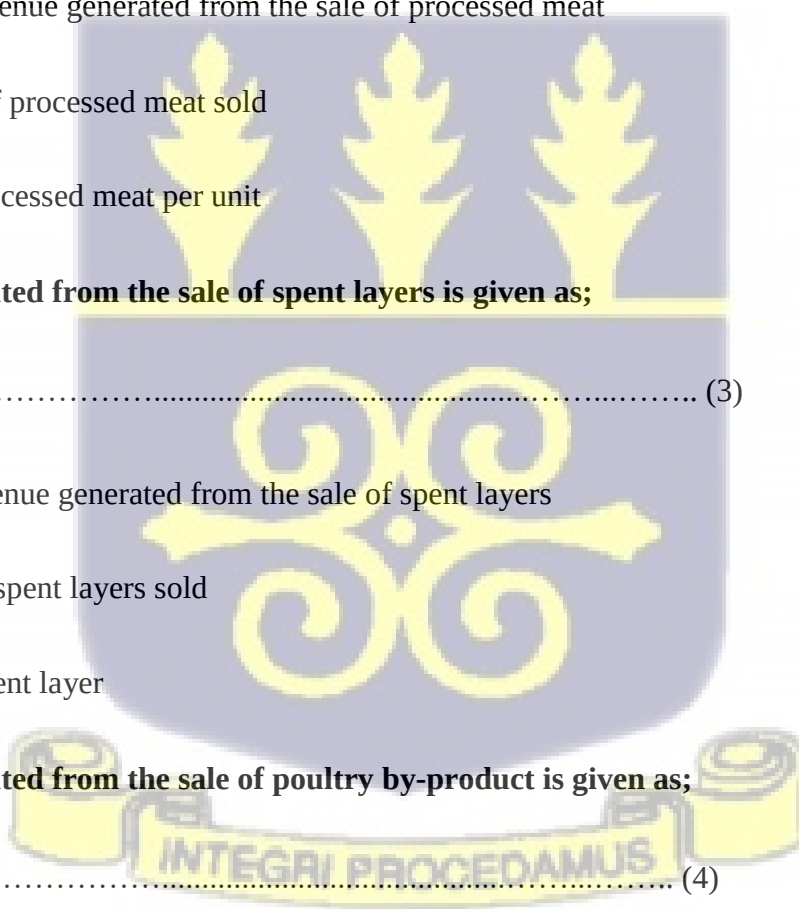
P_s = Price per spent layer

Revenue generated from the sale of poultry by-product is given as;

$$R_d = Q_d \times P_d \dots\dots\dots (4)$$

Where R_d = Revenue generated from the sale of spent layers

Q_d = Quantity of Poultry by-product sold



P_d = Price per unit of poultry by-product

Total revenue (TR) was estimated by addition of all revenues and is given as;

$$TR = R_e + R_m + R_s + R_d \dots \dots \dots (5)$$

The proportion of revenue (P_b) contributed from by-product to a poultry farmers' total revenue is given as

$$P_b = [R_{d1} + R_{d2} + R_{d3} \dots \dots + R_{dn} / TR_1 + TR_2 + TR_3 + \dots + TR_n] * 100\% \dots \dots \dots (6)$$

Where:

P_b = Revenue proportion of poultry by-product (%)

R_d = Poultry by-product revenue per production cycle (GHS), where;

$R_{d1}, R_{d2}, R_{d3}, R_{dn}$, are the poultry by-product revenues per production cycle for each selected poultry farmer.

TR = Total Poultry production revenue per production cycle (GHS), where;

TR_1, TR_2, TR_3, TR_n , are the total Poultry production revenues per production cycle for each select poultry farmer.

To determine factors that influence the extent of revenue contribution of poultry by-products, the Tobit regression model was used for this analysis. A Tobit model was used for this analysis because the dependent variable, revenue proportion of poultry by-product, is a limited dependent variable. The values of the variable are heavily censored between 0 and 100, instead of ranging from minus to positive infinity and therefore using OLS would produce biased and inconsistent

estimates. Revenue proportion of poultry by-product (P_b), shown in Equation (6), is estimated for poultry farmers commercializing poultry by-product and regressed on independent variables. The Tobit regression Model can be expressed mathematically as;

$$P_b^* = x_i \alpha + \varepsilon \dots \dots \dots (7)$$

$$P_b^* = \alpha_0 + \alpha_1 x, \quad \varepsilon \sim \text{Normal}(0, \sigma^2)$$

$$P_b^* = \max(0, Y_i^*)$$

$$P_b^* = 0 \text{ if } Y_i^* \leq 0$$

$$P_b^* = Y_i^* \text{ if } Y_i^* > 0$$

Where P_b^* = Proportion of revenue contributed from poultry by products

ε = Error term

x_i = Explanatory variables

α_i = Model parameters

The empirical Tobit model is thus given as Equation (8) below:

$$P_b^* = \beta_0 + \beta_i X_i + \mu_i \dots \dots \dots (8)$$

Where the error term is normally distributed with zero mean and constant (or homoscedastic) variance ($u_i \sim N(0, \sigma^2) i = 1, \dots, n$), X_i are a vector of explanatory variables corresponding to the i th respondent, and P_b^* is the actual and observed revenue proportion from poultry by-product of the i th respondent.

The empirical Tobit model used in this study is specified as follows;

$$P_b^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \dots + \beta_{15} X_{15} + \mu_i \dots \dots \dots (9)$$

P_b^* = Revenue proportion

X_1 = Gender, captured 1 = male, and 0 = female

X_2 = Age of respondent in years

X₃ = Education level of farmers, captured as 1= No formal education, 2= Primary, 3= JHS/ Middle school, 4= SHS/ SSS, 5= Tertiary

X₄ = Years of selling poultry by-product

X₅ = Poultry Type captured as 1= Layer, 2= Broilers, 3= both

X₆ = Ownership captured as 1= farm owner, 0= otherwise

X₇ = Litter size captured as 1= 50-5,000 birds, 2= <5,000- 10,000 birds, 3 = above 10,000 birds (1 = 50-5,000 birds is set to base to serve as a reference point for categories 2 = <5,000- 10,000 birds and 3 = above 10,000 birds).

X₈ = Quantity of poultry by-product sold

X₉ = Price of poultry by-product

X₁₀ = PFA membership where 1 = Yes and 0 = No

X₁₁ = Quantity of Spent layers sold

X₁₂ = Credit Access captured as 1= Yes, 0= No

X₁₃ = Time of payment captured as 1=Outright, 0=otherwise

X₁₄= Contract captured as 1= Yes, 0= No

X₁₅= Veterinary Access captured as 1= Yes, 0= No

X₁₆= Region of respondent captured a 1= Bono, 0=Ashanti

Three marginal effects are estimated for the Tobit model in Equation (10). Three different marginal effects can be computed based on different definitions of the expected value of the dependent variable P_b^* : (i) the changes in the unconditional expected value of the observed dependent variable, (ii) The changes in the conditional expected value of the dependent variable, and (iii) the changes in the probability of being uncensored. The one of concern is the marginal effect of an independent (explanatory) variable on the expected value of the dependent variable giving the extent of revenue proportion unconditional on sale. This is done by finding the effect of explanatory variables on the extent of revenue contribution of poultry by-product sale. This is called the unconditional expectation of P_b^* since it is based on all the values of P_b^* .

$$\frac{\partial E(P_b)}{\partial (x_i)} = \beta \Phi \left(\frac{x_i' \beta}{\sigma} \right) \dots \dots \dots (10)$$

Table 3.1: Description, Measurement and A Priori Expectation of Variables

Variable	Description	Measurement	A Priori
<i>Dependent Variable</i>	Proportion of revenue from poultry by-product	%	
Revenue proportion			
<i>Independent Variables</i>			
Gender	Gender of respondent	(Dummy; 1 = male, 0 = female)	+
Age	Age of respondent	Years	-
Education	Respondent's level of education	Dummy (0= No formal education, 1= Primary, 2= JHS/ Middle school, 3= SHS/ SSS, 4= Tertiary)	+
Experience	Years of selling poultry by-product	Years	+
Poultry Type	Rearing for meat, eggs or both	(1= Layer, 2= Broilers, 3= both)	-
Ownership	Position of the respondent	Dummy (1= farm owner, 0= otherwise)	
Litter size	The number of birds of a farmer	Categorical (1= 50-5,000, 2= <5,000-10,000, 3 = above 10,000)	+
By-product quantity	Quantity of poultry by-product sold	Continuous (per 80Kg)	+
By-product Price	Price of poultry by-product	Continuous (per 80Kg)	+
Veterinary Access	Access to extension services	(Dummy; 1 = yes, 0 = no)	+
PFA membership	Whether respondent is a member of any Poultry Farmers' Association	(Dummy; 1 = yes, 0 = no)	-
Credit Access	Access to credit	Dummy; 1= Yes, 0= No	+/-
Spent layers	Number of spent layers sold	Continuous (number)	-
Time of payment	Duration of payment for by-product	dummy(1=Outright, 0=otherwise)	+
Contract	Pre-agreement with buyers	Dummy; 1= Yes, 0= No	+/-
Region	Location of respondent	Dummy, 1= Bono, 0=Ashanti	

Justification of variables

Gender: Numerous studies have highlighted the importance of considering gender dynamics in agricultural development programs. Gender can influence farmers' access to resources, decision-making power, and engagement in agricultural activities (Doss, 2018). Ayoola & Dangbegnon (2011) highlighted the importance of understanding the needs of farmers through a holistic, intersectional lens that considers both gender and place-based differences. By including gender as a variable, the model aims to capture any gender-related differences in the intensity of poultry by-product production and its revenue contribution.

Age of Respondent: Age often correlates with experience and knowledge, which can influence farmers' production decisions and revenue generation (Sabran & Abas, 2021; Silva, 2022). Tauer (1995) examined the relationship between age and productivity among farmers. The study found that as farmers age and gain experience, they tend to become more productive due to improved managerial ability. Younger and older farmers may have different approaches to poultry by-product production and sales, making age an important explanatory variable.

Education Level: Education level reflects farmers' skills, knowledge, and access to information. It can influence production efficiency and revenue generation (Doss, 2006). Ninh (2020) confirms the positive impact of education on agricultural output, which implies that policies aiming to provide better education to farmers can lead to increased productivity and revenue generation. Including education level in the model helps account for how education influences the intensity of poultry by-product production.

Years of Selling Poultry By-Product: Farming experience can contribute to entrepreneurial decisions, indicating that farmers' experience can shape their understanding of market

opportunities and revenue generation potential. Farmers with more experience are more likely to adopt new technologies and practices, which can lead to increased productivity and revenue generation (Ainembabazi & Mugisha, 2014). This variable captures the impact of experience on revenue proportion.

Poultry Type: Different poultry types, such as layers and broilers, may have distinct by-product quantities and prices. Incorporating poultry type allows the model to consider variations in revenue proportion based on the type of poultry being produced by a farmer.

Ownership: Whether the respondent is a farm owner or not may influence decision-making and the extent of engagement in poultry by-product sales. Busterna (1989) that, owner-managed businesses tend have a greater stake in the profitability of the firm and therefore take decisions that will increase their personal income. This variable accounts for how respondent position affects revenue contribution.

Litter Size: Litter size represents the scale of poultry production, which can influence the volume of by-products available for sale and the overall revenue proportion. Akunzule (2004) found that flock size was a significant determinant of income. Farmers with larger flocks tended to have higher incomes than those with smaller flocks.

Quantity & Price of Poultry By-Product: These variables directly influence revenue proportion. Larger quantities sold at higher prices will lead to a higher revenue contribution.

PFA Membership: PFA membership might provide access to market information, networking opportunities, and support services. Farmer associations provide access to information, training, and support services, which can enhance farmers' skills and knowledge and lead to increased income (Ainembabazi & Mugisha, 2014). Fafchamps & Minten, (2001) highlight the importance

of social capital in facilitating information flow, trust-building and reducing transaction costs, which can positively affect income generation. Being a PFA member may affect revenue proportion through improved market linkages and other benefits.

Quantity of Spent Layers Sold: This variable is also a secondary revenue source for poultry farmers at the end of their production season and therefore can influence the overall revenue proportion from poultry by-products.

Credit Access: Farmers who have access to credit are able to invest in better-quality inputs, expand their operations, and improve their productivity and profitability (Afolayan *et al.*, 2021). Access to credit can facilitate investments in poultry production and sales, potentially influencing the revenue proportion from poultry by-products.

Time of Payment: The timing of payment for poultry by-products can affect farmers' cash flow and decision-making. Outright payment may influence revenue proportion compared to other payment terms. The mode of payment, such as spot payment or delayed payment, influences farmers' preferences (Ochieng, 2020). Farmers generally prefer spot payments (Ochieng, 2020)

Access to veterinary services: Access to veterinary services is a crucial factor in poultry production. They play a significant role in preventing and managing diseases, ensuring the health and well-being of poultry (Corning, 2014). Healthy birds are more productive (Carrasco *et al.*, 2019). This can positively influence the intensity of poultry by-product production.

Contract: The contract variable provides insights into the dynamics of supply agreements (price, quantity) and their implications for farmers' final revenue from poultry by-products

iii. Identifying and ranking constraints poultry farmers encounter in the poultry by-product market

To identify and rank the constraints faced by poultry farmers in the poultry by-product market, a systematic approach was adopted. The constraints were obtained from a comprehensive review of relevant literature on poultry farming and related agricultural studies. During the pre-testing phase of the questionnaire, a pilot survey was conducted with a small group of respondents to gather insights and feedback on potential constraints. To ensure the relevance and accuracy of the identified constraints in the local context, a pre-testing exercise was conducted. A small group of poultry farmers, who were representative of the study population, participated in this pre-testing phase. They were presented with the list of potential constraints obtained from the literature review. During interactive discussions and interviews, these farmers were asked to share their experiences and rank the constraints according to their perceived severity and impact on poultry by-product marketing.

To analyze the ranking of constraints obtained from respondents, the Kendall Coefficient of Concordance (W) was adopted. Kendall Coefficient of Concordance is a statistical measure used to assess the level of agreement or concordance among multiple respondents when ranking items. It helps determine if there is a consensus in the ranking of constraints and provides a quantitative measure of the level of agreement. The adoption of Kendall Coefficient of Concordance was based on the need for an objective and systematic approach to analyze the ranking data obtained from multiple respondents. By using Kendall Coefficient of Concordance, we can assess the overall agreement or disagreement among respondents in ranking the constraints. This statistical method provides a robust and objective way to summarize the data, ensuring that the results are reliable and representative of the study population's views.

Concordance coefficient (W) is given as;

$$W = \frac{12 \left[\sum T^2 - \frac{\sum T^2}{n} \right]}{nm^2(n^2-1)} \dots\dots\dots (11)$$

Where; T = the sum of ranks of each factor being ranked,

m = Number of sets of ranking by the farmers

n = the number of specific causes being ranked.

The hypothesis and the significance of the rankings are further tested using the chi-square (χ^2) test as follows:

The null (H_0) and the alternative (H_a) hypothesis are stated as follows;

H_0 : There is no agreement among the rankings of the respondents.

H_a : There is agreement among the rankings of the respondents.

The coefficient of concordance (W) is tested for significance in terms of the chi-square (χ^2) distribution: It is given as,

$$\chi^2 = \lambda(n^2 - 1) W / (k + 1) \dots\dots\dots (12)$$

With $n - 1$ degrees of freedom, the parameter k is the number of causes presented at one time.

λ = depicts the number of times that a given comparison occurs.

3.4.2 Software for Data Analysis

To achieve the objectives of this study, the data to be collected was be cleaned, organized in excel. Stata version 17MP was used to estimate the price, total and average quantities of poultry by-product. Stata version 17MP for windows was again used in the analysis of the proportion of revenue from poultry by-products and its determinants. IBM Statistical Package for Social Sciences (SPSS) Statistics version 26 was finally used to analyse the constraints encountered by poultry farmers in the marketing of poultry by-products.

3.5 Data Description

3.5.1 Study Area

The study was conducted in the Bono and Ashanti regions of Ghana. The study was conducted in these regions since they are largest in poultry production in Ghana and has the country's largest local markets and commercial centres (Kusi *et al.*, 2015).

Ashanti region makes up 24,389 square kilometers (10.2% of Ghana's total land area) and is located in the southern portion of the nation. The region's physical location is between latitudes 5.50N, 7.46N, and longitudes 0.15W, 2.25W. After the Northern and Brong-Ahafo Regions, it is the third-largest region. The Western, Central, Eastern, and Brong-Ahafo Regions all share borders with it. There are two rainy seasons in the area, with the major season lasting from April to mid-August and the minor season lasting from September to November. The average annual rainfall is 1,270 millimeters. The period December to March and mid-August to mid-September is relatively dry. The population of the region according to is 5,432,485, representing 17.6 percent of the total country population. The level of urbanization in the Ashanti Region is higher than in all other regions except Greater Accra Region. The region has about 1,519,667 households with an average household size of 3.4. There are 412,055 agricultural households in the Ashanti Region, representing 16.5 percent of total agricultural households in the country. There are 1,087,342 farms in the region, representing 16.4 percent of the 6,625,828 farms in Ghana. Among the crops, the proportion of cocoa farms is highest (22.1%), followed by cassava farms (21.6%), plantain farms (20.1%), and maize farms (11.3%). The Ashanti region is presently a principal pivot for the poultry industry in the country.

The Bono region lies within the transitional zone of the country and covers an area of 11,481 square kilometers. The geographical coordinates for the region is 7° 39' 0" N, 2° 30' 0" W (7.65, -

2.5). It has a tropical climate, with high temperatures averaging 23.9°C and a double maxima rainfall pattern. The terrain of the region is primarily defined by its low elevation, which does not rise above 152 meters above sea level. It features a humid semi-evergreen forest, and the soil is extremely rich. The Bono Region and the Savannah Region are separated by a boundary to the north. Its western boundary is the international border between Ghana and Côte d'Ivoire; its eastern border is Bono East; and its southern border is Ahafo Region. It has a population of about 1,208,649 according to Ghana statistical service in 2021 census. The region has 152,625 households with an average household size of 3.6. The Bono region grows both commercial crops like cashew and lumber as well as food products including maize, cassava, plantains, cocoyam, and tomatoes.

The Ashanti and Bono regions are two of the top poultry producing regions in Ghana possess a great market for poultry products in Ghana (FAO, 2014; Kusi *et al.*, 2015; Mensah-Bonsu *et al.*, 2019). This assertion makes both regions good areas for conducting a study on poultry by-products in Ghana.

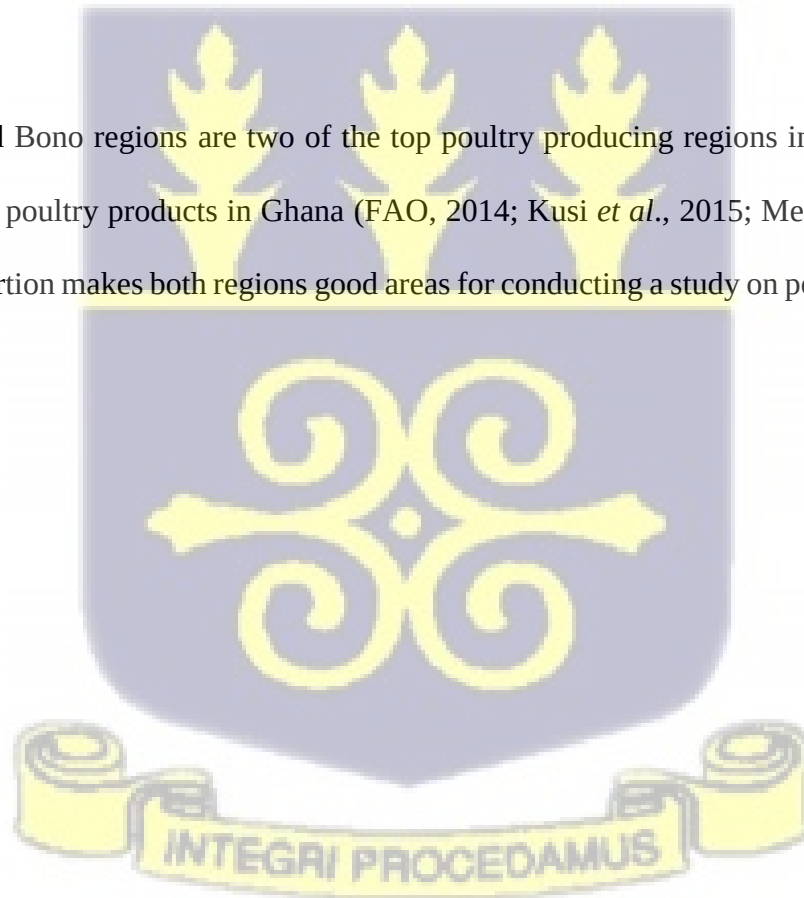
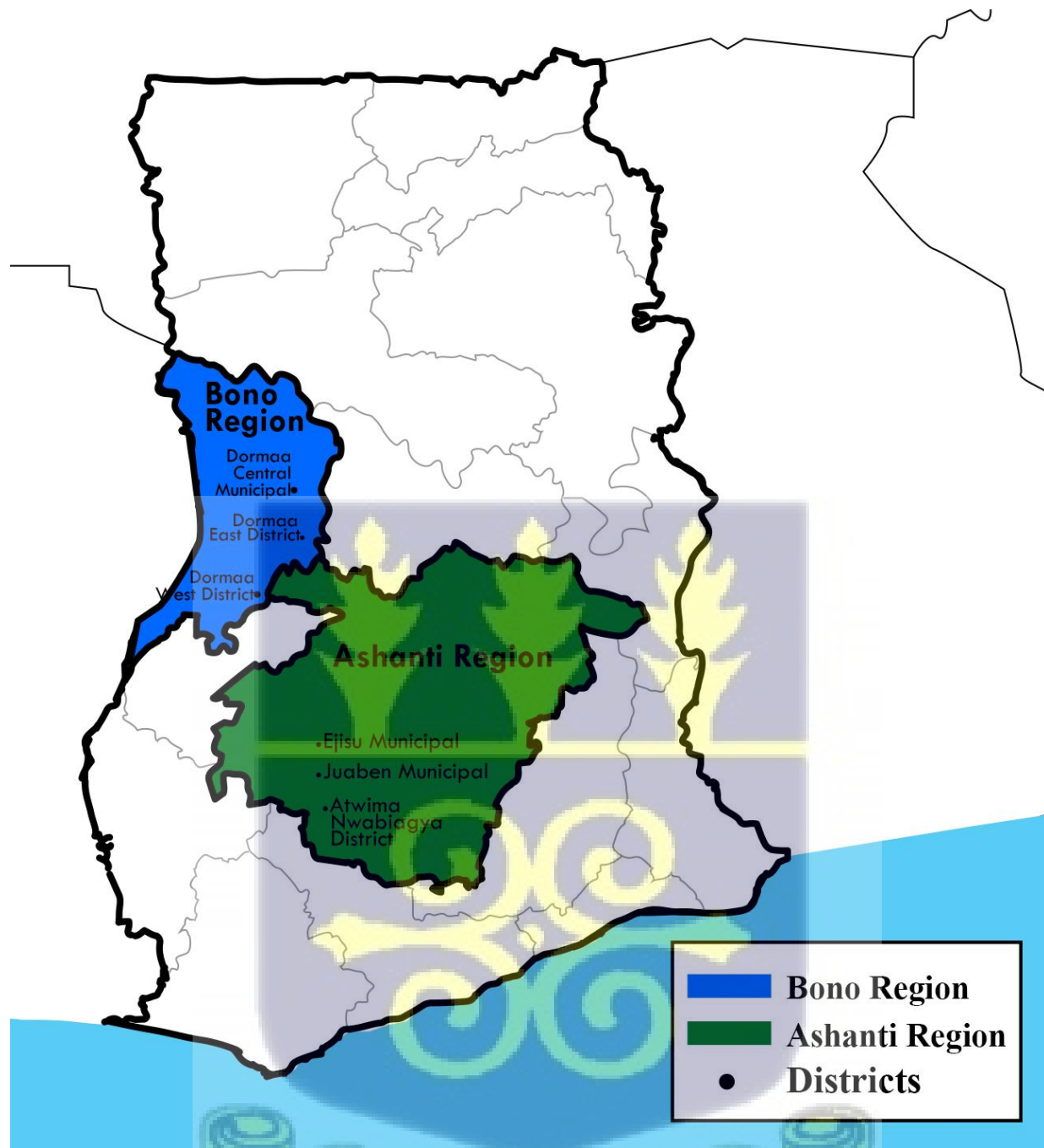


Figure 3.2 Map of the study area



Source: Author's Own Construct (2022)

3.5.2 Sampling Technique and Sample Size

A multistage sampling procedure was used in selection of poultry producers in the country. In the first stage, Bono region and Ashanti region were purposively selected because they are the top poultry producing regions in Ghana (FAO, 2014). In the second stage, three poultry producing districts were purposively selected from each of the regions based on the population of poultry farmers, size and availability of market for the poultry products. Dormaa Central Municipal, Dormaa East District, Dormaa West District were selected from the Bono Region. Ejisu-Juabeng Municipal, Atwima Kwanwoma District and Atwima Nwabiagya District were also selected from the Ashanti Region. In the third stage, two (2) communities were then be purposively selected from each district as shown in Table 3.2. Finally, a systematic random sampling technique was used to sample 10 poultry farmers commercializing poultry by-product from each community to obtain a total sample size of 120 poultry farmers.

The systematic random sampling was done by selecting the first farmer from the community list of poultry farmers randomly. Secondly, an interval for selecting the n th farmer was determined by dividing the total number of farmers in the community by the desired number of farmers (10). The resultant value serves as the constant difference between any two consecutive numbers in the list. The various Department of Agriculture within the districts were visited to obtain the lists of poultry farmers within the district to aid in a systematic random sampling technique of the 10 farmer from each community. For example, in a community of 30 poultry farmers, the first farmer from the community list was selected at random, 5. The interval to pick subsequent poultry farmers in the community was done by dividing the total number of farmers in the community (30) by the required sample size (10), which results, 3. The result becomes the interval and therefore the sample will be individuals 5, 8, 11, 14, 17, 20, 23, 26, 29, 2.

A snowball sampling technique was also used to select seven (7) aggregators and two (3) cattle farmers who purchase poultry droppings. The sample includes four (4) aggregator from Côte d'Ivoire and three (3) aggregators from Ghana. Referral was done by poultry farmers. The snowball sampling method was used because the population for aggregators (buyers) for poultry by-product is unknown and rare.

Table 3.2: Distribution of Sample Size

Region	Districts	Communities	Total size	Sub-sample size
Bono-Region	Dormaa Central Municipal	Dormaa-Ahenkro	40	10
		Aboabo	34	10
	Dormaa East District	Kyeremasu	28	10
		Tutukrom	23	10
	Dormaa West District	Gonokrom	32	10
		Atesikrom	30	10
Ashanti Region	Ejisu Municipal	Ejisu	35	10
		Abankro	18	10
	Juabeng Municipal	Kubease	20	10
		Asienimpong	22	10
	Atwima Nwabiagya District	Barekese	30	10
		Fufuo	25	10

3.5.3 Method of Data Collection

The study used primary data. The data was collected through administration of a semi-structured questionnaire consisting of open and closed ended questions through personal formal and informal interviews. Questionnaires were tested prior to the main study to determine the errors or weaknesses in the questionnaire. As a first step in data collection, a pilot survey was carried out

on a group of randomly selected poultry farms in the Dormaa Ahenkro to validate the suitability and appropriateness of the questions and expected responses by the respondents. In response to the mistakes found in the pilot survey, the questionnaire was amended. The final data collection did not contain these pre-tested surveys. Age, gender, education level, litter size, and experience were among the socioeconomic variables of households that were recorded using a structured questionnaire. Information regarding poultry production and the commercializing of poultry by-product were also collected.

Aggregators and Cattle farmers who purchased poultry by-product were also contacted via telephone calls obtained from some poultry farmers. Information on how the poultry by-product market was organized and whom the poultry by-products were sold to were obtained from them.

3.5.4 Research Design

The research data was collected based on the production cycle of layers which consist of 72 weeks of production. For layer production, this is the typical production cycle. Due to the current state of the poultry industry, where the domestic broiler market faces fierce competition from imported chicken, the majority of broiler producers have shifted to the production of layers (Randon & Ashitey, 2011). In consequence of this, every respondent was into full-time layer production but also produced a minimal number of broiler birds to meet festive seasons only. Therefore, data (price, quantity) on broilers produced during the production cycle of layers were also collected to aid estimated total revenue accrued within the cycle. Poultry droppings that were purchased by channels were not measured. Therefore the study measured the weight (Kg) of full sacks of poultry droppings for 12 different farms. The average weight per unit was 80Kg. Weight of poultry dropping in metric tons were obtained by multiplying the number of bags by 80Kg. The result is further divided by 1000 to obtain results in metric tons.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents and discusses the results of the study. The socio-economic characteristics of respondents are presented in Section 4.1. Findings on the nature of the poultry by-product market within the study area and the proportion of revenue contributed by poultry by-products are presented in Section 4.2. Results and discussions on the determinants of revenue proportion contributed by poultry dropping are provided in Section 4.3. The last section, Section 4.4, presents results on the constraints respondents face in the poultry by-product market.

4.2 Socio-economic Characteristics

The socio-economic characteristics of the respondents are presented in Table 4.1. It includes gender, educational level, age, litter size, their access to veterinary service, ownership of the farm and membership of Poultry Farmers' Associations.

4.2.1 Gender of Respondents

Out of the 120 respondents, majority (85%) of the respondents were males, while females represented 15%. This finding is consistent with a report by Mensah-Bonsu *et al.* (2019) who indicated that poultry production is dominated by men as the occupation is one that requires a great deal of energy and capital which most women do not possess. Thus, most women do not venture into poultry production. (Konlan *et al.*, 2014) indicates that the proportion of females who own or operate a farm is 46.4% of the entire farming population. This shows that the Ghanaian agriculture sector is dominated by males. The dominance of male farmers suggests the need for gender-focused policies and initiatives to promote gender inclusivity in poultry farming. Encouraging and

supporting female farmers can contribute to a more diverse and resilient poultry by-product market.

4.2.2 Education Level of Respondents

From Table 4.1, the educational level of respondents was categorized into five distinct groups; no formal education, Primary education, Junior High School (JHS/ middle school), Senior High School (SHS/ SSS) and Tertiary education. The findings revealed that very few (4%) of the respondents had no formal education. The remaining respondents (96%) have had at least primary education. Thirty-nine percent (39%) of respondents have had secondary level education and this was the highest recorded. There is a low level of illiteracy among poultry farmers who sell dropping as 59% of them have acquired formal education, ranging from senior high school to tertiary (Table 4.1). This is consistent with finding by Wongnaa *et al.* (2023) suggests that poultry farmers in Ghana have a relatively high level of education. This is considered impressive as formal education is generally seen as an approach for combatting poverty and a very important factor that elevates economic productivity (Yúnez-Naude & Taylor, 2001). Martey *et al.* (2019) also reported that formal education increases the knowledge of farmers in embracing agricultural innovations and technologies in Ghana.

4.2.3 Age of Respondents

Analysis from the study indicated that the ages of poultry farmers who sell poultry by-products (poultry dropping) range from 18 years to 68 years (Table 4.1). Thirty-five percent (35%) of respondents within the study area were between the ages of 40-49 years and this was the highest age recorded (Table 4.1). The findings further revealed that the average age for the respondents is 41 years. This is an indication that the poultry farmers who sell poultry by-product (poultry

dropping) are economically active. The economically active group refers to individuals who are currently working or actively seeking work.

Table 4.1 Socio-economic characteristics of respondents

Variable	Frequency	Percentage (%)
Gender		
Female	18	15.00
Male	102	85.00
Education		
No formal education	5	4.00
Primary	7	6.00
JHS/ Middle school	37	31.00
SHS/ SSS	47	39.00
Tertiary	24	20.00
Age		
18 – 30 years	23	19.00
31 – 39 years	31	25.00
40 – 49 years	42	35.00
50 – 59 years	20	16.70
60 years & above	4	3.30
Ownership		
Farm Owner	79	65.83
Farm Manager	37	30.83
Farm Accountant	4	3.33
PFA membership		
Member	110	92.00
Not a member	10	8.00
Litter Size		
50 – 5000 birds	71	59.17
<5000 – 10,000 birds	22	18.33
Above 10,000 birds	27	22.50
Access to Veterinary Service		
Had access	120	100.00
Had no Access	0	0.00
	Minimum	Maximum
Age	18	68
		Mean
		40.8

Source: Survey Data (2022)

In Ghana, the economically active group includes individuals who are employed in both formal and informal sectors, as well as those who are unemployed but actively looking for work from the age of 15 years and above (Otoo *et al.*, 2009). This finding validates the opinion held by Mensah-Bonsu *et al.* (2019) that majority of poultry farmers are within the economically active group of the country. The presence of younger farmers (18 to 30 years) and older farmers (50 years and above) indicates generational continuity and the involvement of both experienced and newer entrants in the poultry farming sector. The average age of poultry farmers in Ghana has been reported to be around 40 years (Bannor *et al.*, 2023). This finding suggests that there is a range of age groups involved in poultry production, with middle-aged individuals being prominent in the sector (Bannor *et al.*, 2023).

4.2.4 Litter Size

Results from the study indicate that majority (59%) of poultry farmers who sell poultry by-product (poultry dropping) are into small-scale poultry production (Table 4.1). The findings further revealed that, respondents producing poultry on a medium scale are the least (18.33%). Aning (2006), classifies Ghanaian poultry farmers into large-scale (above 10,000 birds), medium-scale (5,000–10,000 birds), and small-scale (50 – 5,000) and was used to indicate the number of birds the respondents had. The findings of this study is consistent with study by Chisenga *et al.* (2007), which points out that majority of poultry farmers in Ghana are into small- scale poultry production. The distribution indicates a diverse range of farm sizes among respondents, with a significant number of small to medium-scale poultry farmers.

4.2.5 Ownership

Table 4.1 shows that majority of poultry farms interviewed (66%) are owner-managed whiles the remaining were employee-managed (managers, assistant managers, and accountants). Research

interviews with owners and managers of businesses are the prime and accurate source of information on the activities of the business (Healey & Rawlinson, 1993). This phenomenon can be attributed to owners having a personal stake in a business's success and are more likely to take actions that benefit the long-term profitability and sustainability of the farm. Owner-managers often have an entrepreneurial mentality and a strong drive to innovate. They can introduce new techniques, technological advancements, and explore alternative revenue streams.

4.2.6 PFA Membership

Findings from Table 4.1 indicate that, majority (92%) of respondents are members of a Poultry Farmers Association. The high percentage of respondents being members of the Poultry Farmers Association demonstrates a strong level of association and cooperation among poultry farmers. PFA membership can offer benefits such as collective marketing, access to information, and advocacy, which may positively influence the intensity of poultry by-product production and marketing. Poultry Farmers' Associations play an important role in the development of poultry production in Ghana by providing services such as training, technical support, and access to markets to their members (Pinto, 2009). The assertion by Pinto (2009) explains the high percentage in poultry farmers' affiliation to PFAs.

4.2.7 Access to Veterinary Service

From Table 4.1, all the respondents had access to veterinary service. Veterinary services is a key factor that influences poultry production in Ghana and poultry farmers who have access to veterinary services have more profitable operations than those who do not have access to these services (Faizal & Kwasi, 2015). This finding is promising, as access to veterinary services is critical for disease prevention and overall poultry health, which can directly influence production intensity and revenue proportion.

4.3 Nature of Poultry By-product Market

4.3.1 Availability of poultry by-products

Agricultural markets are essential for commercializing agricultural by-products, creating value from them, and using them efficiently (Ayoo *et al.*, 2019). However, a number of agricultural by-products are characterized by a lack of market access and are infrequently traded or sold. One of the main reasons for the limited market access for agricultural by-products is the perception of low value. Since these by-products are often considered as waste or secondary outputs, they may not be fully recognized for their potential uses and benefits. Lack of awareness and understanding of the value and potential applications of by-products can deter market demand and limit commercialization opportunities. In addition, if there is limited awareness or demand for products derived from these by-products, market opportunities become restricted. Consumers and industries may be unaware of the advantages of using by-products, leading to a lack of interest in purchasing them.

Table 4.2 Total Quantity of Various Forms of Poultry By-product sold

By-product Form	Total Quantity Sold (Metric Tons)	Av. Price/ Unit (GHS)
1. Droppings/ Manure	12,437.12	6.00
2. Viscera	0.00	0.00
3. Feathers	0.00	0.00
4. Head & Feet	0.00	0.00
5. Blood	0.00	0.00
6. Eggshells	0.00	0.00

Source: Survey Data (2022)

Table 4.2 shows the different forms of poultry by-products (droppings, viscera, feathers, eggshells and blood) which are available in the study area. Despite the availability of other poultry by-products such as the viscera (internal organs), blood and feathers, poultry dropping is the only by-product being commercialized by poultry farmers in the by-product market (Table 4.2). Given that there are no markets for these additional poultry by-products, their economic value has been hidden and they are perceived as "free".

All respondents indicated that, even the poultry droppings, which are currently being sold, were previously disposed-off in neighboring forests and burnt due to the lack of market for them. This validates studies by Ayoo *et al.* (2019) and Boateng *et al.* (2009). The studies suggests that poultry farmers would have to be encouraged to regard poultry by-products as a potential source of additional revenue if their markets existed rather than discarding and burning them in forests. The incentives to make investments in the industries that utilize poultry by-products are weak and unresponsive to economic signals in the absence of complete and functional markets for the by-products. The popularity of droppings can be attributed to their use as organic fertilizers, providing essential nutrients for crop growth and soil fertility. Table 4.2 highlights the crucial role of sustainable agricultural practices, where poultry waste is utilized for environmental benefits and income generation, creating a circular economy.

The study was therefore based on the only commercialized by-product in the study area which is the poultry dropping.

4.3.2 Mapping of Actors in the Poultry By-product Market

Poultry Farmers

As shown in Figure 4.1, poultry farmers are the first actors in the marketing channel for the poultry droppings. They perform several important tasks to begin the marketing process. These include

negotiating the quantity they want to distribute to a particular channel and the price they are willing to charge for an agreed poultry dropping with buyers. Secondly, poultry farmers negotiate convenient day and time for the removal and conveyance of the poultry droppings with buyers. They also have the responsibility of temporarily moving available flock of birds into other empty coops for removal of dropping by buyers. From the study, farmers are able to sell through any available channels (Côte d'Ivoire aggregator, Ghanaian aggregators and Cattle farmers) as shown in Figure 4.1. Poultry farmers indicated that their choice of using a channel is dependent on two major factors, which are the quantity of poultry dropping a buyer is willing to buy and how fast the buyer is willing to convey the poultry droppings out of their farm. Poultry farmers consider this necessary to avoid the build-up of diseases in coops because of excess accumulation of nitrous oxide and methane gas. The poultry farmers consider this necessary to avoid the build-up of diseases in coops because of excess accumulation of nitrous oxide and methane gas. In the market for poultry by-products, poultry farmers do not bear any form of cost in the commercialization of poultry dropping. All costs involved in gathering, bagging and transportation of poultry dropping is incurred by the interested buyers.

Aggregators/ Transporters

Aggregators are also equally important actors in the poultry dropping market. Aggregators play an important role in moving poultry droppings in huge volumes from poultry farms to processing sites and end users across Ghana and Côte d'Ivoire. The aggregators are responsible for scouting poultry farms and establishing contacts with farm owners or managers to stay informed on the availability of poultry droppings. Aggregators negotiate needed quantity, price, and hire laborers for the removal and bagging of poultry droppings for transportation. Aggregators bear all costs involved in moving the poultry by-product from the farm-gate to processors and other consumers.

Costs incurred by aggregators include; purchasing of packaging material (bags), hiring and paying laborers to remove, bag and pack poultry droppings from coops into trucks. Cost of transporting droppings to processors and various consumers is also the responsibility of the aggregator. Aggregators for poultry dropping are classified in two categories based on their location or origin i.e. the Ghanaian aggregators and the Ivorian aggregators (Figure 4.1).

The study showed in Table 4.3 that, averagely, majority (80 metric tons) of poultry droppings sold by a respondent in a production cycle is to the Ivorian aggregators. From the study, poultry farmers sell a much less quantity (21 metric tons) of poultry dropping to Ghanaian aggregators. This assertion indicates that the demand for poultry dropping in Côte d'Ivoire is higher than in Ghana. This findings supports study by Ruf *et al.* (2015) which establishes that there is a huge demand for poultry manure in Côte d'Ivoire. The study by Ruf *et al.* (2015) indicate that in Côte d'Ivoire, 77% of cocoa farmers utilize poultry dropping as their primary source of nutrient for their crops. Aggregators from Côte d'Ivoire when interviewed stated that, the poultry by-products purchased from the respondents were primarily sold to organic fertilizer manufacturing companies and crop farmers (cocoa and maize) in Côte d'Ivoire (Figure 4.1). In addition, Ghanaian aggregators who were interviewed indicated that they sold a larger portion of their consignment to cocoa and cashew farmers in the Western, Bono, and Ashanti regions of Ghana (Figure 4.1). The Ghanaian aggregators further indicated that some proportion of the poultry by-product is sold to vegetable farmers in the southern part of the Volta region of Ghana.

Cattle Farmers

Cattle farmers are also key in the poultry dropping market, as they constitute the end-users of poultry droppings (Figure 4.1). They practice a direct channel distribution where poultry dropping is bought by themselves (end-user) to feed their animals. Livestock farmers have been constrained

by expensive feed materials and are therefore resorting to cheaper sources of feed materials (poultry droppings) for animal consumption (Konlan *et al.*, 2014) . From the study, about 2% of the average quantity produced by a farmer is sold to cattle farmers as a source of feed material. Poultry droppings contain significant amounts of protein, fiber, minerals, and vitamins, making them a potential source of nutrients for livestock. The nutritional composition of droppings can vary depending on factors such as the diet of the poultry, age of the birds, and management practices. Studies have highlighted the importance of properly drying droppings to enhance their nutrient content and reduce the risk of pathogen transmission. The cattle farmers explained that the poultry dropping is dried to a minimal moisture content and mixed with copper cake and other essential trace minerals. This finding is consistent with that of Ayoo *et al.* (2019) which states that, poultry dropping can be used as livestock feed in a dry condition because it contains a good amount of crude protein (nitrogen), fiber, fiber, fat and potash.

Organic Fertilizer Processing Companies

Organic Fertilizer Processing Companies also play a vital role in the poultry dropping market within the study area. They are responsible for purchasing poultry droppings in bulk from aggregators, processing them into finished products, repackaging and branding them. The processed dropping is further sold to crop farmers who produce cocoa, cashew, maize, and vegetables. These organic fertilizer processing companies are based in Côte d'Ivoire as the demand for the organic fertilizers is high especially in cocoa production sector (Ruf *et al.*, 2015).

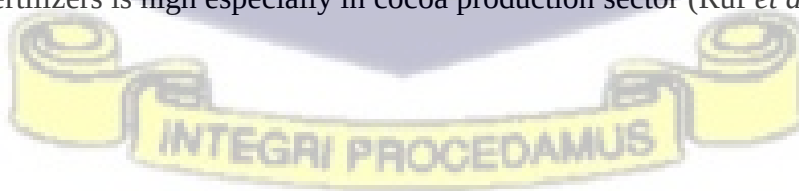
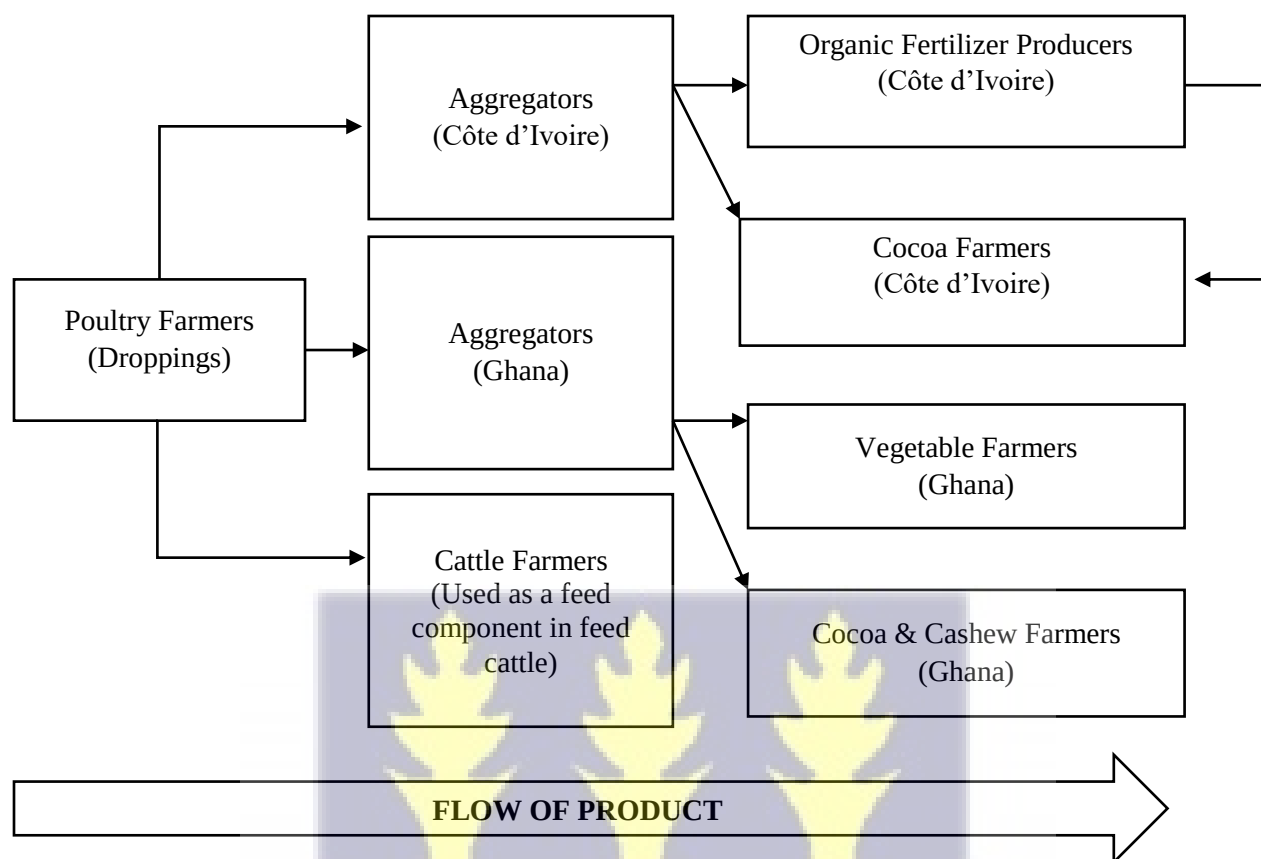


Figure 4.1 Channels of Marketing Poultry Droppings

Source: Author's Own Construct (2022)

4.3.2 Distribution of Poultry By-product to Marketing Channels

Over 9,600 metric tons of unprocessed poultry droppings are sold to aggregators from Côte d'Ivoire representing about 76% of the total quantity of poultry dropping being commercialized within a production cycle (Table 4.3). The study revealed about 2590 metric tons of unprocessed poultry dropping are sold to Ghanaian aggregators, which also represents about 20% of the total quantity of poultry droppings being sold in the Ashanti and Bono regions within a production cycle. Respondents reported that they preferred selling their by-product (dropping) to Ivorian aggregators than selling to other buyers in the marketing channel. This is because they purchase

larger quantities and are extremely very fast in negotiations. Poultry farmers also sold about 162 metric tons of poultry droppings to cattle farmers as feed ingredient.

Table 4.3 Distribution of Poultry By-product to Channels

Channel	Obs	Total Quantity (Bags)	Total Quantity (Metric Tons)	Mean Quantity (Bags)	Mean Quantity (Metric Tons)	Proportion of Total (%)
Aggregators (Côte d'Ivoire)	120	121,016.00	9,681.28	1,008.47	80.68	76.16
Aggregators (Ghana)	120	32,425.00	2,594.00	270.21	21.61	20.40
Cattle Farmers	120	2,023.00	161.84	16.86	1.34	1.30
Own Farm Use (Poultry farmers)	120	3425.00	274.00	28.54	2.28	2.14
Ashanti Region Only						
Aggregators (Côte d'Ivoire)	60	8,895.00	711.60	148.25	11.86	22.32
Aggregators (Ghana)	60	28,095	2247.60	468.25	37.46	70.50
Cattle Farmers	60	2,023	161.84	33.71	2.70	5.08
Own Farm Use	60	835.00	66.80	13.91	1.11	2.10
Bono Region Only						
Aggregators (Côte d'Ivoire)	60	112,121.00	8969.68	1868.68	149.49	94.20
Aggregators (Ghana)	60	4330.00	346.40	72.16	5.77	3.63
Cattle Farmers	60	0.00	0.00	0.00	0.00	0.00
Own Farm Use	60	2,590	207.20	43.16	3.45	2.17

Source: Survey Data (2022)

This quantity represents about 2% of the total quantity of poultry dropping being commercialized. The study also found that, a poultry farmer in the Bono and Ashanti regions used an average of about three metric tons of poultry droppings on their own crop farms within a production cycle. The poultry farmers stated that the dropping was used in growing maize for poultry feed formulation. The study therefore indicates that the demand and use of poultry dropping is higher in Côte d'Ivoire than in Ghana.

The prominence of aggregators from both Côte d'Ivoire and Ghana in the trade of poultry droppings underscores the commercial viability of this by-product. These aggregators play a crucial role in bridging the gap between poultry farmers and other end-users, facilitating the efficient movement of poultry droppings from production sources to various markets. The high proportion of poultry droppings traded through aggregators (76.16% overall for Côte d'Ivoire and 20.40% overall for Ghana) indicates a demand for this resource in regional markets and highlights the importance of well-organized marketing channels.

The data indicates notable regional variations in the distribution of poultry droppings. In the Ashanti Region, Ghanaian aggregators have a dominant presence, controlling 70.50% of the total quantities, while in the Bono region, Côte d'Ivoire aggregators have a significantly higher share of 94.20%. These regional differences may be influenced by factors such as geographic proximity to poultry farms, transportation logistics, regional livestock practices, and trade relationships between the regions and the countries involved.

Interestingly, Table 4.3 reveals a relatively low participation of cattle farmers in the trade of poultry droppings, contributing only 1.30% of the total quantities (overall). This finding suggests that cattle farmers may not be fully aware of the potential benefits of using poultry droppings as livestock feed or organic fertilizer. Efforts to raise awareness among cattle farmers about the

nutritional value and economic advantages of poultry droppings could potentially expand their utilization in livestock production, leading to more sustainable and cost-effective practices.

The extensive distribution of poultry droppings through aggregators presents opportunities for value addition and sustainability. Aggregators can play a crucial role in promoting value-added products derived from poultry droppings, such as processed organic fertilizers or biogas for energy generation. Such value-added activities not only enhance the economic viability of the poultry droppings market but also contribute to more sustainable agricultural practices, promoting circular economy principles.

4.4 Contribution of Poultry Droppings to Poultry Farmers' Revenue

Findings from the study have shown that the price for poultry dropping per 80Kg (0.08Mt) ranges from GHS 2.00 to GHS 12.00 (Table 4.4). The average price for poultry dropping per 0.08Mt is GHS 5.80 (Table 4.4). In-depth questioning of respondents revealed that Ivorian aggregators paid slightly less amount than the estimated GHS 5.80 average while most of the Ghanaian aggregators and cattle farmers purchased the poultry dropping at a higher price than the average. The respondents attribute this occurrence to the fact that Ivorian aggregators purchased more quantities of the poultry dropping than Ghanaian aggregators and cattle farmers did and therefore do negotiate for bulk purchase deals.

Again, estimations from the study showed that a poultry farmer accrue averagely GHS 9,324.00 from the sale of poultry droppings throughout a production season (Table 4.4). Poultry farmers earned at least GHS 470.00 in an entire production season (Table 4.4). This amount is far more rewarding and makes the respondents better off than incurring labor and transportation costs to dispose-off poultry droppings and other by-products.

Table 4.4: Proportion of revenue contributed by poultry dropping

Variable	Obs	Mean	Std. Dev.	Min	Max
Both Bono & Ashanti Regions					
Price/ 0.08Mt of Dropping (GHS)	120	5.80	2.40	2.00	12.00
Revenue from Poultry Dropping (GHS)	120	9,324.00	11,546.00	470.80	55,800.00
Revenue from main products (Eggs, meat, Spent layers) (GHS)	120	2,081,720.00	2,969,012.00	58,908.00	15,370,704.00
Total Revenue (GHS)	120	2,097,785.00	2,971,577.00	59,573.00	15,387,319.00
Proportion of Poultry By-product (%)	120	0.44	0.39	0.79	0.36
Bono Region only					
Price/ 0.08Mt of Dropping (GHS)	60	4.133	1.548	2	10
Revenue from Poultry Dropping sale (GHS)	60	11,217.44	13,008.52	470.77	55,800.00
Revenue from main products (Eggs, meat, Spent layers) (GHS)	60	3,219,447.7	3,513,371.90	134,400.00	15,370,704.00
Total Revenue (GHS)	60	3,244,147.1	3,509,764.80	205,958.31	15,387,319.00
Proportion of Poultry by-product (%)	60	0.35	0.37	0.23	0.36
Ashanti Region only					
Price/ 0.08Mt of Dropping (GHS)	60	7.53	1.94	3.00	12.00
Revenue from Poultry Dropping sale (GHS)	60	7,430.33	9,610.13	498.46	54,500.00
Revenue from main products (Eggs, meat, Spent layers) (GHS)	60	943,991.39	1,674,204.60	58,908.00	10,656,600.00
Total Revenue (GHS)	60	951,421.72	1,678,961.90	59,572.62	10,686,300.00
Proportion of Poultry by-product (%)	60	0.78	0.57	0.84	0.50

Source: Survey Data (2022)

However, there are variations in the prices between the two regions, with the average price being lower in the Bono Region (GHS 4.133) and higher in the Ashanti Region (GHS 7.53). These price differences might be influenced by factors such as supply and demand dynamics, transportation

costs, and market preferences in each region. Again, there are variations in revenue between the two regions, with the Bono Region reporting an average revenue of 11,217.44 GHS and the Ashanti Region reporting 7,430.33 GHS. These revenue figures demonstrate the economic value of poultry droppings as a marketable by-product. The variations in revenue between the Bono and Ashanti Regions regarding the economic value of poultry droppings as a marketable by-product could be attributed to differences in market demand and supply, the presence and efficiency of aggregators, transportation costs. Market awareness and knowledge among farmers, market preferences and uses of the by-product, variations in farming practices, climatic conditions and macroeconomic influences may also account for the variation.

Table 4.4 provides insights into the proportion of poultry by-products relative to total revenue. In both regions combined, the average proportion of poultry by-product revenue is 0.44%. This indicates that while poultry droppings contribute to revenue, they form a relatively small proportion compared to the revenue generated from the main products. Notably, the proportion of poultry by-product revenue is higher in the Ashanti Region (0.78%) compared to the Bono Region (0.35%).

The difference in the proportion of revenue from poultry by-products between the Ashanti and Bono Regions, where Ashanti has a higher price with less quantity traded, while Bono has more quantity traded at a lesser price. The higher price of poultry droppings in the Ashanti Region indicates that buyers in this region are willing to pay a premium for the by-product. This suggests a higher level of price sensitivity among buyers, where they value the quality or specific characteristics of poultry droppings and are willing to pay more for it. In contrast, in the Bono Region, buyers might be more price-sensitive, prioritizing lower prices over other factors, which lead to a higher quantity of droppings being traded at a reduced price. The difference in price and

quantity between the regions could also be influenced by the market structure and the presence of aggregators. The Ashanti Region might have a more organized and competitive market with a better understanding of the value of poultry droppings, leading to higher prices. On the other hand, the Bono Region might have a less competitive market, leading to lower prices due to less demand and price negotiation power

Understanding the proportion of poultry by-product revenue relative to total revenue allows poultry farmers to assess the contribution of poultry droppings to their overall income. Farmers can strategize to optimize revenue by exploring ways to increase the proportion of poultry by-product revenue through effective marketing and value addition strategies. The proportion of poultry by-product revenue has multiple implications for various stakeholders in the poultry industry. It offers insights into revenue optimization, economic viability, diversification strategies, resource management, market expansion, environmental sustainability, policy formulation, and market analysis. By leveraging this information, stakeholders can make informed decisions that foster a sustainable and profitable poultry industry while efficiently utilizing poultry by-products.

4.4.1 Respondents' Rank on How Beneficial the sale of Poultry Dropping is

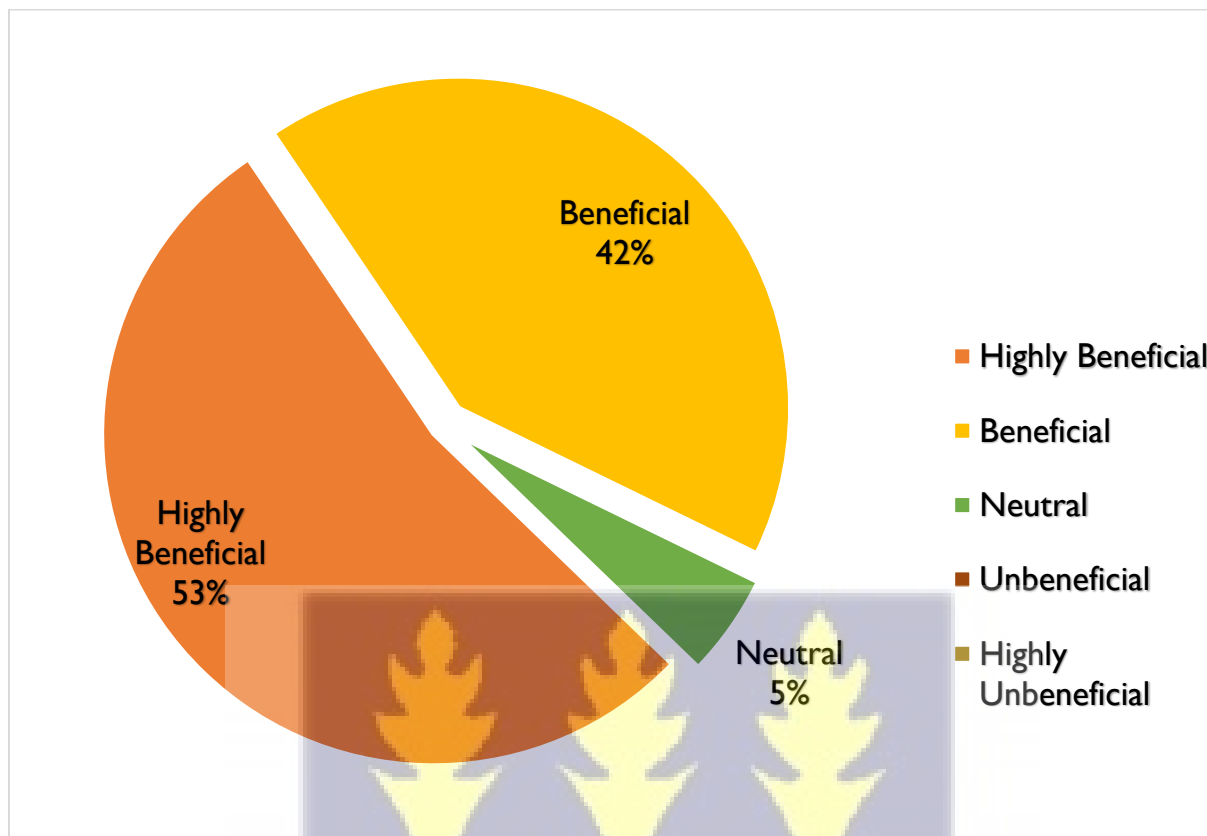
According to Figure 4.2, respondents were asked to rank the level of benefit they perceived from the sale of poultry droppings on a scale of one to five, with one indicating high benefit, five indicating low benefit, and three representing a neutral viewpoint. The results show that more than half (53%) of the respondents considered the commercialization of poultry droppings to be highly beneficial to their poultry business. Additionally, approximately 42% of the respondents regarded poultry droppings as beneficial to their poultry operations. A small percentage (5%) of the respondents remained neutral in their assessment of the benefits of commercializing poultry

droppings, indicating that they neither strongly benefited nor faced significant disadvantages from this practice.

Notably, none of the respondents ranked poultry droppings as unbeneficial or highly unbeneficial to their poultry business. This positive sentiment can be attributed to the efficient nature of the market and its operations, where farmers no longer incur transactional costs such as purchasing sacks for bagging droppings or hiring laborers to remove and package the droppings. Previously, respondents reported incurring expenses for labor and transportation to dispose of poultry droppings in nearby forests, resulting in added financial burdens. However, with the commercialization of poultry droppings, these costs have been eliminated or significantly reduced, which leads to increased perceived benefits for poultry farmers.

The favorable ranking of poultry by-product commercialization suggests that it is viewed as a viable income-generating activity for poultry farmers. By selling poultry droppings as a valuable by-product, farmers can improve their revenue streams and enhance the overall profitability of their poultry businesses. Moreover, the elimination of disposal costs and the creation of an additional revenue stream contribute to a more sustainable and efficient poultry production process.

The positive perceptions of poultry by-product commercialization underscore its importance in the poultry industry. The practice not only generates income for farmers but also reduces waste and promotes environmental sustainability. The findings highlight the potential for further expansion and optimization of poultry by-product utilization in the poultry value chain, offering a promising avenue for enhancing the economic and environmental aspects of poultry farming.

Figure 4.2: Benefits of Poultry Droppings

Source: Survey Data (2022)

4.5 Determinants of Revenue Proportion Contributed by Poultry Droppings

Table 4.5 presents the results from the Tobit regression analysis, showing the factors that influence the proportion of revenue contributed from the sale of poultry dropping. From Table 4.5, the significant Prob > chi2 value of 0.0000 suggests that the overall Tobit model is statistically significant. Table 4.5 presents the estimated marginal effects of the variables influencing the proportion of revenue contributed by poultry dropping. Variables such as the ownership, quantity and price of poultry dropping sold, litter size, quantity of spent layers sold influenced the proportion of revenue contributed by poultry by-product. Other variables such age, gender, Experience in commercialization of poultry dropping, time of payment, region, price of egg and

contract did not influence the proportion of revenue contributed by poultry dropping to poultry farmers revenue.

4.5.1 Ownership

Table 4.5 reveals that ownership variable significantly affected the proportion of revenue contributed by the droppings positively and has a marginal effect of 0.145 implying that poultry farms who were owner-managed have more proportion of revenue contributed from poultry droppings than poultry farms which were employee-managed. Farmers who own their poultry businesses may have more control over the management and utilization of poultry droppings, which can lead to a higher proportion of revenue from droppings. Additionally, owners may be more motivated to maximize profits from all aspects of the business, including by-products like droppings. This may be attributed to the fact that owners having their businesses at heart and always negotiate better prices per unit for their produce, which in turn increases their revenue. Additionally, it is possible that, farms, which are managed by owners, will have a more personal stake in the success of the farm and as a result, they may be more motivated to find ways to generate revenue from droppings. This finding aligns with that of Busterna (1989) that, owner-managed businesses tend have a greater stake in the profitability of the firm and therefore take managerial decisions that will increase their personal income.

4.5.2 Quantity of Poultry Dropping Sold

The analysis in Table 4.5 indicates that the quantity of poultry droppings sold has a positive and statistically significant influence on the proportion of revenue contributed by the droppings to poultry farmers' total revenue. This means that as respondents sell more units (per 80Kg) of poultry droppings, the proportion of revenue from these by-products increases. On the other hand,

respondents who sell fewer quantities, dispose of some portion, or give them out free, tend to have a lower proportion of revenue contributed by poultry droppings.

Table 4.5: Determinants of Revenue Proportion Contributed by Poultry Droppings

Variables	Marginal Effect (dy/dx)	Standard Error	t- value	P>t
Gender	-0.014	0.070	-0.210	0.830
Age	-0.003	0.003	-0.140	0.890
Ownership	0.145***	0.060	2.390	0.008
Member of PFA	-0.280***	0.096	-2.910	0.004
Years of Selling Dropping	0.000	0.005	0.150	0.606
Time of payment	0.038	0.075	0.520	0.498
Quantity of Dropping	0.276***	0.034	8.200	0.000
Price of Egg	0.000	0.012	-0.020	0.980
Price of Dropping	0.094***	0.015	6.300	0.000
Sold Spent Layers	-0.002***	4.44e-06	-4.950	0.000
Region				
Bono Region	-0.125	0.083	-1.520	0.133
Litter Size				
Medium Scale (<5,000- 10,000 birds)	-0.161**	0.072	-2.22	0.028
Large Scale (Above 10,000 birds)	-0.144**	0.106	-1.36	0.017
Contract	0.007	0.057	0.350	0.894
Constant	-1.362	0.370	-3.68	0.000
Pseudo R2 = 0.7938				
Log Likelihood = -17.2203				
Prob > chi2 = 0.0000				
Dependent variable = proportion of revenue from poultry droppings				

*, **, *** indicates significance at 10%, 5% and 1% respectively

Source: Survey Data (2022)

The estimated marginal effect, as shown in Table 4.5, further supports this finding. It implies that for every additional unit (80Kg) of poultry droppings sold by a respondent, there is an average increase of about 0.276 in the proportion of revenue contributed by poultry droppings to poultry farmers' revenue. This indicates that increasing the quantity of poultry droppings sold is directly associated with higher revenue from these by-products.

This observation aligns with the economic theory of a linear relationship between the quantity of goods sold and revenue. As farmers commercialize more units of poultry droppings, the overall revenue contribution from these by-products grows proportionally. This finding emphasizes the importance of efficient marketing and sales strategies for poultry droppings to maximize their revenue potential. The positive relationship between the quantity of poultry droppings sold and revenue proportion suggests that there is sufficient demand for these by-products in the market. Farmers can benefit from adopting better marketing practices and exploring potential avenues to increase the volume of droppings sold. This may include reaching out to more buyers, exploring new markets, or establishing long-term contracts with aggregators or other potential customers.

4.5.3 Member of Poultry Farmers' Association (PFA)

Result from the study indicates that, being a member of a Poultry Farmers' Association influences the proportion of revenue from poultry droppings negatively (Table 4.5). This is statistically significant at 1%, which implies that respondents who are not part of any poultry farmers' association have more revenue contribution from poultry droppings to their total revenue than respondents who are members of the Poultry Farmers' Association. The marginal effect estimation also indicates that being a member of a Poultry Farmers' Association reduces revenue contribution from poultry droppings by about 0.271 (Table 4.5). This finding validates studies by Siteo & Sitole (2019) who stated that non-members of farmers' associations generate more income than members.

This result could be attributed to Poultry Farmers' Associations putting more efforts into educating and training their members on subjects concerning their main produce (egg and meat) while neglecting by-products. Additionally, the association may have policies or regulations in place that limit the ability of its members to profit from selling poultry droppings. Educating respondents on subject regarding poultry by-products could increase the revenue contribution from poultry droppings since about 92% of the respondents belong to a poultry farmers' association (Table 4.1).

4.5.4 Litter Size

For this analysis, respondents with 50-5000 birds (small scale) were set as the base for explaining litter size results. Result from the study indicates that the size of litter of respondents has a negative influence on the proportion of revenue contributed from poultry droppings and this was statistically significant at 5% for respondents with more than 5000 birds to 10,000 birds and 1% for respondent with more than 10,000 birds (Table 4.5). This result implies that respondents with smaller litter size within the study area have a higher proportion of revenue contribution from poultry droppings than respondents with larger litter sizes. The marginal effect estimation also show that respondents with litter size between 50-5000 birds are likely to make about 0.161 more in the proportion revenue contributed from poultry droppings than respondents with litter size between 5000 and 10,000. In addition, respondents with litter size of 50-5000 birds are likely to make about 0.144 more in proportion of revenue contributed by poultry droppings than respondents with litter size above 10,000 birds.

The findings may be attributed to low levels of commercialization of poultry droppings among respondents with more than 5,000 birds. This may be because, the respondents give greater attention to the main poultry products, which offer them greater outcomes while giving significant portions of their droppings out for free or disposing them off. Another possible reason could be

that, the respondents offer bulk purchase discounts to buyer since their capacities are huge and have greater volumes of poultry droppings. On the other hand, respondents with about 50-5,000 birds may regard their revenue from the main poultry products as meager and are constantly looking for additional avenues to generate revenue. This notion could push them to sell a greater portion of their poultry droppings for addition revenue.

4.5.5 Number of Spent Layers Sold

The number of spent layers sold was estimated to have a significant but negative relationship with the proportion of revenue contributed from poultry dropping within the study area (Table 4.4). This implies that, the increase in the number of spent layers sold by respondents reduces the revenue proportion from poultry droppings. The marginal effect estimation also indicates that a unit increase in the number of spent layers sold would decrease the proportion of revenue contributed from poultry dropping by about 0.002. The implication of this finding is that poultry farmers who sell spent layers may experience a reduction in the revenue they generate from poultry droppings. As the birds age, they produce less eggs and more droppings, which can be difficult to manage and utilize effectively. Poultry farmers therefore would have to face a tradeoff between selling spent layers and keeping them for their droppings.

4.5.6 Price of Poultry Dropping

The study's results, as presented in Table 4.5, demonstrate a positive and statistically significant influence of the price of poultry droppings on the proportion of income derived from these by-products. This means that respondents who sell poultry droppings at higher prices per unit generate a greater proportion of their total revenue from poultry by-products compared to those who sell them at lower prices. The estimated marginal effect, as computed in Table 4.5, further supports this finding, indicating that for every additional unit increase in the price of poultry droppings,

there is an average increase of 0.094 in the proportion of revenue contributed by these by-products to the total revenue of poultry farmers. This implies that higher prices for poultry droppings result in higher revenue generation from their sale, reinforcing the economic theory that farm families are incentivized to offer more of a product for sale when the output price is favorable. This outcome aligns with the findings of previous studies conducted by Olwande *et al.* (2010) and Omiti *et al.* (2009), which highlighted the significance of output prices as motivators for producers to increase their market supply and consequently boost their revenue.

The positive relationship between the price of poultry droppings and revenue proportion underscores the importance of pricing strategies in the commercialization of these by-products. Poultry farmers who can obtain higher prices for their poultry droppings through effective negotiation, value addition, or targeting premium markets are likely to experience a higher contribution of these by-products to their overall revenue.

Moreover, the study's findings suggest that there is sufficient demand or perceived value in the market for poultry droppings, supporting farmers' ability to sell them at higher prices. This can have implications for farm profitability and sustainability, as increased revenue from poultry by-products can supplement income from other agricultural activities and enhance overall farm income diversification.

4.6 Constraints Faced by Respondents in the Poultry By-product Market

Seven major constraints faced by respondents (Table 4.6) in the poultry dropping market were identified during the questionnaire pre-testing phase of the study. Respondents ranked the constraints on a scale of 1-7 by assigning 1 to the severest and 7 to the least severe. The results in Table 4.6 indicate that the four prevailing constraints among the respondents in the Ashanti and

Bono regions are low price for the droppings, lack of processing facilities, seasonal demand, and distance from buyers. The Kendall's W from the result is 0.47 (Table 4.6) indicating that there is a 47% level of agreement among the rankers within the poultry dropping market. The model summary showed that the result was significant at 1% with a chi-square value of 262.25.

4.6.1 Low Price

Low price of poultry droppings was the biggest constraint of the respondents as show by the mean rank (2.66) in Table 4.6. The study revealed that market price for poultry droppings was dictated by aggregators within the market and respondents rarely had a say in the pricing. This can be attributed to the aggregators taking advantage of bearing all the costs involved in the sale of the droppings. Low prices tend to discourage poultry farmers from investing in new technologies or techniques that can add value to poultry by-products (Szczepańska-Przekota, 2023). Moisé *et al.* (2013) have revealed that low price of agricultural commodities can limit the participation of small farmers in high-value markets and reduce their income. Similarly, better poultry dropping prices can encourage poultry farmers forward integrate into processing and selling their own droppings. There could be several reasons for the low prices of poultry droppings, such as oversupply in the market, lack of awareness among buyers about the benefits of poultry droppings as a fertilizer, lack of proper storage and packaging, and lack of proper transportation facilities. Farmers may need to find ways to increase the value of their droppings, such as by processing them into a more valuable product like compost, or by finding new markets for their droppings.

4.6.2 Lack of Processing and Storage Facilities

Lack of processing and storage facilities for poultry droppings within the study area ranked second with a mean rank of 3.15 (Table 4.6). The study revealed that there were no processing and storage

facilities in the study area to process the droppings or any other by-product. The availability and operationalization of processing facilities for poultry by-products could foster the culture of forward integration among respondents, thus adding value to not just the droppings but also other poultry by-products. This would increase price per unit of the dropping when processed, therefore increasing the proportion of revenue contributed from poultry dropping. The study also revealed that, no respondent had any form of storage facilities for storing poultry droppings prior to pick-up by aggregators or livestock producers. Poultry droppings are left in coops until buyers arrive.

Table 4.6: Ranking of Constraint in the Poultry Dropping Market

Constraint	Mean Rank	Rank
Low Price	2.66	1 st
Lack of processing and storage facilities	3.15	2 nd
Seasonal Demand	3.24	3 rd
Distance from Buyers	3.39	4 th
Lack of Market Information	3.90	5 th
Access to Credit	5.71	6 th
Poor Road Network	5.95	7 th
N= 120		
Kendall's W ^a = 0.47		
Chi-Square = 262.25		
df = 6		
Asymp. Sig. = 0.000***		

Source: Survey Data, 2022. *** represent 1% level of significance.

Processing and storage facilities for poultry by-products are important. The facilities allow for the safe and efficient processing of not only poultry droppings but also all other poultry by-products,

such as the viscera, head & feet and feather. These can be processed into products that can be used for livestock feed, pet food, and other industrial applications. This helps to reduce waste and make use of resources that would otherwise go to waste. These facilities play a crucial role in the poultry industry, helping to ensure food safety, reduce waste and protect environment. Lack of processing and storage facilities can limit the ability of farmers to produce and market their products effectively (Olumba *et al.*, 2021).

4.6.3 Seasonal Demand

Seasonal demand for poultry droppings in the study area plays a significant role in shaping the poultry by-product market, ranking third with a mean rank of 3.24 (Table 4.6). The demand for poultry droppings exhibited erratic patterns, particularly from Ivorian aggregators who had a major influence on the poultry dropping market. Through interviews, selected Ivorian aggregators revealed that their demand for poultry droppings is strongly influenced by weather conditions, especially during the wet or rainy season. During this period, the deterioration of roads leading to poultry farms makes it impossible for their trucks to access the farms, hindering the collection and purchase of poultry droppings. The seasonal variations in demand pose challenges for poultry farmers in the study area. When demand for poultry droppings is low during specific seasons, poultry farmers may be compelled to sell their droppings at lower prices or dispose of them, which can negatively affect their revenue. This situation can occur due to reduced demand from buyers who may face challenges in transporting and processing the poultry droppings during adverse weather conditions. As a result, poultry farmers may experience fluctuations in their income from the sale of poultry droppings, affecting their overall revenue and financial stability.

The impact of seasonal demand on the poultry by-product market and the revenue generated from poultry droppings highlights the need for strategies to manage and stabilize the market. Poultry

farmers and other stakeholders in the poultry industry must consider factors such as road infrastructure and transportation logistics to ensure a steady supply of poultry droppings to meet market demand throughout the year. Seasonal variations in agricultural commodities can significantly affect food security and undernutrition in agrarian economies (Sands *et al.*, 2014). Seasonal fluctuations in demand can affect market prices and profitability for farmers (Bonuedi *et al.*, 2022).

4.6.4 Distance from Buyer

The distance from buyers of the poultry dropping within the study area ranked fourth with a mean rank of 3.39 (Table 4.6). From the study, respondents consider the distance aggregators travel to purchase poultry droppings from them as constraint as aggregators who are the major buyers of the poultry dropping travel about 60-320 kilometers to purchase poultry droppings. Long distances limit the number of potential buyers, making it harder for the poultry farmers to find readily available markets for their poultry droppings. Additionally, long distances make it difficult for the poultry farmers to establish and maintain relationship with buyers, which is often necessary for successful sales.

4.6.5 Lack of Market Information

As shown in Table 4.6, lack of market information on the supply side was ranked by the respondents as the fifth constraint with a mean rank of 3.90 in the poultry dropping market. Lack of market information, also known as information asymmetries is reported as an issue. Poultry producers in the poultry droppings market have little or no knowledge on the market price, the demand across market and the nature of the retail market. This can lead to exploitative situations that tend to benefit aggregators and do not adequately serve the farmers. Without access to accurate and up-to-date market information, poultry farmers may have difficulty determining the fair

market value of their products (poultry dropping). This makes it difficult for them to price their poultry droppings competitively, leading to lower sales and revenue. In addition, without access to market information, poultry farmers may have difficulty identifying new or alternative markets to sell their poultry by-products. The lack of market information can lead to market inefficiencies, as farmers may not have the necessary information to make informed decisions about what to produce, when to sell, and at what price resulting in suboptimal production and marketing strategies (Jack, 2013).. This can limit their potential customer base and affect their ability to find buyers for the poultry droppings.

4.6.6 Access to Credit

Access to Credit was ranked the last but not the least with a mean rank of 5.71 (Table 4.6). Studies by Yadav & Sharma, (2015) indicated that to increase agricultural output, credit is necessary as a crucial indirect input due to fact that majority of farming households struggle with a lack of resources especially in developing countries. Farmers may have difficulty investing in new technologies, equipment, or practices that could help in adding value to poultry droppings and other available by-products without access to credit. This can limit their ability to stay competitive in the poultry by-product market. Moreover, the seasonality and unpredictability of poultry droppings as a by-product can pose challenges in repaying loans. Poultry farmers may generate income from the sale of droppings irregularly, depending on the production cycle and market demand. This irregular cash flow can make it difficult for farmers to meet fixed loan repayment schedules, discouraging lenders from providing credit to poultry farmers. Empirical evidence suggests that credit constraints have adverse effects on farm output, profits, income, and welfare in rural areas of developing countries. Farmers facing credit constraints may experience lower

income and investment compared to those with better access to credit (Amanullah *et al.*, 2020; Balana & Oyeyemi, 2022) .

4.6.7 Poor Road Network

Contrary to expectations, poor road network was ranked by farmers as the least significant constraint in the commercialization of poultry droppings. This finding indicates that, according to the perceptions of the farmers surveyed, road infrastructure does not pose a major hindrance to the transportation and marketing of poultry droppings in the study area (Table 4.6). One possible explanation for poor road network being ranked as the least constraint by poultry farmers is that they may not be directly responsible for the transportation of the poultry droppings. In the study area, it is plausible that other actors, such as aggregators cattle farmers are responsible for the transportation of poultry droppings.



CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, main conclusions and policy recommendations of the study. Section 5.2 presents a summary of the study while the conclusions from the study are presented in Section 5.3. Finally, Section 5.4 presents the recommendations from the study.

5.2 Summary and Major Findings

The study assessed the markets for poultry by-products and its contribution to poultry farmers' revenue in Ghana. This was achieved by profiling poultry farmers who commercialized poultry by-products, identifying the by-products being commercialized, identifying major players within the market and how the market is organized. The revenue being realized from the sale of poultry by-product by poultry farmers was estimated. Socio-economic and institutional factors were analyzed to examine the influence they have on proportion of revenue contributed by poultry by-product. Finally, constraints poultry farmers face in the poultry by-product market were identified during questionnaire pre-testing and were ranked by farmers.

The study employed the Tobit regression model in identifying the factors influencing the proportion of revenue contributed by poultry droppings. Data was collected from 120 respondents who are poultry farmers commercializing poultry droppings from Bono and the Ashanti regions of Ghana. A total number of 60 poultry farmers commercializing poultry droppings were selected from three major poultry producing districts in each region. Socio-economic and institutional characteristics of the respondents and data on the proportion of revenue contribution from poultry dropping were estimated using STATA 17. Data on the factors influencing the proportion of

revenue contributed by poultry droppings was analysed using STATA 17. SPSS version 26 was used for the ranking of constraints in the poultry dropping market within the study area.

The results from the socio-economic analysis showed that males constituted the majority (85%) of the respondents interviewed as the poultry production is considered as one which requires great deal of energy and capital. A larger proportion (96%) of poultry farmers commercializing had some level of formal education. The mean age of respondents was 40 years indicating a middle aged population in the study area. The study also revealed that more than half (59%) of the respondents within the study area are small-scale poultry producers with litter size of between 50 and 5000 birds.

The study revealed that, the poultry by-product market in the study area has only one product (poultry dropping) being commercialized despite the availability of other poultry by-products like the feathers and viscera. Results from the study indicates that, the main poultry droppings marketing channel in Ghana consist of Ivorian aggregators, Ghanaian aggregators and cattle farmers. The study pointed out that over 9600 metric tons of unprocessed poultry dropping is sold to the aggregators from Côte d'Ivoire representing about 76% of the total quantity of poultry dropping being commercialized within a production cycle while about 2600 metric tons of the unprocessed poultry dropping is sold to Ghanaian aggregators which also represent about 20% of the total quantity of poultry droppings being commercialized in the study area. The study revealed that the average price per 80kg being GHS 6.00. Again, the survey revealed that the average revenue accrued by a poultry farmer from the sale of poultry droppings throughout a production cycle (72 weeks) is GHS 9,324.00 which represents about 0.44% of the total revenue accrued by a poultry farmer in a production cycle.

From the study, the quantity of dropping, ownership, litter size, membership of PFA and number of spent layers sold are all variables that influence the proportion of revenue contributed from poultry droppings. During the pre-testing stage of the questionnaire, respondents revealed seven key challenges they encountered in the market for poultry droppings. These challenges were presented in the main questionnaire and respondents were being asked to rank them. The constraints were ranked by respondents on a scale of 1–7, with 1 denoting the most severe and 7 denoting the least severe. The findings showed that low price for the droppings per unit, a lack of processing and storage facilities, seasonal demand, and distance from purchasers are the most prevailing constraints among respondents in the study areas.

5.3 Conclusions

In conclusion, the research has shed light on the commercialization of poultry by-products in Ghana, specifically focusing on poultry droppings. The findings reveal that the market for poultry droppings is dominated by Ivorian aggregators, who are the largest consumers of poultry droppings, with an annual transport of approximately 7,000 metric tons to Côte d'Ivoire. Despite the potential value of poultry droppings, a Ghanaian poultry farmer only accrues an average of GHS 9,234.00 within a production cycle, representing a mere 0.44% of their total revenue from poultry production.

The study identifies key determinants of the revenue proportion contributed by poultry droppings to a poultry farmer's total revenue. Affiliation to the Poultry Farmers' Association, litter size, quantity of poultry by-product sold, and the price of poultry droppings per unit all play significant roles in influencing the revenue generated from poultry droppings. However, several constraints hinder the full exploration of the poultry by-product market. The most prevalent challenges reported by respondents include low prices for droppings, lack of processing and storage facilities

for poultry droppings, seasonal demand fluctuations, and distance from buyers. These constraints serve as major disincentives for poultry by-product development and marketing.

Interestingly, the research highlights that some cattle farmers recognize the nutritional value of poultry droppings, incorporating them as a significant component in the feed for their cattle due to its richness in crude protein, fiber, fat, and potash.

Overall, the study indicates that while there is potential for poultry by-product commercialization in Ghana, significant barriers exist, preventing poultry farmers from fully benefiting from this market. Addressing these challenges, such as improving market infrastructure and ensuring fair prices for droppings, could incentivize poultry farmers to further explore and capitalize on the opportunities offered by poultry by-products, ultimately enhancing their overall revenue and contributing to sustainable agricultural development in the region.

The findings of this study have several implications for industrialists, researchers, and policy stakeholders in Ghana;

- For industrialists: The findings suggest that there is a market for poultry by-products in Ghana, but that the current marketing channels are inefficient. Industrialists could develop new marketing channels that would allow poultry farmers to get a better price for their by-products. They could also develop processing and storage facilities that would help to overcome the constraints of seasonal demand and distance from purchasers.
- For researchers: The findings suggest that there is a need for further research on the poultry by-product market in Ghana. Researchers could investigate ways to increase the demand for poultry by-products, develop new uses for poultry by-products, and identify ways to overcome the constraints faced by poultry farmers.

- For policy stakeholders: The findings suggest that the government could play a role in promoting the poultry by-product market in Ghana. The government could provide financial support to poultry farmers, develop infrastructure to support the poultry by-product market, and regulate the poultry by-product market to ensure fair prices for farmers.

5.4 Recommendations

- The Poultry Farmers' Associations should facilitate knowledge-sharing and capacity-building initiatives among poultry farmers to improve their understanding of the market for poultry by-products. These programs are designed to enhance the understanding of poultry farmers regarding the market for poultry by-products. By organizing workshops, seminars, and training sessions, the associations can provide valuable information on market dynamics, pricing mechanisms, and value addition opportunities for poultry by-products.
- The Poultry Farmers' Associations should take on the role of advocating for fair pricing mechanisms for poultry droppings. By actively engaging with relevant stakeholders, including buyers, aggregators, and policymakers, the associations can work towards ensuring that poultry farmers receive appropriate compensation for their by-products. the associations can promote transparency and information-sharing in the market. Secondly, the associations can promote transparency and information-sharing in the market. By disseminating information on market trends, demand-supply dynamics, and pricing structures, they empower farmers to make well-informed decisions when selling their poultry by-products.

- The Poultry Farmers' Associations should actively collaborate with the Animal Production Directorate of the Ministry of Food and Agriculture (MoFA) to address the challenges faced by poultry farmers and seek policy support for the development of the by-product market. Collaborating with the Animal Production Directorate offers numerous advantages. Firstly, it enables a closer partnership between the poultry farmers and the government agency responsible for policy formulation and support in the agricultural sector. By working together, both parties can share valuable insights and expertise, leading to more effective and targeted policy interventions. Also, by creating a strong partnership with the Animal Production Directorate, the Poultry Farmers' Associations can amplify their efforts to address the challenges in the by-product market. Together, they can drive positive change, promote sustainable agricultural practices, and create opportunities for increased revenue and improved livelihoods for poultry farmers in Ghana.
- The Animal Production Directorate should develop and implement policies and regulations that promote the sustainable utilization of poultry by-products. These policies should address the challenges identified in the study, such as low prices for droppings, lack of processing and storage facilities, and seasonal demand fluctuations. By creating an enabling environment for the growth of the poultry by-product market, the directorate can incentivize poultry farmers to explore and capitalize on the opportunities offered by all by-products.
- The Animal Production Directorate can also facilitate knowledge-sharing and capacity-building initiatives among poultry farmers to improve their understanding of the market for poultry by-products. Providing training and technical support on proper handling,

processing, and utilization of poultry droppings will enhance the quality of these by-products and increase their market value.

- The Animal Production Directorate should consider measures to improve market infrastructure for poultry by-products, including processing and storage facilities. This will help address the constraints related to lack of facilities reported by poultry farmers, making it easier for them to commercialize their by-products.
- The Animal Production Directorate should engage with other government agencies, such as the Ministry of Trade and Industry and the Ministry of Finance, to advocate for policies that support the development of the poultry by-product market. This may involve seeking financial incentives and tariff exemptions for by-product processing and marketing activities.
- Non-governmental Organizations (NGO's) can conduct researches to identify innovative uses and value addition opportunities for poultry by-products, particularly poultry droppings. The study findings revealed that poultry droppings are rich in crude protein, fiber, fat, and potash, making them valuable components for livestock feed. NGO's can further explore and promote the use of poultry droppings in various applications, such as organic fertilizers, biogas production, and feed additives, to enhance their market value and create new revenue streams for poultry farmers.
- NGOs can play a crucial role in facilitating market linkages between poultry farmers and aggregators. The study highlighted that Ivorian aggregators dominate the poultry by-product market, and they are the largest consumers of poultry droppings from Ghana. NGOs can act as intermediaries to connect poultry farmers with potential buyers and aggregators, thereby improving access to the market for poultry droppings. These linkages

can help poultry farmers find reliable and profitable markets for their by-products, increasing their revenue share.

- Aggregators and livestock farmers should establish strong linkages with farmer organizations to foster better information flow and market access for poultry by-products. By collaborating with farmer groups, aggregators can gain direct access to a larger pool of poultry farmers who can supply them with a steady and reliable stream of by-products. This improved connectivity will facilitate efficient sourcing of poultry droppings, benefiting both the aggregators and the farmers by ensuring a stable market.
- Aggregators should invest in developing processing and storage facilities to enhance the value addition of poultry droppings. Proper processing techniques, such as composting and drying, can increase the market value of the by-products, making them more attractive to potential buyers. Additionally, investing in storage facilities will help preserve the quality of the by-products, ensuring that they remain in good condition until they are sold, thereby reducing wastage and maximizing profits.
- Government support in developing essential infrastructure, such as processing and storage facilities, will facilitate value addition to poultry by-products. Proper infrastructure will improve the quality and shelf life of the by-products, making them more marketable both domestically and for export.
- One significant inefficiency in the market is the unequal bargaining power between aggregators and producers during price negotiations. Aggregators, being dominant players, often have an advantage in setting lower prices for poultry by-products, which can result in lower revenue for producers. This power imbalance hinders fair compensation for farmers and disincentivizes them from fully participating in the market. To address this

issue, the government could consider implementing policies that promote price transparency and fair trade practices. For instance, the establishment of a pricing mechanism that ensures transparency in price determination could help level the playing field and empower farmers in negotiations. Additionally, the government can enforce regulations that prevent price manipulation and ensure that farmers receive appropriate compensation for their poultry by-products.



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APPENDIX 1: Questionnaire

Questionnaire

DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS

UNIVERSITY OF GHANA, LEGON

MPhil Agribusiness (candidate)

QUESTIONNAIRE

This research is solely for an academic purpose. Your participation is entirely voluntary. All information given would be strictly confidential and would not be used for any other purpose aside my research work.

Section A: Basic information

Region: 1. Bono Region [] 2. Ashanti Region []

District:

Community.....

Section B: Socio-Economic Factors

1. Name of Respondent.....

2. Ownership: 1. Farm Owner [] 2. Farm Manager [] 3. Accountant []

4. Other (*specify*).....

3. Sex of respondent: 1. Male [] 2. Female []

4. Age of respondent:

5. Highest level of education: 1. No Formal Education [] 2. Primary []

3. JHS/Middle Sch. [] 4. SSS/SHS [] 5. Tertiary []

Section C: Institutional Factors

7. Are you a member of the Poultry Farmers Association (PFA)? 1. No [] 2. Yes []

8. If yes, has your membership helped you in your last production? 1. No [] 2. Yes []

9. In what way has being a member of PFA helped you? 1. Input Acquisition []

2. Collective Marketing [] 3. Access to Credit [] 4.

Technical Support/ Training [] 5. Access to Market Information []

10. Do you have access to veterinary services? 1. No [] 2. Yes []
11. If yes, how often does the veterinary agents visit in a month? 1. Once [] 2. Twice []
3. Three times [] 4. Four times 5. More than four times []
12. Did you apply for credit in the last production year? 1. No [] 2. Yes []
13. If yes, what source did you apply to? 1. Formal [] 2. Informal [] 3. Both []
14. If yes (Q12), did you have access to the credit? 1. No [] 2. Yes []
15. If yes (Q14), did you receive the exact amount you requested. 1. No [] 2. Yes []
16. If yes (Q14), what was the form of the credit? 1. Cash []
2. Input or in-kind credit [] 3. Both []
17. If no (Q12), why
18. Have you had any training(s) on poultry by-product? 1. No [] 2. Yes []
19. If yes, who organized the training(s)? (*tick as many*) 1. Veterinary Service Directorate []
2. Poultry Farmers Association [] 3. Others (*specify*).....
20. On what subject was the training? (*tick as many*) 1. Marketing [] 2. Processing []
3. Storage [] 4. Others (*specify*).....

Section D: Production Data

21. Number of years being involved in poultry production?
22. How many birds do you have currently? 1. 50-5000 birds [] 2. <5000 – 10,000 birds
3. Above 10,000 birds
23. What type of Poultry are you into? 1. Layers [] 2. Broilers [] 3. Both []
24. i. How many crates of egg have you sold in the last cycle?.....
ii. How much do you sell a crate of egg?.....
iii. How many units of spent layers have you sold in the last cycle?.....
iv. How much do you sell a unit of spent layer?.....
25. i. How many units of broiler chickens have you sold in the last cycle?.....
ii. How much do you sell a unit of broiler chicken?.....
26. Aside poultry production, do you engage in any off-farm economic activities?
1. No [] 2. Yes []
27. If yes, name of the off-farm Jobs

Section E: Poultry By-products

28. How many years have you being involved in selling poultry by-product?

29. Have you sold poultry by-products in the past 12 months? 1. No [] 2. Yes []

30. In what form are the by-products you sell? (*Tick as many*) 1. Droppings []

2. Viscera [] 3. Feathers [] 4. Head & Feet [] 5. Blood [] 6. Eggshell []

7. Others (*specify*).....

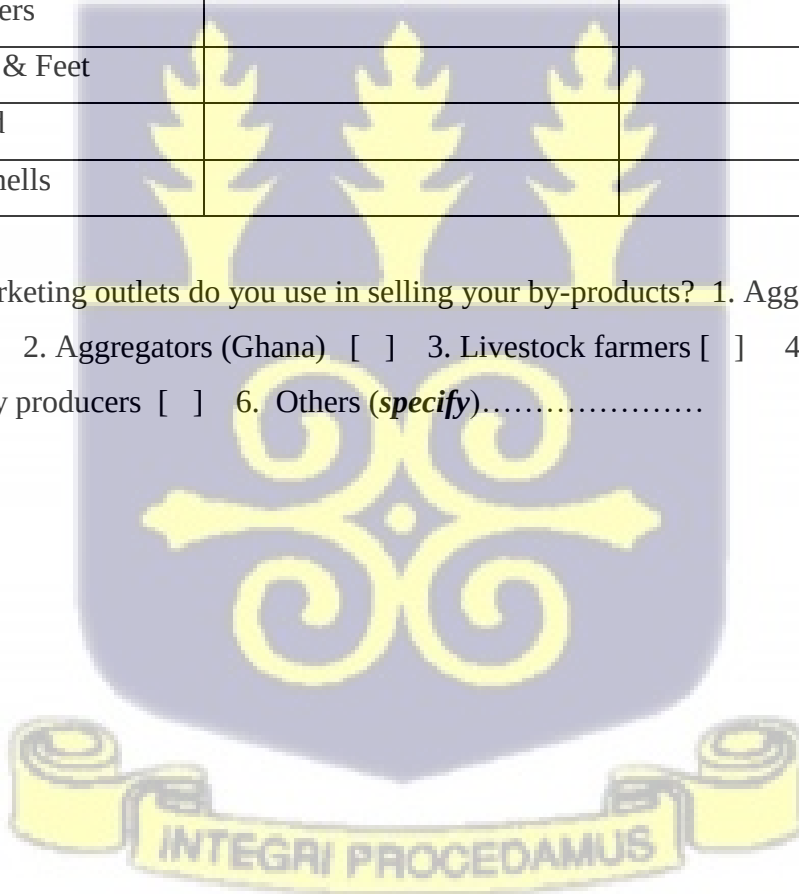
31. Quantity of form of by-product sold

By-product Form	Total Quantity Sold (per 80Kg)	Price/ Unit
1. Droppings/ Manure		
2. Viscera		
3. Feathers		
4. Head & Feet		
5. Blood		
6. Eggshells		

32. What marketing outlets do you use in selling your by-products? 1. Aggregators (Côte

d'Ivoire) [] 2. Aggregators (Ghana) [] 3. Livestock farmers [] 4. Recyclers []

5. Bio-energy producers [] 6. Others (*specify*).....



33. By-product Marketing Information

By-product form	Market Outlet(s) 1= Aggregators (Côte d'Ivoire), 2= Aggregators (Ghana), 3= Livestock farmers, 4= Recyclers, 5= Bio-energy producers. (specify others)	Quantity Sold(per 80Kg)
1. Droppings/ Manure		
2. Viscera		
3. Feathers		
4. Head & Feet		
5. Blood		
6. Eggshells		

34. How do you store your by-product prior to sale or use?

.....

35. Do you use any of these by-products yourself? 1. No [] 2. Yes []

36. If yes, which of these forms of poultry by-product do you use? 1. Droppings []

2. Viscera [] 3. Feathers [] 4. Head & Feet [] 5. Eggshell [] 6.

Others (*specify*).....

37. Purpose for use and quantity

By-product form	Purpose for Use 1= Vegetable Farming, 2= Feed production, 3=Bio-energy production, 4=Recycling, <i>specify others</i> .	Quantity Used(per 80Kg)
1. Droppings/ Manure		
2. Viscera		
3. Feathers		
4. Head & Feet		
5. Blood		
6. Eggshells		

38. Do you have contractual agreement with buyers? 1. No [] 2. Yes []
39. By what means are you often paid? 1. Cash [] 2. E-cash [] 3. Cheque []
40. Are you satisfied with the mode of payment? 1. No [] 2. Yes []
41. If no, which payment method would you have preferred? 1. Cash [] 2. E-cash [] 3. Cheque [] 4. Others (*specify*).....
42. How promptly were you paid? 1. Paid ahead of sale [] 2. Paid at the time of sale [] 3. Paid within a week after sale [] 4. Paid within a month after sale [] 5. Paid after over a month []
43. How would you rate the importance/ beneficiality of your poultry-by-product enterprise to your over-all poultry production business? 1. Highly Beneficial [] 2. Beneficial [] 3. Neutral [] 4. Unbeneficial [] 5. Highly Unbeneficial []

Section F: Poultry by-product Constraint

Do you encounter problems in the poultry by-product market? 1. No [] 2. Yes []

Indicate the problems you face in marketing your poultry by-product.

Constraints	Rank
	On a scale of 1 – 7, where 1 = constraint with the highest magnitude, 7 = constraint with the least magnitude
Poor Road Network	
Access to Credit	
Lack of market information	
Low Demand	
Low Price	
Distance to Buyers	
Lack of processing facilities	

Section G: Marketing Channel Actors Only

1. Name of Respondent.....
2. Nationality.....
3. Location.....
4. Have you bought poultry by-products in the past 12 months? 1. No [] 2. Yes []
5. Which form of Poultry by-products do you buy? (*Tick as many*) 1. Droppings []
2. Viscera [] 3. Feathers [] 4. Head & Feet [] 5. Blood [] 6. Eggshell []
7. Others (*specify*).....
6. What marketing outlets do you use in selling your by-products? 1. Organic Fertilizer
Manufacturers [] 2. Crop Farmers [] 3. Livestock Farmers [] 5. Bio-energy
producers [] 6. Others (*specify*).....



APPENDIX 2: Determinant of Poultry Farmer's Choice of Channel for Selling Droppings

Variables	Aggregators (Côte d'Ivoire)		Aggregator (Ghana)		Cattle Farmers	
	Channel 1		Channel 2		Channel 3	
	Coefficient	Std Err	Coefficient	Std Err	Coefficient	Std Err
Sex	-0.204	0.396	0.066	0.464	0.469	0.524
Age	-0.023	0.020	0.018	0.016	0.037	0.031
Years in Poultry	0.099**	0.042	-0.067**	0.033	-0.010	0.056
Total Revenue	0.664***	0.221	-0.355**	0.168	0.229	0.219
Years of selling dropping	0.120***	0.038	0.062	0.045	-0.069	0.065
Contract	-0.587**	0.298	0.831**	0.358	0.324	0.396
PFA	-5.839***	0.516	0.279	0.480	5.539***	0.483
Ownership	-0.711**	0.406	0.345	0.367	-0.368	0.587
Litter Size						
Medium Scale	-0.031	0.504	0.106	0.591	-0.982	0.604
Large Scale	0.774	0.738	0.056	0.613	-1.290**	0.591
Education	-0.053	0.242	0.304**	0.126	-0.168	0.191
Price of poultry dropping	-0.157**	0.065	0.123**	0.059	0.302***	0.074

*, **, *** indicates significance at 10%, 5% and 1% respectively

Marketing Channels	Coefficient	Std Error
Marketing Channel 2 & Marketing Channel 1	-0.743**	0.438
Marketing Channel 3 & Marketing Channel 1	0.143	0.212
Marketing Channel 3 & Marketing Channel 2	-0.294	0.187

Likelihood ratio test of $\rho_{21} = \rho_{31} = \rho_{32} = 0$:

$\chi^2(3) = 6.62913$

Prob > $\chi^2 = 0.0847$

APPENDIX 3: Proportion of Revenue Contributed by Poultry Dropping (By Region)**Bono Region**

Variable	Obs	Mean	Std. Dev.	Min	Max
Price/ 80Kg of Dropping (GHS)	60	4.133	1.548	2	10
Revenue from Poultry Dropping sale (GHS)	60	11,217.44	13,008.52	470.77	55,800
Total Revenue from sale of Main Products (Eggs, meat, Spent layers) (GHS)	60	3,219,447.7	3,513,371.90	134,400.00	15,370,704.00
Total Revenue (GHS)	60	3,244,147.1	3,509,764.80	205,958.31	15,387,319.00
Proportion of Poultry by-product (%)		0.35	0.37	0.23	0.36

Ashanti Region

Variable	Obs	Mean	Std. Dev.	Min	Max
Price/ 80Kg of Dropping (GHS)	60	7.53	1.94	3.00	12
Revenue from Poultry Dropping sale (GHS)	60	7,430.33	9,610.13	498.46	54,500.00
Total Revenue from sale of Main Products (Eggs, meat, Spent layers) (GHS)	60	943,991.39	1,674,204.60	58,908.00	10,656,600.00
Total Revenue (GHS)	60	951,421.72	1,678,961.90	59,572.62	10,686,300.00
Proportion of Poultry by-product (%)		0.78	0.57	0.84	0.50

**APPENDIX 4: Variance Inflation Factor for Independent Variables in the Tobit
Regression Model**

	VIF	1/VIF
Gender	1.219	.821
Age	1.477	.677
Ownership	1.633	.612
Member of PFA	2.498	.4
Years of Selling Dropping	1.413	.708
Time of payment	1.182	.846
Quantity of Dropping	1.356	.738
Price of Egg	1.353	.739
Sold Spent Layers	2.651	.377
Litter Size	1.453	.688
Medium Scale (<5,000- 10,000 birds)	3.667	.273
Large Scale (Above 10,000 birds)	1.952	.512
Contract	1.451	.689
Mean VIF	1.793	

