PROFIT EFFICIENCY OF LAYER PRODUCTION IN BRONG AHAFO AND GREATER ACCRA REGIONS OF GHANA

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN AGRICULTURAL ECONOMICS

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DECLARATION

I, **MAWULI YEVU**, do hereby declare that except for the references cited, which have been duly acknowledged, this thesis titled **"PROFIT EFFICIENCY OF LAYER PRODUCTION IN BRONG AHAFO AND GREATER ACCRA REGIONS OF GHANA"** is the product of my own research work in the Department of Agricultural Economics and Agribusiness, University of Ghana Legon, from August 2012 to June 2013. This thesis is not published or submitted either in part or in whole anywhere for the award of a degree in any other University.

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DEDICATION

I dedicate this thesis work to my family, my daddy Mr. Kwadzo Yevu, my mum Madam Happy Kpodo, my brother Simon K. Yevu, all my siblings: Redeemer, Daniel, Moses, Michel, Evans, Shine, Christiana, Josephine, Patience, Catherine and Makila.

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ABSTRACT

This study assesses the profit efficiency of layer production in the Brong Ahafo and Greater Accra Regions of Ghana. The study specifically used farm level data to estimate the level of productivity of various inputs, profit efficiency levels, identify determinants of profit efficiency and further identified and ranked major constraints to layer production using Henry Garrett's ranking technique. A multi-stage sampling technique was used to collect cross-sectional data from 300 layer producers in nine districts in the two Regions during the 2011/2012 production year. Using the single-stage maximum likelihood estimation method, a translog stochastic frontier profit function and farm-specific inefficiency models were simultaneously estimated using FRONTIER 4.1c. The results show that prices of feed and price of labour (wage) are the most significant factors negatively affecting profit levels of layer producers in the study area. All the input variables responded positively to layer output. The findings also show that layer production is characterized by increasing returns to scale. The results show that on average, the layer producers are 54.23% profit efficient revealing that layer producers are not operating on the profit frontier. Moving to the profit frontier, layer producers would on the average, be able to reduce their cost by 45.77% to achieve the optimal profit and production, given current method of operation. The results further indicate that training in poultry farming, membership of farmer based organization, provision of extension service/contact, interaction of age and experience, gender, experience, age, housing type and mortality rate are the main factors that significantly explain the variations in profit efficiency among layer producers in the study area. High cost of feed, high cost of medicine and vaccines, difficulties in accessing subsidized yellow maize, and high cost of day old chicks, are the major constraints to layer production identified in the study area. The study therefore concludes that layer producers in the study area are profit inefficient. This therefore suggests that policies directed at these factors could significantly improve profit efficiency of the layer producers. The study recommends that layer producers should reduce their inefficiency level in order to achieve higher profits. Also, the study recommends that extension agents and other NGOs should constantly encourage layer producers to form associations in order to create the platform for sharing of technical knowledge among the experienced and younger farmers. In addition, intensive technical training in poultry production and management through frequent seminars and workshops should be organized by MOFA and GNPFA in partnership with training institution for layer producers in order to enhance their skills and capacity of production. It is also recommended that policies and programs aimed at drawing the youth into layer production should be pursued by giving them incentive packages. Policy makers should specifically focus on enacting policies that will enable layer producers get feed at a lowest cost, easy access subsidized yellow maize and other form of inputs. Layer producers are also advised by the study to consider adopting the battery cage system of housing in their operation.

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LIST OF ABBREVIATIONS

ADB	Agricultural Development Bank
DFID	Department for International Development
ECOWAS	Economic Community of West African States
EU	European Union
FAO	Food and Agriculture Organization
FBO	Farmer Based Organization
GDP	Gross Domestic Product
GNPFA	Ghana National Poultry Producers Association
HPAI	Impact of Highly Pathogenic Avian Influenza
IMF	International Monetary Fund
ISSER	Institute of Statistical Social and Economic Research
MiDA	Millennium Development Authority
MLE	Maximum Likelihood Estimate
MOFA	Ministry of Food and Agriculture
MOTI	Ministry of Trade and Industry
NGO	Non-Governmental Organization
OLS	Ordinary Least Squares
USA	United States of America
VAT	Value Added Tax
WTO	World Trade Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Agricultural growth has historically played a major role in Ghana's development and continues to be crucial for the country's economic growth. Though the agricultural share for Gross Domestic Product (GDP) has fallen from about 33.6% in 2008 to 29.9% in 2011 (ISSER, 2012), strong poverty reduction and livelihood enhancement is unfeasible without strong agricultural growth as agriculture continues to be the main source of household income. Agriculture consists of crops, fishery and livestock. The livestock sector is largely dominated by poultry production, contributing 34% which represent the highest contribution to total meat production in the country (MOFA, 2011).

Livestock production in Ghana mainly consists of cattle, small ruminants, swine and poultry industries. According to MOFA/DFID (2002), the poultry component serves as a 'safety net' providing an important source of ready cash for emergency needs. Thus, even though poultry contributes only 5% to the agricultural Gross Domestic Product, its role in rural livelihoods, food security, poverty reduction as well as supply of protein requirements is enormous.

The poultry industry in Ghana has undergone a significant transformation since the early 1960s, from the use of the extensive system of production to the use of the intensive system. According to Aning (2006), poultry production was practiced by about 66% of the 3.7million households in Ghana especially in the Guinea Savannah Agro-Ecological zone. There is also an active commercial poultry production sector that depends on exotic chicken breeds and to a lesser extent guinea-fowl. This occurs mainly in the urban areas of Greater Accra, Ashanti and Brong- Ahafo Regions to take advantage of the larger local markets. Aning (2006) categorized the poultry sector into three namely; large-scale (above 10,000 birds), medium-scale (5,000 – 10,000 birds) and small-scale (50 – 5,000 birds) producers, producing mainly eggs. Livestock Programme Information data for 2006 indicates that, there is steady increase in poultry population over 2001 to 2005 with Greater Accra having the highest (18,044,753).

According to Diao (2008), the poultry industry contributes to the agricultural GDP of Ghana. The sector's contribution in terms of animal food production and employment generation cannot be underestimated. Poultry provides animal products such as meat and eggs which are good sources of animal protein that are rich in the essential amino acids required for body functions. The annual production of poultry products is estimated to be 14,000 metric ton of meat and 200 million eggs (MOFA, 2002).

The sector offers greater employment opportunities and quick income generation for the youth. Poultry production employs labour, both skilled and unskilled, for production activities. It is assumed that nearly 2.5 million households benefit from village poultry production and the number of commercial poultry workers estimated from commercial farms is about 7000 (Aning, 2006). According to MOFA (2002), the poultry component constitutes an important sector of agriculture, and can provide ready cash for emergency needs.

Akinwumi and Adeyeye (1979) further stated that poultry keeping has some advantages over other livestock because they are able to convert feed into useable protein in the form of meat and eggs which are high in nutritional value. Poultry meat is also tender, palatable and acceptable to consumers. Return to investment is high if properly managed because the cost of its production is relatively low compared to other livestock (Adepoju, 2008). Poultry keeping has a short production cycle making capital not tied down over a long period. A poultry enterprise can produce meat within six to seven weeks (broilers for example) and have the first egg produced within sixteen weeks (Ashitey and Randon, 2011), indicating that it has rapid monetary turnover (Laseinde, 1994).

In the past, commercial poultry production was well established in the country with substantial infrastructure (poultry houses, feed mills, hatcheries and processing plants). However, some of these equipment became idle due to high cost of other inputs, capital as well as competition from cheap imports. In the light of that, the government of Ghana in 2003, imposed a special tax of 20% on all poultry products imported into the country to protect and encourage local production which was later rescinded in 2004 (Aning, 2006). According to MOFA (2011) the livestock population increased from 43,320,000 in 2009 to 47,752,000 in 2010, however poultry production is still on the decline in the country.

1.1.1 Layer Production Systems in Ghana

Layer production in Ghana is classified into three main types namely: the extensive, semi-intensive and intensive systems. The technology which is widely used in Ghana is the intensive system of production. In between the extensive and intensive systems is the semi-intensive, commonly found in urban and peri-urban where birds are confined in a fenced area outside during the day and only housed at night (Aini, 1990). The extensive system of production is either free range or backyard. Under the free range system, birds are not enclosed and can freely roam in search of food over a wide area. Simple shelters and perches may sometimes be provided for the birds. For backyard system, the birds are housed only at night and allowed to roam freely during the day (Bessie, 1987). The owner only intervened by providing feed and water supplement, overnight housing and some provide vaccines/medication. The intensive system is mainly used by layer producers where birds are completely kept in houses or cages. Capital expenditure is high and birds are totally dependent on owners for all their requirements. Production cost and productivity in this system is also relatively higher than the extensive and semi-intensive systems (Sonaiya and Swan, 2004). The birds are either kept in the deep litter or battery cage system. In the battery system, each bird is confined to a cage just large enough to permit limited movement and allows it to stand and sit comfortably. However, in the deep litter system, the birds are kept in large pens up to 250 birds each, on floor covered with litter such as saw dust or leaves up to depth of 8-12 inches. This study is on layer production, focusing on raising birds under intensive management system.

1.2 Problem Statement

Several works (Batsa, 1993; Aning, 2006 and Gyening, 2006) have indicated that Ghana is still trailing with animal protein intake of 53gram per head per day compared to the recommended 65gram. The estimated poultry products consumption in Ghana is 12 eggs and 1.2 kg meat per annum; this is also far less than the world average of 154 eggs and

9.7 kg meat (World Poultry Science, 1999). The implication is that the shortfall in animal protein intake is attributable to either low production (supply) of animal protein-giving products or inadequate patronage of these products by consumers. According to the Ministry of Trade and Industry (2010), the demand for poultry products far exceeds what local producers currently produce. This assertion shows that the shortfall in animal protein intake might be due to low local supply of animal protein-giving products. Consistent with the assertion by Flake and Ashitey (2008), the domestic poultry sector contributes only 10% of local demand.

Despite the potentials for poultry production in Ghana, many poultry enterprises are reported to operate at very low capacities (FAO, 2006). This results in low returns compared to the given amount of input committed. This indicates that poultry producers are not operating at the maximum and this results in poultry products being inadequate relative to the increasing demand for such products (Bamiro *et al.,* 2006). In line with this, Flake and Ashitey (2008) noted that poultry imports have more than tripled between 2000 and 2007, to cater for the increasing demand of poultry products in Ghana.

Layer farming over the years has been considered as one of the highest priority areas, and therefore the layer farming industry has received substantial support and incentives from both the government and the Non-Governmental Organizations (NGOs) over the years since the mid-1990s. The NGOs such as Ricerca and Cooperative zone located in the Western and Eastern regions, Heifer International in Brong Ahafo, Ashanti and Greater Accra regions, Opportunities Industrialisation Centre (OIC) in the Northern region, Kindness International in the Upper East region, World Vision Ghana in Eastern and Upper East regions, Sankofa Foundation in Greater Accra region and German Technical Cooperation (GTZ) in the Eastern region have been supporting layer producers. The support includes the removal of customs duties on poultry inputs (feed, additives, drugs and vaccines), training of the layer producers and improved access to veterinary services (Akunzule, 2006; Aning, 2006; Ashitey *et al.*, 2011).

The government through its policies has tried to support the poultry (layer) industry over the years. For instance, in 2005, the government of Ghana imported 20,000 metric tonnes of yellow maize which was given to the layer producers at a highly subsidized price in order to encourage the producers to increase production. The government also instituted the Poultry Development Board (PDB), in the same year that advises government on the growth, modernization and sustainability of the poultry industry. Also, the government of Ghana in collaboration with the Agricultural Development Bank (ADB) designed an ADB Broiler Out grower Scheme in 2003 to facilitate capitalization and marketing of birds and poultry products. The incentives include subsidies on yellow maize, day-old chicks and vaccination of the farms during disease outbreaks (Akunzule, 2006; Aning, 2006; Ashitey and Rondon, 2011).

Despite all these interventions by government and NGOs directed towards increasing returns to layer production, the growth in domestic poultry (layer) sector still remains low. The downward trend of the poultry industry in Ghana has been attributed primarily to high cost of inputs (feed, drugs and water) and high cost of energy which have shot up the production cost to above 60% of total cost (Aning, 2006). Contributing to the debate of salvaging the poultry sector, Anku (2005) expressed concern that the inability of poultry farmers to use their limited available resources (especially feed) efficiently, make their cost of production very high and thereby making them uncompetitive with imported poultry products. Also, GNPFA (2009) in their report attributed the declining trend to high cost of production due to high cost of feed, lack of credit facilities, weakness in the management and low profit. However, these views were not based on any comprehensive empirical studies.

Despite the fact that these views might be possible constraints to the poultry sector, most of the poultry (broiler) producers have drifted from the production of broilers to the production of layers for eggs as noted by Flake and Ashitey (2008) and Aning (2006). This drift was confirmed by the 2009 national poultry census, indicating the layer count which stands at 21 million birds whiles that of the broilers are at 5 million (Ashitey and Rondon, 2011). The layer producers have also complained of not receiving the maximum returns from the resources committed to production even with the numerous interventions. This therefore raises issues of efficiency in resource use in the light of scarcity of resources coupled with increasing cost of production.

For poultry production in Ghana only few researchers such as Okantah *et al.* (2003) focused on small-scale poultry production in peri-urban areas. Mensah-Bonsu *et al.* (2010) investigated the role of poultry and the impact of HPAI on livelihoods and Nimoh *et al.* (2011) focused on the effect of formal credit on the performance of poultry industry in urban and peri-urban areas in the Ashanti region. Though efficiency measurement is very important in an industry, no comprehensive work has been done in Ghana to estimate profit efficiency of layer producers. Therefore, this study will assess the profit efficiency of layer production in Brong Ahafo and Greater Accra regions.

Specifically, this study seeks to address the following research questions:

1. What is the level of productivity of layer producers with respect to input use?
2. What are the current levels of profit efficiencies of layer producers?
3. What are the major determinants of profit efficiency in layer farming?
4. What are the major constraints confronting the layer producers?

1.3 Objectives of the Study

The main objective of this study is to assess the profit efficiency of layer producers in the Brong Ahafo and Greater Accra Regions of Ghana. Specifically, the study seeks:

1. To determine the level of productivity of layer producers with respect to input use,
2. To estimate the level of profit efficiencies of the individual layer farms in the regions,
3. To identify the determinants of profit efficiency of the layer producers,
4. To identify and rank the major constraints facing layer production.

1.4 Relevance of the Study

The measurement of efficiency remains an important area of research both in developing and developed countries. The measurement of efficiency goes a long way to determine the profitability of an enterprise which links agricultural growth to profit (Abdulai and

Huffman, 2000). The relationships between market indicators and household characteristics have not been well studied in Ghana. An understanding of these relationships could provide policy makers with information to design programmes that can contribute to measures needed to expand the food production potential of a country (Abdulai and Huffman, 1998). Yusuf and Malomo (2007) stressed that knowing the level of efficiency of producers is very important from a policy perspective in an economy where new or improved technologies are not fully exploited.

Therefore, in an economy where some of her populace derive their livelihood and jobs from layer production and its related activities, the importance of profit efficiency study cannot be overstressed. This is because knowing the efficiency level of layer producers in Ghana will help develop a more sustainable and high productive system and also, help layer producers to improve upon the use of their scarce resources.

Also, in the light of trade liberalization and increasing cost of input, this study is relevant because it will identify ways by which the layer producers could be supported and made to compete favourably with poultry imports. Besides, improvement in the profitability in layer production is very essential in keeping layer producers in business to improve their incomes and food security needs. Identifying factors that affect profit level of layer producers by the study will help government fashion out specific policies to increase profit levels of layer producers with the ultimate aim of enhancing their well-being. Furthermore, the study will guide policy makers in making specific poultry sector policies that will be geared towards expanding layer production in Ghana. Also, identifying the main factors explaining variations in the profit efficiency levels by the study would help provide useful information for stakeholders in designing appropriate policies that can contribute to bridging the efficiency gap and thereby enhancing the productivity of layers producers.

Finally, knowing the constraints to layer production would also help government in policy formulation that would help safeguard the layer production industry from collapsing with the aim of developing the domestic production of poultry products. This study would also help fill the knowledge gap in profit efficiency on layer production in Ghana and also add to the body of literature for further studies in the poultry industry in Ghana and beyond.

1.5 Organization of Study

This study is organized into five chapters. Following chapter one, chapter two covers relevant literature on the meaning of efficiency, and the theoretical basis for measuring efficiency. It also covers profit function, profit efficiency and empirical review of profit efficiency studies. This chapter also outlines the poultry sector in Ghana and the constraints of the sector. Chapter three discusses the empirical methodological procedures used to achieve the specific objectives. It also includes methods of the data collection; sources of data, geographical area and sampling techniques used in the study. The results of the analysis are presented and discussed in chapter four, while chapter five presents the summary, conclusions and policy recommendations.

CHAPTER TWO

LITERATURE REVIEW

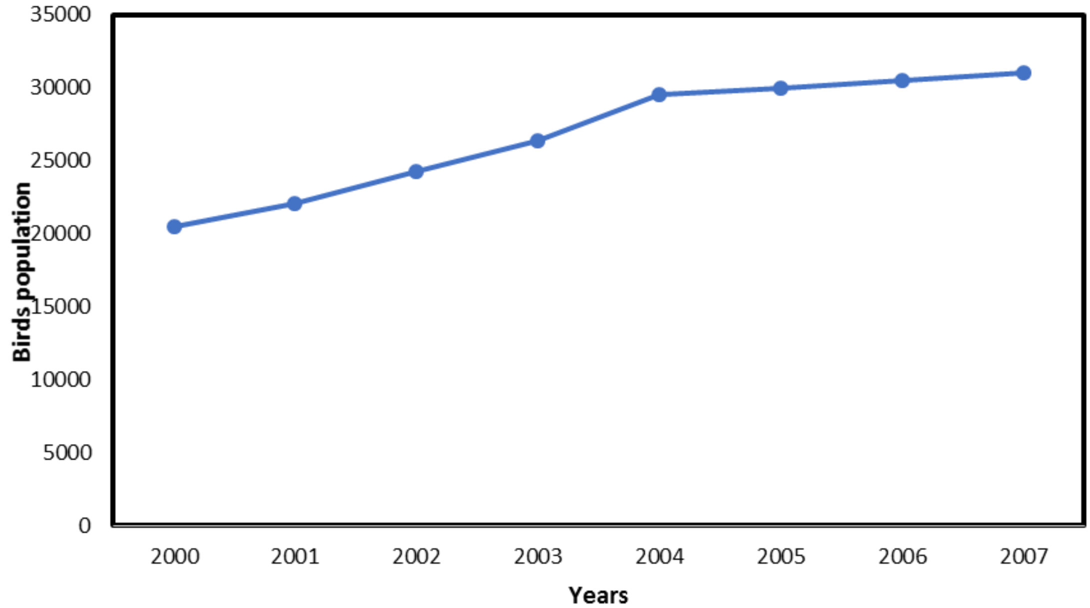
2.1 Introduction

This chapter presents the relevant literature on the performance of the poultry industry, meaning of efficiency, types of efficiency, theoretical basis for measuring efficiency and Profit function. This chapter also presents empirical review on efficiency studies in agriculture worldwide and in Ghana. This chapter further presents some constraints affecting the poultry sector.

2.2 Performance Analysis of the Poultry Industry

A survey by Livestock planning and information unit (2006) reveals that the country had a total of 32,857,790 chickens as at 1996. The Greater Accra Region had the highest number of chickens, with a total of 25,285,158 birds. The Ashanti Region followed with a total of 2,190,072 birds. The region with the least number of birds was the Western Region with a flock size of 304,110 birds. The survey projected that by the year 2005, the total flock of chickens in the country will be 33,525,809, with the Greater Accra Region still taking a greater proportion with a flock size of 18,044,753. The Ashanti Region will still follow with a flock size of 5,795,693. The Brong Ahafo Region follows with 2,503,559 birds, overtaking the Northern, Volta and Eastern Regions. The Western Region will still have the least number, with 472,982 birds. The national poultry flock grew steadily from the year 2000 to 2005. It then stabilized with little variations from 2005 to the year 2007. The population of chickens from 2000 to 2007 is illustrated in Figure 2.1.

Figure 2. 1: Trends of Chicken Population in Ghana

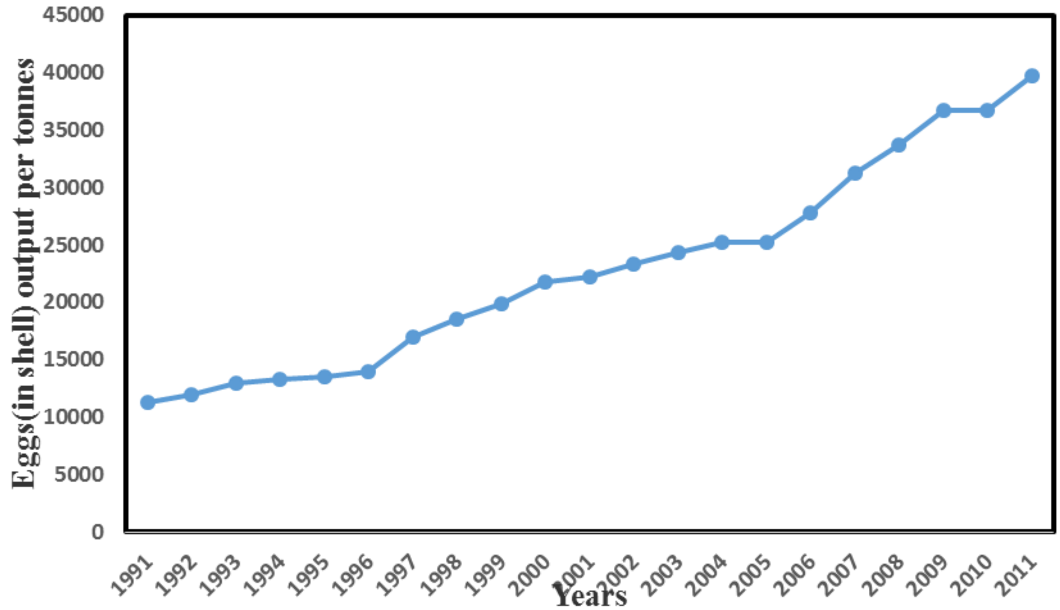


Source: Aning (2006)

Trends of Layer production in Ghana

The output level of layer production in Ghana has been relatively constant over the last 21 years. Figure 2.2 illustrates Ghana's output level of eggs (in shell) from 1991 to 2011. Ghana's layer output level increases gradually from 11,263 tonnes in 1991 to 13,913 tonnes in 1996. It then rose sharply from 1996 to 1997 and then maintained the increase slowly till 2003 which may be attributed to the implementation of the tariffs on imports and the government subsidies to the sector. In 2006 to 2008 there was a sharp increase in the output produced which may be attributed to the effort of the NGOs because most of the them started operating by assisting the layer farmers at that time. Relatively constant from 2009 to 2010 and sharply increased from 36,700 tonnes to 39,750 tonnes in 2011 (FAO, 2011). Some of the major production areas of layer production in Ghana are Brong Ahafo Region specifically Dormaa Municipality (Dormaa Ahenkro, Dormaa East and west and central), Sunyani; Greater Accra Region in the districts such as Ga-East, Ledzekuku-Krowor, Ashaiman and Ashanti Region (Kumasi)(Mensah-Bonsu *et al.,* 2010 and MOFA, 2011)

Figure 2. 2: National poultry output for Layer (eggs in shell)



Source: FAOSTAT (2012)

2. 3 Constraints to layer production in Ghana

Gyau (2011) on challenges and prospects of marketing poultry and poultry products in Kumasi, Ghana identified fluctuating price of maize, high interest rate on loans, government's failure to protect the local industry by enacting laws to check the importation of cheap foreign poultry products and lack of subsidies on poultry inputs like feed, drugs, equipment as problems affecting the poultry industry.

According to Koney (2004), scarcity of feed, its high cost and its poor quality, poor quality of day-old chick, inappropriate government policies such as inadequate budgetary allocation, fixation of prices and failure to implement tariffs and bans on the importation of poultry, difficulty in obtaining bank loans and disease control are the major constraints affecting the poultry production in Ghana. This author fails to rank the constraints in order of severity on the poultry production and moreover the author considered the poultry production in general. On the other hand, a study in some peri-urban areas in Ghana identified constraints in areas of husbandry, feeding and health, availability of inputs, information and credit (Okantah *et al.,* 2003). In conclusion it can be deduced that, constraints to poultry production varies from location to locations and country to country.

2. 4 Meaning of Efficiency

Theoretical literature on production efficiency began in the 1950s with the works of Koopmans (1951), and Debrew (1951) but was first measured empirically by Farrell (1957). Farrell (1957) provided the drive for developing the literature on empirical estimation of efficiency which led to better understanding of the concept of efficiency. Koopmans (1951) provided a definition of technical efficiency, while Debrew (1951) introduced its first measure of the 'coefficient of resource utilization'. Following Debrew (1951) in a seminar paper, Farrell (1957) provided a definition of frontier production function, which embodied the idea of maximality. According to Farrell (1957) the actual productivity of a firm relative to a maximal potential productivity is the firm's level efficiency. Farrell (1957) introduced the methodology for efficiency measurement by distinguishing three types of efficiency namely: technical efficiency, allocative efficiency and economic efficiency.

2.4.1 Types of Efficiency

This includes Technical and allocative which interact to give the economic efficiency. Technical efficiency is refers to the ability of a firm to obtain maximum output from a given set of inputs. It can be measured as input and output-oriented. The input-oriented measure occurs when a firm has ability to produce a maximum output from a given set of inputs. The output-oriented measure is the ability of a firm to use as modest inputs as possible to produce a given level of output. According to Fan (1999) technical inefficiency is a state in which actual or observed output produced from a given input mix is less than the maximum possible output. Yilma (1996) study on efficiency among smallholder coffee producers in Uganda referred to an efficient farm as that which produces more output from the same measurable inputs than a farm which produces less with the same given inputs.

Allocative efficiency is the ability of a firm to use optimal factor combinations, given their respective prices and the production technology. This component of efficiency measure includes; cost minimization (input-oriented model), profit maximization (output-oriented model) and revenue maximization. Nwaru (1993) defined allocative efficiency as a choice of optimum combination of inputs consistent with the relative factor prices. Under competitive conditions, allocative efficient firm equates its marginal returns of factor inputs to the market price of output (Fan, 1999). Akinwumi and Djato (1997) in relative efficiency study of women farm managers in Cote d'Ivoire defined allocative efficiency as the extent to which producers make efficient decisions by using inputs up to the level at which their marginal contribution to value of production equal to factor costs.

Farrell (1957) showed that economic efficiency is the product of technical and allocative efficiency. Bagi (1982) and Onyenweaku *et al.* (2004) defined economic efficiency as the ability of a farm to achieve the highest possible profit given the prices and levels of resources of that farm. By that definition, economically efficient firm should be both technically and allocatively efficient. However, this is not always the case as posited by Akinwumi and Djato (1997). The argument is that it is possible for a firm to be either technically or allocatively efficient without necessarily being economic efficient. The reason for this variation may be attributed to the farmer's inability to make efficient decisions in the use of inputs. It was also argued that at a point where technical and allocative efficiency occur together they are both necessary and a sufficient condition for economic efficiency. This assumes that the farmer has made right decisions to minimize costs and maximize profits, positing that the farmer is operating on the profit frontier. The productive efficiency definition by Kumbhakar and Lovell (2000) corresponds to what is called economic efficiency and the objective of producers becomes one of attaining a high degree of economic (cost, revenue or profit) efficiency.

These definitions of economic efficiency are made based on the use of the production function framework. However, within a profit function context, profit efficiency is defined as the ability of a firm to achieve the highest possible profit, given the prices of inputs and levels of fixed factors of that firm (Ali and Flinn, 1989). It is however important to recognize that in least developed countries market failures are inherent due to the following reasons, unwarranted government interventions, lack of information on the markets, outbreak of pests and diseases and poor infrastructure network.

2. 5 Frontier Estimation Methods

Different techniques have been considered in literature for the construction of the efficient frontier against which the individual efficiencies are either calculated or estimated. Farrell (1957)'s efficiency measure used an input-oriented approach whilst Färe and Lovell (1978), employed output-oriented approach. The two researchers posited that input-oriented and output-oriented measures of efficiency are equal under a constant return to scale restriction. Therefore the efficiency techniques are broadly categorized into parametric and non-parametric. The choice of a particular technique depends on the researcher because both have concept of frontier in common. However, the econometric method is commonly used to determine technical efficiency of firms since this approach allows for statistically testing various hypotheses. The two techniques broadly used are, parametric and Non-parametric.

2.5.1 Non-Parametric Technique

The non-parametric approach, which is assimilated into Data Envelopment Analysis (DEA) involves the use of linear programming methods to construct a non-parametric piece-wise surface (or frontier) over the data (Coelli *et al.*, 2005). DEA is a deterministic technique and computationally simple and has the advantages that it can be implemented without knowing the algebraic form of the relationship between outputs and inputs (Coelli *et al*., 2005). This implies that one can avoid unnecessary restrictions about functional form that can affect the analysis and distort efficiency measures (Fraser and Cordina, 1999; Krasachat Wirat, 2003). Aside this, the non-parametric techniques interpret noise effects and inefficiency effects as inefficiency (Ajibefun, 2008). Based on this weakness, the parametric technique was developed.

2.5.2 Parametric Technique

The parametric frontier technique pre-defines a functional form of the efficient frontier. The parametric frontier can be expressed for a cross-section data as: $Y_i = f(X_i, \beta) * TE_i$ where, Y_i is a scalar output of the i^{th} producer; X_i is N vector of inputs; β represents unknown parameters to be estimated; $f(X_i, \beta)$ is the frontier production function and TE_i represents output-oriented technical efficiency of the i^{th} farm. The parametric frontier estimation can be categorised into deterministic technique (Aigner and Chu, 1968) and stochastic technique (Aigner *et al.*, 1977) according to the specification of the error component. The former is estimated via either mathematical programming as suggested by Aigner and Chu (1968) or econometric technique and the latter is estimated only by econometric technique.

2.5.3 Deterministic Frontier

The deterministic frontier production function proposed by Aigner and Chu (1968) is given as: $Y_i = f(X_i; \beta).\exp(-u_i)$, $u_i \geq 0$ where u_i represents technical inefficiency. The condition that $u_i \geq 0$ ensures that $Y_i \leq f(X_i; \beta)$, therefore TE of the deterministic frontier is expressed as: $Y_i = \frac{f(X_i; \beta).\exp(-u_i)}{f(X_i; \beta)} = \exp(-u_i)$. The deterministic frontier production function has the advantage of being simple to use. However, Russell and Young (1983) criticized the deterministic frontier production model, because it assumes that all deviations from the efficient frontier are under the control of the decision maker. On the other hand, two types of factors can affect the performance of a firm. These include factors outside the control of the firm such as unfavourable weather conditions, failure of markets and measurement errors and; whereas factors under the control of the firm include socioeconomic characteristics, and management practices are regarded as inefficiency. Thus, a stochastic parametric frontier production function was developed to incorporate these effects while estimating technical efficiency of the firms (Aigner, Lovell, & Schmidt, 1977; Meeusen & Van den Broeck 1977).

2.5.4 Stochastic Frontier Analysis

The Stochastic Frontier model as first proposed simultaneously by Aigner *et al*. (1977) and Meeusen and Van den Broeck (1977) to estimate technical efficiency of producers/firms using parametric econometric techniques. The stochastic frontier production function takes into account the technical inefficiency and firm's specific random shocks separately in the analysis process. Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977) pointed out that deviations from the production frontiers are because of two types of factors, such as factors entirely outside the control of the firm or farmer and factors under the control of the farmer. This signifies that deviations are not entirely under the control of the farmer, but some factors such as bad weather, approximation errors, and etcetera are totally not under farmers' control. The stochastic frontier approach is known to deal with stochastic noise and also test of hypothesis regarding production structure or technology. The SFA model can be estimated using "corrected" ordinary least squares method (COLS) or the maximum likelihood (ML) method. According to Battese and Coelli (1995a), the ML estimator gives more asymptotically consistent estimates.

The production function methods have been extensively used in estimating efficiency in literature and the extension of the production function model lead to profit function model which incorporate cost and revenue components for efficiency measurement.

2.6 The Theory of Profit Function Model

The use of a profit function model has become increasingly popular for its application in empirical studies of production in recent years. The extensive use of this model appears to be based on the realization that it has some theoretical proprieties which makes it a more flexible methodological tool in analyzing various agricultural problems than the conventional production function model (Pudasaini, 1981). A profit function is an extension and formalization of the production decisions taken by a farmer. From production theory, a farmer is assumed to choose a combination of variable inputs and outputs that maximize his profit subject to technology constraint available to him (Sadoulet and De Janvry, 1995). The basic production function can be generalized as h

$$Q = h(X, S) \quad (1)$$

where Q is a vector of output produced, X is a vector of variable inputs used, **S** is a vector of fixed inputs used and h is a technology. Assuming the technology to be homogeneous across farms, profit function is specified as follows:

Maximize $PQ - WX$ ……., subject to $Q = h(X, S)$ (2)

where: P is a vector of prices of outputs (Q) produced and W is a vector of prices of variable inputs(X) used in the production.

Considering a set of inputs and outputs the profit maximizing input demand and output supply functions are generally respectively expressed as:

$$X^{*} = x(w, S) \tag{3}$$

$$Q^{*} = q(w, S) \tag{4}$$

Substituting equation (3) and (4)(which is a function of the normalized variable input prices and the quantities of the fixed input) into equation 2 gives a profit function which is the maximum profit that the farmer can obtain given prices of output (p) and input (w), availability of fixed factors S and production technology h (.). The profit function can be written as;

$$\pi = p^{'}q(w, S) - w^{'}x(w, S) \tag{5}$$

The normalized profit function outlined in equation:

$$\pi_i = f(P_{ij}, S_{ik})\exp(\varepsilon_i) \tag{6}$$

This makes profit non-linear in its error term. However, the profit function can be log-linearized to obtain the form :

$$In\pi_i = Inf(P_{ij}, S_{ik}) + \varepsilon_i \tag{7}$$

where: π_i is normalized profit of firm i^{th} defined as gross revenue minus variable cost divided by the farm-specific output price; P_{ij} represents prices of variable input *j* on farm *i* divided by the farm-specific output price; S_{ik} represents the level of fixed input on farm $_i$ where *k* are a number of fixed inputs; $_{i} = 1,\ldots,$ n number of farms in the sample and ε_i is error term (assumed to behave in a manner consistent with the frontier concept (Ali and Flinn, 1989). The ‘‘composed’’ error term comprising of two components that is random error and inefficiency effect (Aigner *et al.*, 1977; Meeusen and Van de Broeck, 1977).

This error term is defined as: $\varepsilon_i = \exp(v_i - u_i)$. The two components v_i and u_i are assumed to be independent of each other. The v_i represent random error or variations in output that are assumed to be independent and identically distributed as $N(0, \sigma_v^2)$ due to factors outside the control of producers as well as the effects of measurement errors in the output variable and stochastic noise. The u_i is a non-negative random variable, associated with inefficiencies of production, which are assumed to be independently distributed such that u_i is obtained by truncation (at zero) of the normal distribution with mean μ_i and variance $\sigma_\mu^2 = \left(u \sim N(\mu_i, \delta^2{}_u)\right)$(Battese and Coelli, 1995a; Coelli *et al.*, 2002). Z_i is a vector of explanatory variables associated with profit inefficiency of producers over time and δ is a vector of unknown parameters to be estimated. In other words, the term measures the profit shortfall (π_i) from its maximum possible value (π_i^*) given by the stochastic frontier (Ali and Flinn, 1989). The inefficiency effect, μ_i, in the stochastic profit frontier model could be specified as below;

$$\mu_i = \delta_0 + \sum_{i=1}^{n} \delta_i Z_i \qquad (8)$$

The stochastic profit frontier function is an extension of incorporating farm level prices and input use in the frontier production function. The incorporation of the farm specific level prices leads to the profit function approach formulation (Ali and Flinn, 1989; Wang *et al.*, 1996a). Yotopoulos *et al.* (1970) argued that a frontier production function approach may not be appropriate when estimating efficiency when in reality producers face different prices and have different factor endowments. As a result, they have different best-practice production functions and, thus different optimal operating point (Rahman, 2003). Hence the use of stochastic profit function to estimate farm specific efficiency directly (Kumbhakar, 1987, 2001; Kumbhakar *et al.*, 1989; Ali and Flinn, 1989; Kumbhakar *et al*., 1991, Ali *et al.*, 1994; Wang *et al.*, 1996b). The profit function approach combines the concepts of technical, allocative and scale inefficiency in the profit relationships and any errors in the production decision translate into lower profits or revenue for the producer (Rahman, 2003).

2.6.1 Advantages of Profit Function Approach over Production Function

The profit function model has some advantages over production function model. In the first place, a normalized restricted profit function is assumed to be a function of the quantities of fixed factors and the prices of variable factors. The profit function and factor demand functions are generally estimated jointly (Pudasaini, 1981). Thus, a profit function model yields statistically consistent estimates whiles a production function estimated by ordinary least square may results in simultaneous equation bias and inconsistency (Abdulai and Huffman, 1998). In addition, a farmer is assumed to behave according to empirically testable rules which comprise profit maximization as a special case. Input demand and output supply functions are obtained directly from the normalized restricted profit function without having to assume profit maximization and solve for the first order condition for profit maximization as in the case for production function approach. In addition, the influence of institutional features is introduced directly into the profit function and behavioral rules. Lastly, the profit function approach takes into consideration differences in technical and allocative efficiencies in production.

Under mild ‘’regularity conditions’’ which require that the function must be monotonically increasing in output, non-negative, convex, and homogeneous of degree zero in all prices, profit function is a logical extension of production function (Sadoulet and Alain de Janvry, 1995).

2. 7 Empirical Review on Profit Efficiency Studies

Studies on farm-specific efficiency or inefficiency can be related to farmer socioeconomic and demographic characteristics or environmental factors of agricultural units. These variables may measure information status and managerial skills, such as education, technical knowledge and extension contacts, as well as system effects exogenous to the farm, such as credit, input markets or tenancy (Udoh and Etim, 2009).

Hyuha (2006) assess profit efficiency in Rice production in Eastern and Northern Uganda. A multi-stage sampling techniques was employed to collect a cross-sectional primary data of 297 farmers of which 253 were used because of 44 outliers were identified in the data. A restricted normalized profit function was computed for the farm as gross revenue less variable costs divided by farm specific rice price. The study reveals that the imputed cost of normalized family labour, fixed inputs (land under rice (hectares) and capital have a negative and statistically significant influence on maize production. The result further established limited access to extension services, low education, limited non-farm employment opportunities and lack of experience in rice growing as sources of inefficiency.

Ojo *et al.* (2009) examined profit efficiency of small scale cowpea farmers in Niger state, Nigeria, using the stochastic profit frontier approach. Structural questionnaire were used to collect data from 100 cowpea farmers randomly from Paiko and Gurara Local Government Areas of the state. They found that the levels of profit efficiency ranged from 11.62 percent to 91.90 percent with mean of 78 percent, implying that an estimated 22.25 percent of the profit was lost due to a combination of both technical and allocative inefficiency in cowpea production. The authors concluded that, although farmers generally relatively efficient, they still have room to increase the profit efficiency in their farming activities at about 23 percent efficiency gap from optimum remains yet to be achieved by all farmers. Age, farmers' educational level, and years of farming experience were found to be significant and have positive effect on efficiency level of farmers. It was recommended by the author that investment in rural education through effective extension delivery program in the current economic environment of Nigeria should be provided.

Hoang and Yabe (2012) analysed the impact of environmental factors on profit efficiency of rice production in Vietnam's Red River Delta using both OLS and MLE translog stochastic profit frontier function with a two-stage approach. The dataset was extracted from 349 rice farmers, using personal interviews. The authors obtained an average profit efficiency of about 75 percent with environmental factors significantly changing profit efficiency. Plant disease, soil fertility, irrigation application and water pollution were the four environmental factors identified to cause profit loss in rice production. The authors concluded that farmers should reduce households' size, farm plots, apply row seeding technique and improve environmental factors to obtain high profit efficiency with special consideration given for irrigation water quality improvement.

Effiong and Onyenweaku (2006) also examined profit efficiency in broiler production in Akwa Ibom State of Nigeria, using the stochastic profit function approach. A multi stage random sampling method was used to collect data from 60 broiler farmers for the 2004 production year. The study revealed that Labour cost(wage rate), price of feed or feed supplements, price of drugs, farm size and capital inputs have significant effects on profit level of broiler farms in the study area. The authors found that with the mean profit efficiency of 81 percent, it implies that profit efficiency of the broiler farmers could be increased by 19 percent through better use of available resources. The authors concluded that education level of farmer, farming experience, extension contact and gender were the major factors that positively influence efficiency levels of broiler farmers.

Oladeebo and Oluwaranti (2012) examined the profit efficiency in cassava production in south western part of Nigeria, using a stochastic Cobb-Douglas profit frontier model. A simple random technique was employed using a structured questionnaire and oral interview to obtain a cross-sectional data from the 109 cassava farmers in the study area. The result of the analysis showed that profit efficiency ranges from 20 percent to 91 percent with the mean profit efficiency of 79 percent, suggesting that an estimated 21 percent loss in profit was due the combination of both technical and allocative efficiencies in cassava production. Thus an average cassava farmer could increase profit by 21 percent by improving their technical and allocative efficiencies. Household size, amount of credit used, amount of agrochemicals used as well as farm size were the major factors identified as significantly affecting farm-specific profit efficiencies. The authors concluded that there is scope for increasing profitability of cassava production in the study area and Nigeria as the whole by directing policy to focus on the significant inefficiency factors.

Ogundari (2006) investigated factors that determine the profit efficiency among small scale rice producers in Nigeria. The results showed that their profit efficiency were positively influence by age, educational level, farming experience and household size.

Ogunniyi (2011) also examined the profit efficiency among Maize farmers in Oyo State of Nigeria using the stochastic translog profit frontier approach. A multi-stage sampling technique was used to collect a cross-sectional data from 240 maize farmers from four agricultural zones; Ibadan/Ibarapa, Oyo, Ogbomoso and Saki using a structured questionnaire. The results showed that profit efficiency varied widely among the sampled farmers, ranging from 1 percent to 99.9 percent with the mean efficiency of 41.4 percent. The mean efficiency suggested that there exists room to increase profit by improving the technical and allocative efficiency among the farmers. The Author identified education, experience, extension and nonfarm employment as factors statistically influencing the profit efficiency significantly in the study area. The author concluded that the policy implication of these finding inefficiency in maize production can be reduced significantly by improving the level of education among the farmers and awareness by extension agents.

Jarbar *et al*. (2006), investigated the policy and scale factors influencing efficiency in dairy and poultry production in Bangladesh where they zero in on profit efficiency level determination using the normalized translog functional form. A cross-sectional data of 120 layer farmers were used. The result showed that, feed cost, veterinary cost, labour cost and land holding have a positive effect on the profit level. The authors found flock size, contact with extension and veterinary service and contract with the buyer to have a positive impact on the profit efficiency of the layer producers in the Bangladesh.

Olumayowa and Abiodun (2011) examined the profit efficiency and poultry waste management in Egba division of Ogun State, Nigeria, using translog stochastic frontier profit function approach. A data was collected using a simple random technique using a structured questionnaire from 72 poultry farmers. The result showed that cost of birds' stock, labour and feed were positive and significant implying that additional cost to use more of these variable would lead earn higher profit that is profit efficiency. Medical cost had a negative coefficient and significant indicating that medical cost had a declining effect on amount of profit made. The authors argued that this may be as a result of high cost of drugs and veterinary services. The result further showed that the mean profit efficiency of the poultry producers in the study area is 68.44 percent indicating that there is opportunity to still increase profit by 31.6 percent if technical, allocative and scale efficiencies are improved upon. The authors identified age and sex as factors that contributed significantly to inefficiency in poultry farming and had experience and education significantly contributing to the reduction of the profit inefficiency in the study area. The authors concluded that the livestock farmers should be trained through workshops, conferences and extension services on the conversion and ultilization of livestock waste or manure. It was recommended that government should reduce import on poultry drugs so as to enhance increased production and profitability. In this paper the authors failed to find out the interactive effects of farmers age and experience on the profit efficiency.

Ali and Flinn (1989) analysed profit efficiency among Basmati Rice Producers in Pakistan Punjab, using a stochastic frontier profit function. Random sampling technique was adopted to collect a primary data from the 120 Rice Farmers from the administrative unit comprising of 60 farmers from two villages which were near the main trunk road and the other far from the trunk road. The author estimated both the Ordinary Least Square and Maximum Likelihood Estimation for the profit functions. The result showed that the mean level of inefficiency at farm resources and price levels was 28 percent, with a wide range of 5 percent to 87 percent. Over half (54 percent) of the sampled farmers showed a profit loss of 25 percent or more. The result further revealed that average loss of profit was Rs 1,222 per hectare cultivated. Authors identified farm household's education, off-farm (non-agricultural) employment, and credit constraint as socioeconomic factors influencing profit loss. Water constraint and late application of fertilizer as the institutional determinants of profit loss. It was further revealed from their study that farmers with easier access to information such as extension services and fertilizer depots, greater market access, better health because of health dispensary and have reduced water price were comparatively operating at the higher efficiency. The authors concluded that a 25 percent reduction in profit loss among Basmatic rice producers may generate over Rs

240 million of extra profits each rice season. These authors fail to use the full translog function because the authors deleted from the model the number of variables that lacked significance for example the dummy variables and their interaction terms that were specified in the model earlier, interaction between wage rate and other variables were also deleted from the results presented.

Nganga *et al.* (2010) estimated the production efficiency of smallholder milk producers in Meru south district of Central Kenya using a stochastic profit frontier and inefficiency model in their study. Integrated modelling platform for mixed animal crops systems (IMPACT) structure questionnaire was employed to collect primary data including four convectional inputs and socioeconomic factors affecting production. Result showed that profit efficiencies of the sampled farmers varied widely between 26 percent and 73 percent with a mean of 60 percent indicating that an estimated 40 percent of the profit is lost due to a combination of both technical and allocative inefficiencies in the smallholder dairy milk production. The authors found level of education, experience, and the size of the farm influenced profit efficiency positively while profit efficiency decreased with age. The authors concluded that profit inefficiency among smallholder dairy milk producers can be reduced significantly with improvement in the level of education of sampled farmers.

Tijani *et al.* (2006) analysed profit efficiency among Nigerian poultry egg farmers focusing on Aiyedoto Farm Settlement using a stochastic profit frontier and inefficiency model. A multi-stage sampling technique was employed to collect primary data from 70 layer farmers, using a structured questionnaire. The result showed that wage, feed cost and cost of drugs were the variables that significantly affect the profit level of the egg farmers. The result further showed that Profit efficiencies of the sampled farmers varied widely between 29.1% and 99.3% with a mean of 84% suggesting that an estimated 16% of the profit is lost due to a combination of both technical and allocative inefficiencies in the poultry egg production. The mean profit inefficiency decreased over time. The results further observed that only level of education positively influenced profit efficiency while on the contrary access to credit led to a decrease in profit efficiency. The authors concluded that profit inefficiency in poultry egg production can be reduced significantly with improvement in the level of education of sampled farmers.

2.7.1 Empirical Review of Profit Efficiency Studies in Ghana

Abdulai and Huffman (1998) examine profit inefficiency of rice farmers in the Northern Region of Ghana employed the stochastic frontier model using the farm-level survey data of 20 rice farmers. The empirical results show that farmers' human capital represented by level of education improves their allocative performance. The author also reported access to credit and greater specialization in rice production had positive effect on production efficiency. He also found out that farmers location in areas with better facilities like extension services and agricultural input delivery systems also tend to exhibit greater production efficiency.

In related study, Abdulai and Huffman (2000) again studied on structural Adjustment and Economic efficiency of Rice Farmers in Northern Ghana employed stochastic profit function model using 37 rice farmers. The authors used LIMDEP, version 7.0 to obtain the Maximum Likelihood estimate of the normalized translog stochastic profit frontier. The authors considered both family and hired labour as labour in their analysis. The empirical results showed mean profit inefficiency of 27.4 percent. The profit inefficiency result further indicated that household head's access to education, access to credit, interaction between credit and education improves profit efficiency.

2.7.2 Statistical Packages Used in the Efficiency Studies

In literature various Statistical packages such as LIMDEP, TSP, Shazam, GAUSS, SAS, and etcetera have been used in estimating stochastic frontier in the area of production and profit frontier. The two most commonly used packages for estimating of stochastic production frontiers and profit frontier are FRONTIER 4.1 (Coelli, 1996) and LIMDEP (Greene, 1995). According to Sena (1999) both packages pointed out that FRONTIER 4.1 is a single purpose package specifically designed for the estimation of stochastic production frontiers, while LIMDEP is a more general package designed for a range of non-standard econometric estimation. One major merit of using FRONTIER is that estimates of efficiency are produced as a direct output from the package. The user is able to specify the distributional assumptions for the estimation of the inefficiency term in a program control file.

2. 8 Conclusion

The review of existing literature has shown that most of the profit efficiency studies use different estimation methods and the most common among them is the stochastic profit function and the maximum likelihood estimation. For profit efficiency studies few researchers used the normalized translog profit function in their estimation. Although profit efficiency literature exist extensively for other countries around the world, only few researchers in Ghana (Abdulai and Huffman 1998 and 2000) attempt research into profit efficiency and even that is on the only rice.

Even though determinant of the profit efficiency such as extension contacts, age of the farmer, experience, education and et cetera is well-established in the literature for different agricultural units none seems to exist to the best of researchers' knowledge for the layer production in Ghana. Also, the gap identified in the literature reviewed was that none of the studies on the profit efficiency went further to find the joint effect of the inefficiency variables (policy indicators) on profit efficiency.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents theoretical framework of efficiency model adopted in this study. It also looks at the methodology used for addressing the various objectives of the study. In addition, it presents the theoretical framework and the analytical models specified for each objective. It also defines the variables in the model, hypotheses of the study and further discusses methods of data collection including sources of data, geographical area of study and selection procedure for respondents.

3.2 Theoretical Framework of Efficiency

3.2.1 Approaches to Measuring Efficiency

From Pioneering study by Farrell (1957), there have been a lot of studies in the area of measuring efficiencies looking at different fields. With reference to the field of agriculture, the modeling and estimation of stochastic frontier approach (SFA), was originally introduced simultaneously by Aigner *et al*. (1977) and Meeusen and Van den Broeck (1977), which has proved to be invaluable. A critical analysis of the frontier literature dealing with farm level efficiency in developing countries conducted by Battese (1992), Bravo-Ureta and Penheiro (1993), Coelli (1995) and Thiam *et al*. (2001), indicated that there were extensive theoretical issues that had to be dealt with in measuring efficiency in the context of frontiers. Some of these included selection of functional forms and their relevant approaches such as parametric and non-parametric.

3.2.2 Theoretical Framework of Stochastic Frontier

This model addressed the weaknesses of the deterministic model by introducing 'v' into the deterministic model to form a composed error term model (stochastic frontier). The error term of the stochastic model is assumed to have two additive components: a symmetric component accounting for pure random factors and a one-sided component that captures the effects of inefficiency relative to the stochastic frontier. The model is specified as follows:

$$Y = f(X_i;\beta)\exp(v_i - u_i), \quad i = 1,\ldots\ldots\ldots, N \qquad (9)$$

where, Y is the level of output for observation, $f(X_i;\beta)$ represents a suitable production function functional form (Cobb–Douglas or translog functional form) and (v-u_i) is error term, with v representing factors which are not under the control of the layer producer (external to the producer) and are assumed to be independently and identically distributed (iid) as N $(0,\sigma_v^2)$; The error term u_i is also assumed to be distributed as a truncation of normal distribution with mean μ and variance δ^2_u; $\{u \sim N(\mu, \delta^2_u)\}$. N represents the number of layer producers involved in the cross-sectional survey of the farms

Stevenson (1980) has shown how the half-normal and exponential distributions can be generalized to truncate normal ($N(\mu, \delta_u^2)$) and gamma distributions, respectively. It is also possible to estimate standard errors and test for hypotheses that the observed inefficiency is not due to farmer's practices only as suggested in deterministic model (Thiam *et al*., 2001). An explicit formula to separate the two component error terms for both half normal distribution and exponential distribution cases were provided by Jondrow *et al*. (1982).

The use of stochastic frontier analysis has merits that include, it control for random unobserved heterogeneity among the firms. The inefficiency effect can be separated from statistical noise. Secondly, by using the stochastic frontier analysis (SFA), the statistical significance of the variables determining efficiency can be verified using the statistical tests. Thirdly, the firm's specific inefficiency is not measured in relation to the ''best'' firm. Hence, SFA is less sensitive to outliers in the sample. The SFA can be extended to include consideration of panel data and time varying technical efficiencies; the extension of the methodology to cost, revenue and profit frontiers; estimation of stochastic input and output distance functions; and the decomposition of the cost frontier to account for both technical and allocative efficiency. These reviews extensions are provided by Forsund *et al*. (1980); Ali and Flinn, (1989) and Coelli (1995). According to Coelli *et al.* (1998), the stochastic frontier is considered more appropriate and has been extensively applied in some efficiency studies in recent years (Oladeebo and Oluwaranti, 2012; Todsadee, *et al*. 2012; Simonyan *et al.* 2011 and Idiong, 2007)

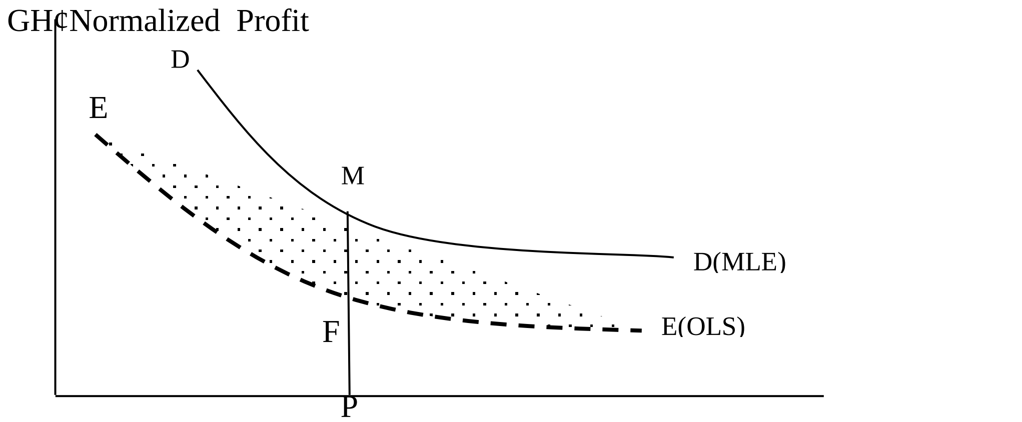
3.2.3 Specification of the Functional Form

The Cobb-Douglas functional form is the most commonly used in estimating the stochastic production frontier. Although its most attractive feature is simplicity, this is associated with a number of restrictions. Most notably, the returns to scale are restricted to take the same values across all firms in the sample, and elasticity of substitution is assumed equal to one. However, more flexible functional forms like the translog production function have been commonly used. The translog form imposes no restriction upon returns to scale or substitution possibilities, but has the weakness of being liable to multicollinearity and degrees of freedom problems (Coelli, 1995b). Therefore the solution to these problems would be to estimate both C-D and Translog, and then use the results of the values of the Log likelihood at the set critical value to reject or accept one model over the other. This study would run both the C-D and translog frontier profit function models.

3.3 The Stochastic Profit Frontier Model

Despite intensive use of a production function approach in literature, it fails to capture inefficiencies associated with different factor endowments and different input and output prices across farms. Under such conditions, the farms may exhibit different optimal points. Lau and Yotopoulos (1971 and1973) argued that a production function approach to efficiency measurement may not be appropriate when producers face different prices and have different factor endowments. This argument therefore popularized the application of the profit function approach, in which farm specific prices and levels of fixed factors are incorporated in the analysis of efficiency. The merit of using this approach is that input and output prices are treated as exogenous to farm household decision making, and they can be used to explain input use. This approach is extensively applied based on the fact that it is a more methodologically flexible tool for analysing various agricultural problems (Pudasaini, 1981)

Figure 3. 1: Frontier MLE and OLS Stochastic Profit Function



Source: Ali and Flinn (1989)

In the framework of frontier literature, DD in Figure 3.1 represents profit frontier of poultry farms in the industry (the best practice firm (layer farm) with the given technology such as the housing type and feeding system). EE represents the average response function (profit function) that does not take into consideration the farm specific inefficiencies. All layer farms that fall below DD are not attaining optimal profit given the prevailing input and output prices in the product and the input markets. They are producing at allocative inefficient point, F in relation to M in Figure 3.1. Hence from the Figure 3.1, the profit frontier for a sampled farms interaction between farm-specific prices (P_j) and the level of fixed factors (Z_j) allows the profit frontier to be farm-specific. In the context of the Figure 3.1 above the profit efficiency is defined as FP/MP. In Figure 3.1, a firm operating at F, is not efficient and its profit inefficiency is measured as 1-(FP/MP) (Ali and Flinn, 1989; Sadoulet and Janvry, 1995).

Profit inefficiency in this framework is defined as profit loss from not operating on the frontier, taking into consideration farm-specific prices and fixed factors. The stochastic frontier approach has gained popularity in its application in empirical firm-specific efficiency studies. The stochastic profit function approach has been applied in rice production in Pakistan Punjab, Bangladesh (Ali and Flinn 1989 and Rahman, 2002 and 2003) and Nigeria (Ogundari, 2006; Wadud and Rashid, 2011), Oladeebo and Oluwaranti (2012) for cassava producers in Nigeria. Galawat and Yabe (2012) for rice in Brunei Darussalam. It has also been applied in Fadama Telfaira, maize and poultry production in Nigeria and other countries (Nwanchukwu, and Onyenweaku, (2007); Ogunniyi, (2011); Effiong and Onyenweaku, (2006); Tijani *et al.*, (2006); Ali and Flinn, (1989); Kumbhakar and Bhattacharya, (1992) and Ali *et al.* (1994). For Ghana, it has been applied for rice farming in Northern Ghana by Abdulai and Huffman (1998) but none have been applied to the best knowledge of the researcher for layer production in Ghana.

Therefore this study adopts Battese and Coelli, (1995) model by postulating a profit function that is assumed to behave in a manner consistent with the stochastic frontier concept. This model is then applied to 300 layer producers using the intensive, deep litter or battery cage systems to determine their profit efficiency levels in the Brong Ahafo Region and Greater Accra Region of Ghana because these producers are being faced with different inputs prices and resource endowments and hence their relative inputs and output prices were used.

Considering a firm that maximizes profits subject to perfectly competitive input and output markets and producing output technology that is quasi-concave in the (n x 1) vector of variable inputs X, and the (m x 1) vector of fixed factors, Z, the stochastic profit function model which is assumed to be ''well-behaved'' can be expressed as:

$$\pi_i = f(P_i, Z_i).\exp \varepsilon_i \tag{10}$$

Where i =1….n is the number of farms in the sample, π_i is the normalized profit of the i[th] farm, computed as gross revenue less variable cost, divided by farm-specific output price; P_i is the vector of variable input prices of the i^{th} farm divided by output price; Z_i is the vector of fixed factor of the i^{th} farm and 'exp' is an exponential function and ε_i is an error term, assumed to behave in a manner consistent with the frontier concept (Ali and Flinn, 1989), that is,

$$\varepsilon_i = v_i - u_i \tag{11}$$

where v_i's are a symmetric random error (noise error) term that is assumed to account for exogenous factors beyond the control of the layer producer e.g. outbreaks of diseases, measurement error, extreme weather, etcetera and also assumed to be independently and identically distributed (i.i.d) as [$N\left(0, \sigma_V^2\right)$] and the u_i's are a non-negative random variable, associated with inefficiency in production, which is distributed as truncation at zero (0) of the normal distribution with mean $\mu_i = \delta + \sum_{d=1}^{n} \delta Z$ and variance $\sigma_\mu^2 = \left(u \sim N(\mu_i, \delta^2{}_u)\right)$ where Z_{di} is the dth explanatory variable associated with inefficiencies on farm i and δ_0 and δ_d are the unknown parameters to be estimated.

The profit efficiency of the farm, i in the context of stochastic frontier profit function is defined as:

$$PE_i = E\left[\exp(-\mu)\middle|\varepsilon_i\right] = E\left[\exp(-\delta_o - \sum \delta_d Z_{di})\middle|\varepsilon_i\right] \quad (12)$$

where, PE is profit efficiency of farmer *i* and lies between 0 and 1 and is inversely related to the level of profit inefficiency. E which is the expectation operator, is achieved by obtaining the expressions for the conditional expectation μ_i upon the observed value of ε_i . The method of maximum likelihood is used to estimate the unknown parameters, with the Stochastic Profit frontier and the inefficiency effects functions estimated simultaneously. The likelihood function is expressed in terms of the variance parameters, $\gamma = {\delta^2}_u / \delta^2$, $\delta^2 = \delta_u^{\,2} + \delta_v^{\,2}$ (Battese and Coelli, 1995).

3.4 Analytical Framework

The analytical framework used for the study was the stochastic profit frontier model developed by Battese and Coelli, (1995) and Rahman (2002). The framework incorporates farmer managerial ability, farm operational factors and environmental factors of layer producers using the intensive production system into stochastic profit frontier model.

3.4.1 Empirical Model Specification for Profit Efficiency Estimation

The empirical model was adopted to analyze the profit efficiency of layer producers using the intensive production system in Brong Ahafo Region and Greater Accra Region of Ghana. This was done by incorporating the profit inefficiency effects in a modified translog Profit frontier model specified as:

$$In\pi_i = \beta_0 + \sum_{j=1}^{6} \beta_j InP_{ji} + 0.5 \sum_{j=1}^{6} \sum_{k=1}^{6} \beta_{jk} InP_{ji} InP_{ki} + v_i - u_i \quad (13)$$

where, In denotes natural logarithm; i denotes the i^{th} farm, π_i normalized gross profit per bird for i^{th} layer farm defined as gross revenue per bird less variable cost per bird divided by farm-specific average price of eggs and spent layer (P_y) and then by the sample mean of the normalized gross profit per bird. $P_{i's}$ are the normalized variable input prices obtained by dividing variable input prices by farm-specific average price of eggs and spent layer (P_y) and by sample mean of the normalized input prices; P_k represents the price of input k used by the i^{th} layer producers(i= j =1, 2, 3, 4,5 and 6); P_6 is the fixed input. β_0,β_i, β_{ik}, β_{im} and β_z are parameters to be estimated. Table 3.1 shows the detail description of the variables in the equation (13).

Table 3. 1: Description of Variables in the Frontier Profit Function Models

Variable	Descriptions	Expected sign
π'	Normalized profit of the j^{th} layer producer defined as gross revenue less variable cost divided by farm specific price (dependent). Note the j is suppressed.	
Variable factors		
P_1	Price of birds stock (for example day-old chicks) normalized by price of output (average price of spent layer and eggs)	-ve
P_2	Price of feed (that feed intake by the birds in a production year) normalized by output price	-ve
P_3	Wage rate of labour (the cost of hired labor and family labour normalized by output price)	-ve
P_4	Drug and Medication price normalized by the price of output	-ve
P_5	the cost of "other inputs" (other inputs; electricity, water, wood shaving, transportation, fuel normalized by price of output	-ve
Fixed factors		
P_6	Capital input(depreciated value of poultry house/ building, equipment) and value of land used in poultry farming	-ve

Note: Man-days calculation in the model was done following Coelli and Battese (1996) rule; one adult male and one female, working for 1 day(8hours) equal to 1 and 0.75 man-days, respectively.

3.4.2 Empirical Model to Estimate Determinants of Profit Efficiency

To explain variations in the profit efficiency levels of sample layer producers in the study area, the factors hypothesized as the determinants of profit efficiency are incorporated into a model as:

$$\mu_i = \delta_0 + \sum_{d=1}^{12} \delta_d Z_{di} \quad (14)$$

where δ is the parameter to be estimated, μ is a non-negative error term that is profit inefficiency effects relative to the stochastic profit frontier, Z is a vector of variables explaining inefficiency effects and δ_0 = constant in equation. The variables included in the inefficiency model in equation 18 are presented in Table 3.2

Table 3.2: Description of Variables in the Inefficiency Model

Variable	Descriptions	Measurement	Expected sign
M	Inefficiency effects		
δ_0	Intercept term		
Z_1	Gender(male=1, female=0)	Dummy	-ve
Z_2	Age of farmer (Primary decision maker)	Years	-ve/+ve
Z_3	Farming experience	Years	-ve
Z_4	Age*Experience (interaction)	Years	-ve
Z_5	Formal poultry farming training/education(specialization) (1=yes, 0=no)	Dummy	-ve
Z_6	Extension contact/visit with(1=yes,0=no)	Dummy	-ve
Z_7	Membership of Farmer Based Organization(FBO)(1=if a member, 0=otherwise)	Dummy	-ve
Z_8	Access to credit (1=access,0=no access)	Dummy	-ve/+ve
Z_9	Housing type (1=deep litter, 0=otherwise)	Dummy	+ve
Z_{10}	Mortality rate	Percentage	+ve
Z_{11}	Land ownership(leased=1,0=otherwise)	Dummy	-ve
Z_{12}	Regional effect(1=Greater Accra, otherwise=0)	Dummy	-ve

3.4.3 Hypotheses Test for Profit Efficiency Model

1. H_o: $\beta_{ij} = 0$; the null hypothesis that Cobb-Douglas(C-D) production function is statistically valid representation of the data (C-D) is an adequate representation of the profit frontier function. The alternative hypothesis is H_A: $\beta_{ij} \neq 0$

Testing the specification of technical inefficiency model would be undertaken by

2. H_o: $\gamma = \delta_o = \delta_1 = \delta_2 =, \ldots, \ldots, = \delta_{12} = 0$; the null hypothesis that inefficiency effects are absent from the model at every level (Each poultry farm is operating on the profit frontier). The alternate hypothesis is H_A: $\gamma \neq \delta_o \neq \delta_1 \neq \delta_2 \neq, \ldots, \ldots, \neq \delta_{12} \neq 0$

3. H_o: $\gamma = 0$; inefficiency effects are non-stochastic. Under $\gamma = 0$, the stochastic frontier model reduces to the traditional average response function (OLS) in which the explanatory variables of the inefficiency model are incorporated into the production function. The alternate hypothesis is H_A: $\gamma \neq 0$

4. H_o: $\delta_o = \delta_1 = \delta_2 =, \ldots, \ldots, = \delta_{12} = 0$; states that the simpler half-normal distribution is an adequate representation of the data, given the general truncated normal distribution that is assumed by the study. The alternate hypothesis is H_A: $\delta_o \neq \delta_1 \neq \delta_2 \neq, \ldots, \ldots, \neq \delta_{12} \neq 0$

5. H_o: $\delta_1 = \delta_2 =, \ldots, \ldots, = \delta_{12} = 0$; states that farm specific factors do not influence the inefficiencies (variables included in the inefficiency effect model have no effect on the level of profit efficiency). The alternate hypothesis is H_A: $\delta_1 \neq \delta_2 \neq, \ldots, \ldots, \neq \delta_{12} \neq 0$

6. H_o: $\delta_{12} = 0$, states that there is no regional effect on profit efficiency of production. The alternate hypothesis is H_A: $\delta_{12} \neq 0$.

The statement of hypotheses above are validated using the generalized likelihood-ratio test, LR which is specified as:

Generalized Likelihood-ratio test, $LR = -2\,[ln\,\{L\,(H_o)\} - ln\,\{L\,(H_1)\}]$ (15)

where, $L(H_o)$ and $L(H_1)$ are values of likelihood function under the null (H_o) and alternative (H_1) hypotheses respectively. The LR has approximately a Chi-square (or mixed Chi-square) distribution, if the given null hypothesis is true with a degree of freedom equal to the number of parameters assumed to be zero in (H_o). Coelli (1995) proposed that all critical values can be obtained from appropriate Chi-square distribution. However, if the test of hypothesis involves γ = 0, then the asymptotic distribution necessitates mixed Chi-square distribution. The critical value for such a test is obtained from Table 1 of Kodde and Palm (1986).

3.4.4 Model for Estimating Profit and Production Input Elasticity

This was achieved by estimating the profit elasticity and converting it into indirect production elasticity. Using the translog function, profit elasticity with respect to various input prices are functions of input prices. Therefore, profit elasticity was obtained by differentiating the translog function with respect to input prices specified in equation (17). However, when the normalized profit and input prices variables have been re-scaled by their respective sample means, the first-order coefficient can be interpreted as elasticity of profit with respect to the different input prices (Coelli *et al.*, 2005, Onumah *et al.*, 2010). Therefore, the first order coefficients of the estimated translog function were only used to explain the extent of effect of changes in input prices on profit levels of layer producers in the study area. To achieve the objective of determining the productivity of various inputs used in production by layer producers, the production elasticity of inputs from the profit function were estimated. Since the profit function is a dual of the production function, the productivity of both variable and fixed inputs used in production can be indirectly estimated (Adeyeye and Akinwumi, 1989; Babatunde, 2004). The identities used were:

$$\beta'_j = -\beta_j^*(1-u^*)^{-1} \qquad (16)$$

$$\alpha'_j = \alpha^*_j(1-u*)^{-1} \qquad (17)$$

where, the parameters β^{*}_{j} and α_{j}^{*} are estimates from the stochastic translog profit function model (17), whiles $\beta_{j}^{'}$ and $\alpha_{j}^{'}$ are the indirect production elasticity for variable and fixed inputs respectively to be estimated. The u^{*} is the summation of the coefficients of all the variable inputs prices in the normalized profit function (the estimates from the model 17 above). The return to scale was computed by summing the indirect elasticity (productivity) estimates.

3.4.5 Identification and Ranking of Constraints

In literature, Kendall's Coefficient of Concordance and the Henry Garrett ranking methods were applied in empirical studies in analyzing constraints. The Kendall's Coefficient of Concordance (*W*) is a measure of the agreement among several (*p*) judges in this case layer producers who are assessing a given set of *n* objects. In the ranking, the factor with the least score is the most important factor to respondents and hence highly ranked. W ranges between 0 and 1 where 0 implies perfect disagreement in the ranks and 1 implies perfect agreement in the ranks. One key limitation to the use of Kendall's Coefficient of Concordance is that, it does not take into consideration heterogeneity in the challenges faced by a population at the individual level. This method is most appropriate for homogenous group who are affected by similar factors.

Garrett and Woolworth (1969) proposed Garrett method of ranking constraints. It is operationalized by presenting a number of factors to respondents to rank in the order of their importance. The ranks assigned to the factors are then computed into percentage positions using the Garrett formula. The converted percentages are compared to the Garrett score table and the corresponding scores for each factor are taken. The various scores for each factor are then aggregated. From the total score, a mean score is computed by dividing the total by the number of respondents who ranked that factor. The mean score are used to tell which factor is more important or predominant. The criterion is that the factor with the highest mean score is the factor that is predominant in terms of importance and in that order.

As opposed to the Kendall's, the Garrett technique is most appropriate in cases of heterogeneous group. Heterogeneity could be caused by location, ecology or by climatic conditions. Thus, the Garrett method allows the respondents to first identify which factor(s) affect them, before ranking these factors. The method provides a means of dealing with missing cases, since respondents are likely not to choose factors which are not relevant to them. It also has an in-built test of agreement approach, where the mean scores are found per those who rank the particular factor. Thus, since all respondents have equal opportunity of identifying and ranking some or all the factors, the final mean score reflects the position of the entire sample. Therefore, the Garrett ranking technique is very useful in making policy recommendations for a diverse population. This ranking technique was used by Manoharan *et al.* (2003) in milk production and Mahanty and Rajendran (2003) in India for ranking egg producers' constraints and Patil *et al.* (2012) in Kartanaka on Cotton. This study therefore employed Garret ranking technique.

Garret's ranking technique was used to rank the constraints to poultry production. For these constraints, the orders of importance given by the respondents were converted into scores by using the formula:

$$\text{Percent position} = \frac{100(R_{ij} - 0.5)}{N_j} \tag{18}$$

where, R_{ij} is the rank given to the i^{th} constraint by j^{th} layer producer and N_j is the number of constraints being ranked by j^{th} layer producer.

The percent position of each rank obtained was converted into scores with the help of the ranking table given by Garrett and Woodworth (1969). The scores of individual constraints are added and the total is divided by the total number of respondents who ranked the particular constraint. The mean scores for the constraints are arranged in the order of their ranks and the constraint with the highest mean score is considered as the most pressing constraint.

3.5 Study Area

This study covers the layer producers using the intensive system of production in the Greater Accra region and Brong Ahafo Region of Ghana. These regions were chosen as a result of their engagement in layer production as indicated by the FAO classification documents and Aning (2006) and Mensah-Bonsu *et al.* (2010). The Greater Accra region was chosen for the study due to the presence of Greater Accra Poultry Farmers Association which is the most vibrant Poultry Farmers Association in the country. The region has a large layer population in the country. The region has a high potential of increasing layer production. Moreover, the region has a large market for the poultry products because of its cosmopolitan nature. Brong Ahafo was chosen because they have larger number of farmers in the layer production and also have easy access to poultry inputs at relatively lower cost because of their location close to the La Cote d'Ivore boarder and vegetation. Moreover, the poultry laboratory was cited in the region to help identify and diagnose diseases in order to reduce the rate of mortality of birds in the layer farms.

Brong Ahafo Region

The study is based on farm level data on layer production in the Brong Ahafo Region. Agricultural activities dominate the micro economic environment of the area especially in the area of livestock; poultry production is most prominent in the region. Crops mainly cultivated are cocoa, teak, oil palm, maize, yam and cassava. Some of the districts such as Sunyani West and Berekum Districts are in the semi-deciduous forest zone, which satisfy the weather requirements for maize production in the Region. This makes the region more conducive for poultry activities because maize forms the major component of poultry feed. Dormaa and Sunyani Municipal are the most dominant areas in the region for poultry production. The region was one of selected regions for the study because layer production is prominent and it is the highest in layer production in Ghana and employs a high proportion of the Labour Force in the region. At the moment the Poultry Industry specifically table egg production is operating at a large scale level. Poultry production in the region is the largest. Generally, there has been an enormous increase in production due to growing interest in the industry. Dormaa has 13 large scale poultry farms.

Greater Accra Region

The region had a total counted population of 4,010,054 in 2010 which accounts for 16.3% of Ghana's total population of the entire country. The region is the second most populated region after the Ashanti region (4,780,380) (GSS, 2012). The Greater Accra region is the smallest of the 10 administrative regions in terms of area, occupying a total land surface of 3,245 square kilometres or 1.4 percent of the total land area of Ghana. The region has 10 districts namely; Dangbe East, Dangbe West, Tema Metropolis, Ashaiman Municipal, Ledzokuku/Krowor Municipal, Adenta Municipal, Accra Metropolis, Ga East Municipal, Ga West Municipal, Weija (Ga South) Municipal (GSS, 2012). The main agricultural activities in the region are livestock/Poultry production, fishing, maize cultivation, cassava production, vegetables, fruits and tree crops. In particular, Greater Accra is one of the regions that favours the production of poultry due to its large population size. Majority of the farms are also located in the peri-urban areas of the region. (www.ghananation.com/Greater Accra). Refer to appendix 2 for the map of the study areas.

3.6 Source of Data Collection and Sampling Technique

A multistage sampling technique was used to collect a cross-sectional data for 2011/2012 production year from the layer producers in nine selected districts in Greater Accra and Brong Ahafo regions using a structured questionnaire. The nine districts comprise four districts from Greater Accra region and five districts from Brong Ahafo region were selected mainly because of their involvement in layer production activities in the two regions.

Purposive sampling technique was used in the first stage to select the two regions. Based on the interview of officials of Ghana Poultry Farmers Association and Regional Livestock directors at MOFA in order to know the districts and communities within which the Layer producers operate, five districts namely; Sunyani West, Dormaa East, Dormaa West, Dormaa Municipal and Sunyani Municipal were purposively selected from Brong Ahafo region and four districts namely; Ga East district, Ashaiman Municipality, Ledzokuku-Krowor Municipality and Ga South in the Greater Accra region because they are the major layer production districts in the two regions. After this stage, the communities within the districts in which layer producers were also purposively selected and visited. The data were collected based on the layer producers' proportion in each districts.

Finally, simple random sampling technique was used to collect the data from layer producers from the list of proportionally selected producers from each districts for a total of 138 layer producers in Greater Accra region and 162 layer producers in the Brong Ahafo region summing up to a total of 300 layer producers in the two regions.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the study. The first part of the chapter presents some of the socio-economic characteristics of the layer producers and summary statistics of the output and inputs variables. Productivity analysis and discussion of empirical regression results, the prediction of profit efficiency estimates and the determinants of profit efficiency and analysis of constraints faced by the layer producers are also highlighted.

4.2 Socioeconomic Characteristics of Layer Producers Sampled

Table 4.1 shows that age distribution of the three hundred (300) layer producers interviewed in the study area (Brong Ahafo and Greater Accra regions) ranges from 20 to 73 years with mean age of 46 years. This indicates that there is a wide gap between the ages of the producers. Out of this, majority (40.7%) of layer producers fall between the age group of 40-49 years. About 27.7% of layer producers are between the ages of 50-59 years, followed by 19.3% falling between 30-39 years. About 7.7% of the layer producers interviewed fall between 60-69 years, 3.3% between 20-29 years and the least (1.3%) percentage of the layer producers falling within the age category of 70 and above years. The result depicts that layer production is done by both the young producers and old as well but relatively larger proportion (63.3%) of the producers are below 50 years and the rest 36.7% are 50 years and above in both study areas. This therefore implies that layer production is relatively dominated by middle-aged people as confirmed by the mean age of 46 years in the study area. The possible reason may be that as layer production requires more capital (capital intensive) middle-aged men and women might have accumulated enough capital for investment and are in addition quite energetic and can undertake some rigorous farm operation as noted in Mukhtar (2012).

Table 4. 1: Socio-economics Characteristics of the Respondents

Socioeconomic Variable	Item	Frequency	Percentage
Age	20-29	10	3.3
	30-39	58	19.3
	40-49	122	40.7
	50-59	83	27.7
	60-69	23	7.7
	≥70	4	1.3
	Mean	45.91	
	Minimum	20	
	Maximum	73	
Gender	Male	252	84
	Female	48	16
Marital status	Single	34	11.3
	Married	258	86
	Divorced	2	0.7
	Separated	4	1.3
	Widowed	2	0.7
Religion	Christian	266	88.7
	Muslim	32	10.7
	Traditionalist	2	0.7
Educational Level	No schooling	7	2.3
	Primary school	5	1.7
	JHS/Middle school	101	33.7
	SHS/TS/VS	104	34.7
	Tertiary	83	27.7
Farm ownership	Solely owned	275	91.7
	Family	20	6.7
	Association/group	5	1.7
Occupation status	Full time	201	67
	Part-time	99	33
Training in Poultry farming	No	43	14.3
	Yes	257	85.7
Extension contact	No	101	33.7
	Yes	199	66.3
Farming experience	1-10	210	70
	11-20	62	20.7
	21-30	24	8
	>30	4	1.3
	Minimum	1	
	Mean	9.68	
	Maximum	43	

Source: Author's field survey data, 2013

The results show that 84% of the producers are male with the rest 16% being female indicating that layer production in the study areas is mainly male dominated. This finding is in consonance with that of Mukhtar (2012) who also had a similar results among the poultry-egg producers in Bauchi State, Nigeria and argued that the result is expected given the drudgery nature, physical and energy demands as well as the capital intensive nature of investment required to establish such a venture.

From Table 4.1, it was indicated that majority of the layer producers were married, about 11.3% were single, 1.3% were separated and the rest were divorced some of who are widowed. On religion, majority (88.7%) of the layer producers are Christians, about 10.7% are Muslims and the rest are traditionalist. This result implies that, Christians dominate the layer production in the study areas.

Most (34.7%) of the layer producers have had their educational level up to either Senior High School or Technical or Vocational School. About 33.7% had their educational level up to Junior High School level/Middle School level, 27.7% of the producers interviewed had their educational level up to the Tertiary level which comprises Training Colleges, Polytechnic, and Universities. Approximately 1.7% of the layer producers had their educational level up to Primary school and the remaining 2.3% did not have any formal education. According to Alhassan (2008), the achievement of the frontier output requires that the producers have some adequate formal education to understand and use modern methods of farming. However, since most of them have low level of education, it implies that there is the need for intensive training on recommended practices aided by demonstrations for effective and efficient application of the improved methods of farming.

On poultry farm ownership, it was realized that majority (91.7%) of the layer producers owned their farms solely or individually, 6.7% of the layer producers' farms were owned by the family and the rest 1.7% of the layer producers' farms were owned by an association/groups/partnership in the study areas. This could imply that farms individually owned and operated may tend to perform or be managed better than those owned by groups especially when it comes to implementation of innovative technologies as asserted by Onumah *et al*. (2010).

It was found that majority (67%) of the producers were into layer farming as their major or full time business whilst the rest 33% were into it on a part-time basis. Having majority of the producers being into full time farming is a good indication that producers will give maximum attention to the layer production activities and this would enhance productivity leading to high profit. A similar explanation was given by Onumah *et al*. (2010) in their work on fish farmers. However, producers who are into layer production on part-time, engaged in other working activities such as government work (salary works) such as security service (policing, immigration services and etcetera), teaching, civil servant, driving, and in other jobs such as trading, crop farming, artisans and as such have employed care takers to man the farms on their behalf.

On degree of specialization with regards to skills acquisition, it was found that majority (85.7%) of the producers had formal training in the layer farming whilst the rest 14.3% had no formal training in layer farming activities but had to learn on the job.

Table 4.1 shows that majority (66.3%) of the layer producers received extension advice and the rest 33.7% did not receive extension visit at all. This is good because extension agents assist in the diffusion and adoption of new technologies which is important because it is geared towards the achievement of the frontier output since it enables them to apply the best farming practices through extension or veterinary advisory services offered them and this could help increase poultry production and promote profit efficiency of the layer producers (Abdulai and Huffman, 1998).

Farming experience on the part of producers ranges from 1 to 43 years. Majority (70%) of the producers have farming experience between 1-10 years. About 20.7% of the producers have farming experience between 11-20 years. About 8% have 21-30 years of experience and the rest of producers have farming experience above 30 years. The average layer farming experience is 10 years. The longer the years of layer farming the more exposed the farmer becomes and the more efficient he is expected to be (Nwaogu, 2006).

The minimum household size is 1 and 53 as a maximum while the mean is 6. The household size comprises not only the biological children of the farmer but also the non-biological children of the farmers. It is captured as the number person the farmer look after. Referring to Table 4.2, a majority (55.3%) of the producers, have household size between 1-5 person(s). About 40.3% of the respondents have household size which ranges from 6-10 people, followed by 2.3% having their household ranging from 16 and above and the rest have their household size ranging from 11 to 15 people. The average household size indicates that layer producers are characterized by large family size.

For membership of farmer-based organisations farmers who are members benefit with regards to producers sharing their ideas and good practices as this is believed to enhance the sharing of information on improved technologies through interactions as well as easing inputs acquisition and utilization constraints faced by decision makers (Kebede, 2001). It can be seen from Table 4.2 that majority (70%) of the producers belong to Farmer Based Organization whilst the rest thirty percent (30%) do not belong to any farmer based organization or association.

For land ownership, it has been revealed from Table 4.2 that a large proportion (64%) of the producers own the land under production through purchase, followed by 34% of the producers owning their land through lease (rent) and the rest 2% were using government lands given to them at free of charge under the Youth in the Agricultural Program. Producers rarely had access to credit for layer production during the 2011/12 production year. About 72.3% of layer producers did not have access to credit while only 27.7% of the producers did access credit either from banks, relatives or friends. Their reason being that interest rate charges are too high and the demand for collaterals and in some cases farmers fulfilling the requirement of being bank customers for some specific number of years made by the banks serve as bottlenecks in credit acquisition.

With regards to the number of birds stocked, it was realized that majority (75.7%) of the producers are operating on small-scale with their bird population ranging from 50-5000, followed by the medium scale (with total birds stocks ranging from 5001-10000) with 14% and the rest 10.3% being large scale having a total bird stock above 10000 birds. This classification was done according to the work of Aning (2006). The minimum stock of birds from the study is 150 birds and maximum of 183,000 with the mean being 5659 birds. This implies that most of the layer producers in the study areas are operating on a medium-scale.

Taking the average weight of birds at the first lay, the minimum weight of the layer bird at the laying point is 1.20 kilogram and maximum weight been 1.90 kilogram with the mean weight been 1.72kilograms. It was realized that majority (98%) of the birds are having their weight ranging from 1.60-1.90 kilograms and the rest 2% had their weight ranging from 1.20-1.50 kilograms.

In the study area, it was revealed that it takes a minimum of 16 weeks for the layer bird to start dropping or laying and the maximum of 24 weeks. On the average it takes almost 19 weeks (18.76 weeks) for a layer bird to start laying. It was also realized that majority (45.3%) of the sampled farms' birds takes 18-19 weeks to start laying, followed by 26% of birds taking 20-21 weeks to start laying. About 20.7% of producers' birds take 16-17 weeks to start laying and the rest takes above 21 weeks to start laying or dropping eggs.

For mortality rate of the birds, it was realized that there was high level of mortality among the birds in the study area. About 0.1% was the minimum mortality rate and the maximum of 38% of the total bird stock with the average of 6.48% which is more than the allowable mortality rate of (5%) among the layer birds. Majority (70%) of the mortality rate of the birds in 2011/2012 production year fell within the range of 1.1-10.1% followed by 14% representing the range of 10.2-20.2% mortality rate. About ≤1%

mortality rate was the third order with 11.67% of the layers followed by 3% of the birds falling within 20.3-30.3% and the least percentage of 1.33% of the producers recording mortality rate of their birds >30.3% mortality. As shown in Table 4.2.

Table 4. 2: Other Socio-economics Characteristics of the Respondents

Socioeconomic Variable	Item	Frequency	Percentage
Household size	1-5	166	
	6-10	121	
	11-15	6	
	≥16	7	
	Minimum	1	
	Mean	5.97	
	Maximum	53	
FBO membership	Member	210	70
	Not member	90	30
Land ownership	Purchase	192	64
	Lease	102	34
	Government	6	2
Use of credit	Yes	83	27.7
	No	217	72.3
Birds stock	50-5000	227	75.7
	5001-10000	42	14
	>10000	31	10.3
	Minimum	150	
	Mean	5658.69	
	Maximum	183000	
Average body weight at first lay	1.20-1.50	6	2
	1.60-1.90	294	98
	Minimum	1.20	
	Mean	1.72	
	Maximum	1.9	
Number of weeks start laying	16-17	62	20.7
	18-19	136	45.3
	20-21	78	26
	>21	24	8
	Minimum	16	
	Mean	18.76	
	Maximum	24	
Mortality rate of the birds (%)	≤1	35	11.67
	1.1-10.1	210	70
	10.2-20.2	42	14
	20.3-30.3	9	3
	>30.3	4	1.33
	Minimum	0.10	
	Mean	6.48	
	Maximum	38	
Type of housing	Battery cage	8	2.7
	Deep litter	288	96
	Battery cage/deep litter	4	1.3

Source: Author's field survey data, 2013

This high mortality rate may be due to high stocking capacity of the birds, mismanagement of the poultry birds, poor feeding, inappropriate application of vaccines and drugs in times of diseases outbreak and et cetera. For the type of housing being used by the producers, it was realized that majority (96%) of the layer producers use only deep litter, about 2.7% of the producers only battery cage housing system and the rest 1.3% of the producers both the battery cage and deep litter system of housing.

4.2.1 Summary Statistics of the Normalized Output and Input Variables Used

The summary statistics of output and input variables used in the layer production are presented in Table 4.3.

Table 4. 3: Summary Statistics of Output and Input Variables Used in the Layer Production

Variable	Unit of Measurement	Minimum	Mean	Maximum	Std. deviation
Profit	Ghana cedi(GH¢)/bird	1.0682	2.6345	9.4971	1.1701
Price of DOC	Ghana cedi(GH¢)/bird	0.1176	0.2644	0.4459	0.0605
Price of Feed	Ghana cedi(GH¢)/bird	1.3186	5.6947	9.2723	1.3026
Price of Vaccine &Medicine	Ghana cedi(GH¢)/bird	0.0444	0.0635	0.0795	0.0059
Wage of Labour	Ghana cedi(GH¢)/bird	0.0121	0.2676	1.1818	0.1830
Other operating cost	Ghana cedi(GH¢)/bird	0.3849	1.1328	3.1453	0.3272
Capital input	Ghana cedi(GH¢)/bird	0.1972	2.0470	13.0910	1.9357

Source: Author's field survey data, 2013

Output is measured as profit earned at the end of the production year, in Ghana cedi per bird. The results indicate a wide variation in profit earned by the layer producers, ranging from a minimum of GH¢ 1.07 to GH¢ 9.49, and the mean profit earned per bird is GH¢2.63**,** means that most of the layer producers produce below the maximum profit per bird. This might be due to inefficient methods of farming at the given technology. The profit gap between the mean and the minimum profit is GH¢ 1.57 per bird, and that between the mean and the maximum profit is GH¢ 6.86 per bird. This also suggests that there is potential for increasing the mean profit per bird of layer production in the study area.

4.3 Testing of the Hypothesis

The results of the various tests of hypotheses for the statistical validity of the dataset and the adequacy of the specified stochastic frontier profit function and inefficiency models using the generalized likelihood ratio test are presented in Table 4.4.

Table 4. 4: Hypotheses Tests for Model Specification and Statistical Assumptions of Stochastic Frontier Model

Null Hypothesis	Test statistic (λ)	Degree of freedom	Critical Value	Decision
1. H_0: $\beta_{ij} = 0$	306.38***	21	38.93	Rejected H_o
2. H_0: $\gamma = \delta_0 = \delta_1 = \delta_2 =,..,= \delta_{12} = 0$	306.07	14	23.06 [a]	Rejected H_o
3. H_0: $\gamma = 0$	3.88	1	2.71 [a]	Rejected H_o
4. H_0: $\delta_0 = \delta_1 = \delta_2 =,. ,.,= \delta_{12} = 0$	303.08***	13	27.69	Rejected H_o
5. H_0: $\delta_1 = \delta_2 =,\dots,\dots,= \delta_{12} = 0$	296.71***	12	26.22	Rejected H_o
6. H_0: $\delta_{12} = 0$	-0.47***	1	6.64	Accept H_o

[a]Critical value at levels of 0.05. Values with *** are tests of one sided error from the frontier output and 1% significant level. The correct critical values for the test of hypothesis involving **γ** are obtained from Table 1 of Kodde and Palm (1986,p. 1246).

The first null hypothesis which specifies that the Cobb-Douglas functional form is a valid representation of the data is rejected in favour of the translog functional form. The rejection of the null hypothesis at 1% significance level means that the translog functional form is an adequate representation of the data. From Table 4.4, the result for the second null hypothesis that specifies that the profit inefficiency effects are absent in the model at every level, that is layer producers are efficient and have no room for efficiency growth was rejected in favour of the alternative hypothesis meaning that there is profit inefficiency among producers in layer production. Thus, the inclusion of the profit inefficiency model is significant addition to the estimation.

The third hypothesis which specifies that inefficiency effects are not stochastic was rejected. This validation is strongly confirmed by the high value of gamma (γ) equal to 0.999, which is statistically different from zero. Hence, the traditional average (OLS) function is not an adequate representation for the data. The fourth hypothesis that the intercept term and the coefficients associated with socio-economic and farm specific characteristics in the profit inefficiency model are zero (the inefficiency effects are half normally distributed) was also rejected. The fifth null hypothesis that the farm-specific profit inefficiencies are not affected by farm specific factors (explanatory variables/characteristics) included in the inefficiency model was also rejected meaning that the variables present in the inefficiency model have collectively significant contribution in explaining profit inefficiency effects for layer producers, although individual effects of some variables may not be significant. Thus, the explanatory variables in the profit inefficiency model do contribute significantly to the explanation of profit inefficiency for the sampled producers. This implies that the joint effects of these variables on profit inefficiency are statistically significant.

The sixth null hypothesis that there are no regional effects on profit efficiency was accepted. This means that there is no locational effect on the profit efficiency of the layer producers in the study areas. This may be as result of the extension agents being mobile and effective in delivering their services to the layer producers.

4.4 Maximum Likelihood Estimation (MLE) for Stochastic Profit Frontier

The estimates of the stochastic translog profit frontier model are presented in Table 4.5. However, discussion is done using the profit elasticity presented in Table 4.6.

Table 4. 5: Maximum Likelihood Estimates of the Stochastic Profit Frontier Model

Variables	Parameters	Coefficients	Standard Error	t-ratio
Constant	β_0	0.5541***	0.1334	4.153
LnPrice of Day-Old Chick/bird	β_1	0.0936*	0.0714	1.311
LnPrice of Feed/bird	β_2	-0.6215***	0.0507	-12.21
LnPrice of Medicine/Vaccines/bird	β_3	0.6626***	0.1923	3.445
LnWage of Labour/bird	β_4	-0.0838***	0.0193	-4.354
Ln Othercost/bird	β_5	-0.0407	0.0486	-0.838
LnCapitalcost	β_6	0.0447**	0.0235	1.902
0.5(LnPDayOldChick)^2	β_7	0.3531	0.3045	1.159
0.5(LnPFeed)^2	β_8	-0.4234***	0.1636	-2.588
0.5(LnPMedicine/Vaccines)^2	β_9	2.7309	2.4361	1.121
0.5(LnWage of Labour)^2	β_{10}	-0.0379	0.0462	-0.821
0.5(LnOthercost)^2	β_{11}	0.1256	0.1307	0.961
0.5(LnCapitalcost)^2	β_{12}	0.0223	0.0373	0.599
LnPDayOldC*LnPFeed	β_{13}	0.2531	0.2238	1.131
LnPDayOldChick*LnPMedicine/Vaccines	β_{14}	-0.8606	0.6951	-1.238
LnPDayOldChick*LnWageofLabour	β_{15}	0.0950	0.1051	0.904
LnPDayOldChick*LnOthercost	β_{16}	-0.1458	0.2153	-0.677
LnPDayOldChick*LnCapitalcost	β_{17}	-0.0052	0.0738	-0.071
LnPFeed*LnPMedicine/Vaccines	β_{18}	0.4761	0.5508	0.865
LnPFeed*LnWageofLabour	β_{19}	0.2056**	0.0915	2.246
LnPFeed*LnOthercost	β_{20}	0.2579*	0.1830	1.409
LnPFeed*LnCapitalcost	β_{21}	0.0324	0.0698	0.464
LnPMedicine/Vaccines*LnWageofLabour	β_{22}	-0.3372	0.2836	-1.189
LnPMedicine/Vaccines*LnOthercost	β_{23}	-0.6753**	0.3018	-2.237
LnPMedicines/Vaccines*LnCapitalcost	β_{24}	0.1067	0.2056	0.512
LnWageofLabour*LnOthercost	β_{25}	0.0933	0.0881	1.059
LnWageofLabour*LnCapitalcost	β_{26}	0.0445*	0.0324	1.373
LnOthercost*LnCapitalcost	β_{27}	0.0789	0.0659	1.197
Sigma squared	ζ^2	0.0378***	0.0020	18.788
Gamma	γ	0.9999***	0.0081	123.635
Log-likelihood		70.769		

Source: Author's field survey, 2013 *, **, and*** = statistically significant at levels of 10%, 5% and 1% respectively.

The estimated sigma square (ζ^2) parameter (0.0378) in the stochastic profit frontier function is significantly different from zero at 1%, indicating a good fit of the model and the correctness of the specified distributional assumptions. The estimated gamma (γ) parameter (0.999) is significant at 1% meaning that, the profit inefficiency effects are significant in determining the level and variability of layer production in the study area. The observed variations in profit efficiency among the layer farmers are due mainly to differences in farm practices and characteristics of sampled layer farmers rather than random factors.

4.4.1 Estimated Profit Elasticity with respect to Inputs Prices

The estimated elasticity parameters of variables with respect to gross profit of layer producers reveals that the five out of six independent variables are significant. These show relative importance of these variables to profit. Table 4.6, reveals the profit elasticity with respect to various input prices and capital inputs used. These profit elasticities are directly obtained from the coefficient estimates of the profit frontier model.

Table 4. 6: Estimated Profit Elasticity with Respect to Input Prices

Variables	Profit Elasticity
Price of Day-old Chicks/bird	0.0936*
Price of Feed/bird	-0.6215***
Price of Medicine/Vaccine/bird	0.6626***
Wage of Labour/bird	-0.0838***
Other cost/bird	-0.0407
Cost of capital inputs	0.0447**

Source: Author's field survey data, 2013; *, ** and *** represent 10%, 5% and 1% significant levels respectively

The profit elasticity with respect to price of day-old chicks and price of medicine/vaccines have a positive and significant relationship with profit which has not met the a-priori expectations.

The profit elasticity of price of Feed, and Wage rate (both hired and family) had a negative and significant relationship with gross profit of the layer producers with price of feed being the most important variable decreasing gross profit of the producers in the study areas. This implies that one percent increase in the price of feed would lead to 0.6626% reduction in the profit level of the layer producers. This finding is consistent with that of Effiong and Onyenweaku (2006) and AL-Masad (2010) who also found a strong negative relationship between the price of feed and profit.

An increase in the amount of money invested into layer production in the form of capital input that is through land acquisition, building of housing equipment translates to the higher returns. The profit elasticity of capital input is positive and significant but has not met the a-priori expectations. However, this finding is consistent with the findings of Effiong and Onyenweaku (2006) who also found a positive relationship between capital cost and profit.

4.5 Indirect production Elasticity (Productivity) Estimates of Inputs Used

The results of the indirect elasticity of production with respect to the variable factors are presented in the Table 4.7.

Table 4. 7: Indirect Production Elasticity Estimates of Inputs used (Productivity of inputs)

Production Factors (Variables)	Indirect Elasticity estimates
Variable factor	
Day-old Chicks/bird	0.0946*
Feed/bird	0.6279***
Medicine/Vaccine /bird	0.6694***
Labour/bird	0.0847***
Other cost/bird	0.0411
Fixed factor	
Capital inputs	0.0452**
Indirect Input Elasticity (RTS)	1.5629

Source: Author's field survey data, 2013.

From Table 4.7, the estimate of the elasticity of output is highest with respect to Medicines/Vaccines (0.6694), followed by feed with 0.6279, day-old chicks with 0.0946, labour with 0.0847, capital inputs with 0.0452 and other cost of 0.0411. All the input factors contribute positively to output.

The positive estimate for medicine/vaccine indicates that an increase in the use of this input increases layer output. Layer production involves high level of risk and for the producer to achieve minimal mortality requires that medication is provided to protect the layer against disease and pathogen attacks. The 0.67 indirect production elasticity estimate which is highest contributor to output in this study implies that a 1% increase in the amount of money spent on medicine/vaccines per bird would result in 0.67% increase in layer output. This results agree with the findings of Alabi and Aruna (2005); Ohajianya (2005) and Adepoju (2008) who also reported a positive and significant relationship between medicine/vaccine cost and output in their respective poultry efficiency studies in Nigeria.

The study also found positive relationship between feed input variable and layer output with feed being the second highest to have a positive impact on layer output indicating that increase in feed used per bird would lead to an increase in the layer output. The indirect production elasticity estimate for feed implies that a 1% increase in the feed usage will increase layer output by 0.63%. Feed is absolutely a necessary resource in layer production and that increasing its usage is expected to increase layer output. Apart from its quantity, the quality of feed that contains all necessary nutrients is very important in increasing layer output. This also is in agreement with the study of Alabi and Aruna (2005); Ohajianya (2005); Oji and Chukwuma (2007); Binuomote *et al. (*2008) and Ezeh *et al*. (2012) in their various poultry studies noted a positive and significant response with output.

The quantity of day old chick used had a positive effect on the mature layer output produced by layer producers. The result shows that 1% increase in the quantity of day old chick used will increase layer output by 0.0946%. This result is consistent with Adepoju (2008); Ezeh *et al*. (2012) and Ohajianya (2005) who also found a positive effect on output and argued that the positive sign implied that an increase in the stock of birds would lead to an increase in the level of poultry output. However, this result is contrary to the finding of Ike and Ugwumba (2011) who found negative effect on output. The author argued that as more day old chick are brought to increase stock, mortality rate increases particularly with poor management. He also noted that especially when the stocking capacity is exceeded with the given specific floor space, it could result in a higher mortality.

The positive and significant relationship with quantity of labour (both family and hired) measured in man-days implies that the number of labour man-days used is significant in influencing the number layer output. The result from Table 4.6 shows that 1% increase in the number of man-days of labour usage will lead to 0.0847% increase in layer output. This finding is consistent with the Chowdhury (2010) who also found positive relationship with both family and hired labour and argued that they are each productive.

Other inputs such as water, energy, litter management and transportation are also equally important. Even though it has the positive expected sign it is not statistically significant.

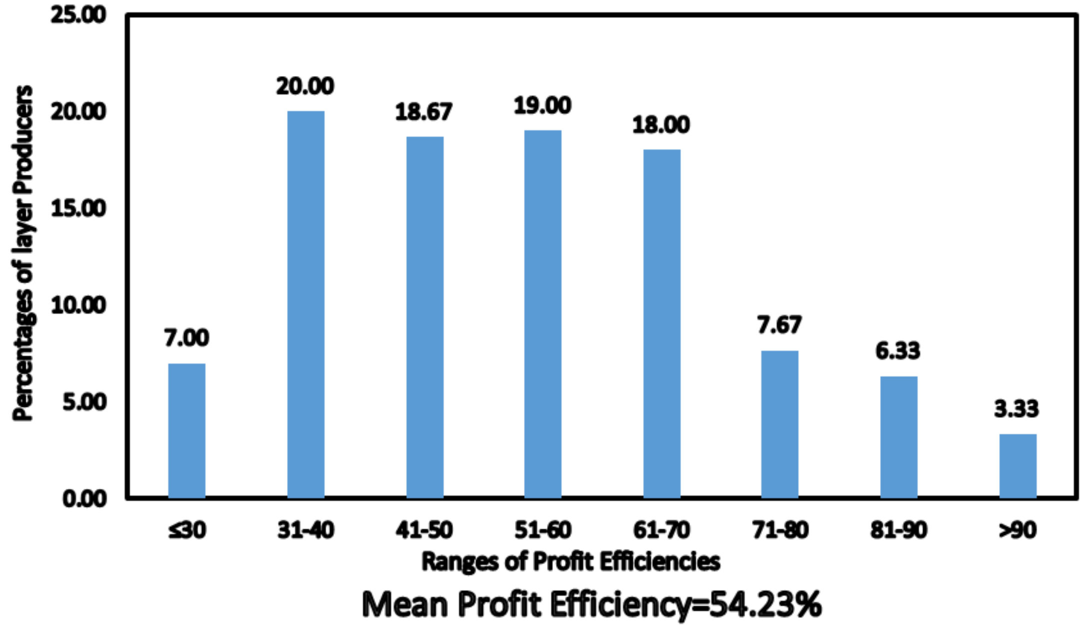
The indirect production elasticity of capital input such as the poultry equipment, housing unit usage has a positive impact on layer output. By this a 1% increase in the capital input use will lead to 0.0452% of layer output. The reason might be because the layer producers are really using their fixed cost input very efficiently so they are not feeling the impact of the fixed cost to reducing their output. This finding concurs with Ohajianya (2005) who also found the positive relationship between capital input and changes in the output of poultry in his study.

The overall return to scale calculated in Table 4.7 is 1.56 implying that layer producers in the study areas given the technology are characterized by increasing returns to scale and are operating at stage one of production. This also means that if the layer producers increase all the input variables by 1%, the layer output will increase by 1.56 %.

4.6 Profit Efficiency Analysis

The study reveals that profit efficiency varies widely among producers, ranging from a minimum of 21.43% to a maximum of 99.97%. The wide variation in the profit efficiency estimates can be associated with differences in efficient allocation and use of inputs among the producers. The mean estimated profit efficiency of 54.23% means that layer producers in the study areas have the scope of increasing their profit by 45.77% by adopting the available production techniques used by the most efficient farmer.

Figure 4. 1: Distribution of Profit Efficiency of Layer Producers



Source: Author's field survey data, 2013.

In Figure 4.1, it is observed that majority (20%) of the layer producers have profit efficiency scores ranging from 31 to 40, followed by 19% of layer producers having their profit efficiency score between 51 and 60. Out of the 300 producers 18.7% have their profit efficiency score ranging from 41 to 50. Eighteen percent of layer producers have their profit efficiency score ranging from 61 to 70. About 7.7% layer producers have their scores ranging from 71-80, followed by 7% layer producers have their scores been less than and equal to thirty. About 6.3% of layer producers have their scores ranging from 81-90. The remaining 3.3% of layer producers have the profit efficiency scores greater than ninety. If the least efficient layer producer is to achieve the efficiency status of the most efficient layer farmer, then that layer farmer must reduce their cost by 78.56%. On average, for a layer farmer to achieve the optimal profit efficiency, he/she must reduce cost by 45.75%. Similar results have been reported by other researchers elsewhere. Tijani *et al*. (2006) worked on poultry (eggs) producers in Nigeria and had a mean efficiency of

84.34%. In Kenya, Nganga *et al*. (2010) carried out work on smallholders' milk producers and obtained a mean efficiency of 60%.

4.6.1 Cross Tabulation of Profit Efficiency Across Region

The profit efficiency estimates are categorized under the two regions and cross tabulation is done across the two regions of the study. The results show that the profit efficiency scores range from a minimum of 21.43% to a maximum of 99.97% with the mean of 54.85% for the layer producers in Brong Ahafo region. For a least efficient farmer to achieve the most efficiency status in the region, the farmer has to reduce his cost by 78.56%. On average, the producers in the region have to reduce their cost by 45.13% in order to achieve the maximum efficiency status in Brong Ahafo region. Table 4.8 illustrates the details of the cross tabulation results of the two regions.

Table 4. 8: Profit Efficiency across the two Regions

Profit Efficiency	**Frequency**			**Percentage**
Range	**Brong Ahafo Region**	**Greater Accra Region**	**Pooled data**	**% of farms**
30	12	9	21	7
31-40	27	33	60	20.0
41-50	30	26	56	18.7
51-60	31	26	57	19.0
61-70	35	19	54	18.0
71-80	11	12	23	7.7
81-90	10	9	19	6.3
>90	6	4	10	3.3
TOTAL	**162**	**138**	**300**	**100.0**
Minimum	21.43	27.87	21.43	
Maximum	99.97	96.66	99.97	
Mean	54.85	53.49	54.23	
	Mean Profit Efficiency is 54.23			

Source: Author's field survey data, 2013

For layer producers located in Greater Accra Region, they have their profit efficiency score ranging from 27.87% as the minimum to 96.66% as the maximum with the average score of 53.49%. For a least efficient farmer to achieve the maximum efficiency status in this region the farmer must reduce his/her cost by 71.17% and on average the producers must reduce their cost by 44.66% to attain the maximum efficiency status in the region. On the basis of their mean profit efficiency, even though the mean profit efficiency of layer producers in Brong Ahafo region appears to be slightly higher than that of Greater Accra region, there is no significant difference between the mean profit efficiencies in the two regions (Refer to Appendix 3 for the t-test). This confirms the acceptance of the null hypothesis that there is no regional effect on profit efficiency levels.

4.7 Determinants of Profit Inefficiency of Layer Production

The signs of the coefficient of these variables are important in explaining the level of observed profit efficiency among the layer producers. A negative sign implies that the variable has the effect of reducing profit inefficiency whilst a positive sign has the effect of increasing profit inefficiency. The result of the sources of the inefficiencies is presented in Table 4.9.

Table 4. 9: Maximum Likelihood Estimates of the Profit Inefficiency Model

Variables	Parameter	Coefficient	Standard Errors	t-ratio
Constant	Z_0	0.8579***	0.0619	13.839
Gender	Z_1	-0.0828***	0.0326	-2.543
Age	Z_2	0.0039**	0.0023	1.752
Experience	Z_3	0.0171**	0.0099	1.713
Age*Experience	Z_4	-0.0003**	0.0002	-1.820
Training in poultry farming	Z_5	-0.1527***	0.0568	-2.687
Extension contact	Z_6	-0.4354***	0.0439	-9.919
Membership of FBO	Z_7	-0.0852**	0.0419	-2.028
Credit	Z_8	0.0138	0.0133	1.038
Housing type	Z_9	0.1065*	0.0719	1.482
Mortality rate	Z_{10}	0.1262***	0.0010	12.265
Landownership	Z_{11}	-0.1435	0.0331	-0.434
Regional effect	Z_{12}	-0.0311	0.0318	0.979

Source: Author's field survey data, 2013 *,**and*** statistically significant at levels of 10%, 5% and 1% respectively

The results show that producers' gender, age, experience, interactive term of age and experience, training in poultry farming, contact with extension service agents, membership of farmer based organization, housing type, and mortality rate are statistically significant in the inefficiency model. With the exception of age, experience, housing type and mortality rate, other significant variables in the inefficiency model were negative and had met the a-priori expectations (Table 4.9).

The result of the age variable is positive and significant at 5% level. This means that older layer producers are more profit inefficient than the younger ones who are progressive and willing to implement new production systems. This finding is consistent with the finding of Abdulai and Huffman (1998), Onumah *et al.* (2010), Onumah and Acquah, (2011), Nganga *et al*. (2010) and Oyebanjo and Otunaiya (2011).

The result of the of experience variable is positive and significant at 5% level. This implies that, layer producers who have more years in the farming business are more profit inefficient than the less experienced ones. This may be so because more experienced producers may tend to rely on their technical know-how and thereby tend to shun any innovative ideas being brought forward. The young ones may tend to learn more and thereby look forward to embracing the new technologies and ideas hence may tend to be more efficient than the older producers. This finding is similar to the finding of Effiong and Onyenweaku (2006), Begum *et al*. (2009) and Onumah *et al.* (2010). However, the finding is contrary to the findings of Rahman (2003), Sharma *et al.* (1999), Adesiyan *et* *al.* (2011) and Mukhtar (2012) who argued that the more experienced the farmer is the more profit efficient the producer becomes.

The estimated coefficient associated with contact with extension service agents is negative and statistically significant, implying that contact with extension service agents by layer producers for advice helps to reduce profit inefficiency. Number of extension visits improves upon profit efficiency significantly at 1%. The use of extension services including advisory services and training of the producers improve upon the farmer's ability to adopt productivity enhancing inputs and utilize them efficiently. This finding is consistent with those of Rahman (2002) and (2003), Alhassan (2008), Ogunniyi (2011), Hyuha (2006) who reported that, access to extension services improved upon the technological know-how of the producers and thereby make them perform significantly better in terms of earning profit and incurring less profit loss and hence operating on the higher level profit efficiency. Kalirajan (1991) explained that extension workers' limited contact with the producers and producers' misunderstandings of the technology were responsible for the disparity in the efficiency output among the producers.

The coefficient of gender is negative and statistically significant at 1%. This implies male layer producers are more profit efficient than their female counterparts. This may stem from the fact that, male producers devote most of their time working on the farm. It may also be due to them having more strength or being more energetic than their female counterpart. This result is in agreement with the findings of Kibaara (2005), Adesiyan *et al.* (2011) and Onumah *et al.* (2010) and Onumah and Acquah (2011) that being a male farmer reduces inefficiency. Onyenweaku and Effiong (2005) had a contrasting result that being a male farmer increases inefficiency.

Membership of farmer based organization has a negative coefficient and is statistically significant at 5% level. This means that, producers that belong to the farmer groups or associations or other groups or cooperative tend to be more profit efficient than their counterpart who do not belong to any other groups. This may be as a result of producers having the opportunity to attend seminars, workshops and other training activities, share ideas, information with other producers on layer production practices through interaction with other producers. These tend to improve upon their technical, allocative and managerial capability and efficiency hence improving their profit efficiency. This finding is similar to the result of Galawat and Yabe (2012), Mukhtar (2012) and Idiong *et al.* (2005).

The coefficient of training in poultry farming is negative and statistically significant at 1% level. This means that producers that have any formal training or have been to seminars on poultry tends to be more profit efficient than those who do not have any training in poultry business. Skills acquisition and enhancement leads to development and thereby make producers understand how to go about the management of their farms. This finding is also consistent with that by Abdulai and Huffman (2000) for rice producers in Northern Ghana. Galawat and Yabe (2012) on profit efficiency in rice production in Brunei Darussalam also had similar results.

The interactive term of age and experience has the negative coefficient and it is significant at 5% level. This suggests that layer producers grow in age and acquire more experience in the layer production, acquire more skills and are able to better manage their resources and so tend to be more profit efficient. At the same time, younger layer producers are ready to take risks and are receptive to new ideas and gain more experience to become more profit efficient. This is because as the producers remain longer in the industry they tend to know how to treat some diseases and symptoms which enables them to notice any such symptoms early in their birds thereby quickly trying to deal with them and by so doing reducing the mortality rate and enhancing their profitability. This has also been noted by Effiong and Onyenweaku (2006) who found age and experience to positively influencing economic efficiency. Onumah and Acquah (2011) also had similar finding among fish farmers in Ghana.

4.8 Major Constraints Affecting Layer Production Identified

The constraints facing layer production were identified from the literature and presented to the layer producers to rank from 1 to 10. The most pressing was assigned 1 and the least pressing assigned 10 and were ranked to know the most pressing and the least pressing constraint using Garrett's Ranking Technique. The results are presented in the Table 4.10.

Table 4. 10: Ranks of Constraints by Layer Producer

Constraint	Garretts' Mean score	Positions
High cost of feed	79.81	1
High cost of medicine and vaccines	56.82	2
Difficulties in accessing subsidized yellow maize	56.61	3
High cost of day old chicks	52.93	4
Poor quality of day old chicks	52.85	5
Inadequate government incentives and policy	49.90	6
Poultry disease outbreak	46.48	7
Difficulties in accessing veterinary services	41.26	8
Competition from imported poultry product	32.03	9
High cost of utilities	29.70	10

Source: Author's field survey data, 2013

From Table 4.10, the high cost of feed was the most pressing constraint with a mean score of 79.81 facing the layer producers in the study areas. This is because the feed ingredients are mostly imported, some are bought from neighbouring countries and also regular fluctuations in the availability of maize annually adversely affect the industry hence results in high prices because of the transportation cost. This is ranked as the first problem because feed is the major input that poultry farmers use hence as the cost increases they cannot buy the required amount to feed their birds on time thereby culminating into low output since the birds are not being given enough feed in order to produce the required output. This finding is similar to past findings of Mahanty and Rajendran (2003), Alabi and Aruna (2006), Olanloye (1998) and Hassan (2002) who also found feed cost to be a major constraint to poultry production in their respective studies.

High cost of medicine and vaccines with a mean score of 56.82 was ranked second. This is ranked second because layers require periodic vaccination and medication which also determines the cost of layer production. Since the supply of medicines and vaccinations to poultry farmers is mostly in the hands of the private sector, they tend to maximize profit by increasing the price of the vaccines and medicines and since these are a necessity to layer production, producers do not have any choice but to buy them resulting in high cost of operation. This finding is in agreement with the findings of Mahanty and Rajendran (2003).

The third constraint was the difficulties in accessing subsidized yellow maize with a mean score of 56.61. This is because yellow maize is an important input in layer production.

Layer producers find it difficult to get the subsidized yellow maize that government has imported into the country in order to augment and reduce their feed cost. This may be due to poor distributional approach leaving the layer producers to buy their feed at higher cost resulting in higher cost of production hence reducing their profit level.

The fourth constraint was high cost of day old chicks with a mean score of 52.93. This is because the producers prefer the imported breeds which are more expensive. Their preference for the imported breeds is also due to the fact that the local breeds mature at a slower rate and are more susceptible to disease outbreaks than the imported ones.

The fifth constraint was the poor quality of day old chicks with a mean score of 52.85. This might be attributed to inability of local hatcheries to supply good and sufficient day-old chicks due to their inability to produce to full capacity and on schedule. Local hatcheries are performing poorly in terms of quality with low standard of hygiene. This consequently leads to poor quality chicks with high mortalities. Additionally, most local hatcheries do not properly sort their day old chicks. Healthy day old chicks are usually mixed with unhealthy ones. This in tend leads to losses through mortality which actually affect the production by reducing the producers' profit. This finding is similar to the findings of Alabi and Aruna (2006).

In the Table 4.10, inadequate government incentives and policy, poultry disease outbreak, difficulties in accessing veterinary services, competition from imported poultry product and the least ranked is high cost of utilities.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of findings, conclusions and recommendations of the study. Section 5.2 gives a summary of the findings in this study, while sections 5.3 and 5.4 present conclusions and recommendations respectively emanating from the study.

5.2 Summary of Findings

This study used normalized translog stochastic profit frontier to assess profit efficiency of layer producers in Brong Ahafo and Greater Accra Regions of Ghana. This was achieved by specifically determining the level of productivity of various inputs used, the profit efficiency level of layer producers, identifying the determinants of inefficiency and ranking constraints. Henry Garrett ranking technique was employed to rank the constraints identified. A total of 300 layer producers were selected from two regions using multi-stage sampling technique. The single stage maximum likelihood estimation which incorporates inefficiency effects was used to identify the profit inefficiency for the layer producers using FRONTIER 4.1 software.

The results of the log likelihood tests showed that Cobb-Douglas model was not the right model necessitating the adoption of frontier translog model. Thus the profit frontier translog model best fit the study. Also the profit inefficiency effects are related to the exogenous variables.

The results also showed that the price of feed, and wage have significant negative effect on the profit efficiency levels as expected and significant at 1% respectively in the study areas. The estimated indirect elasticity for day old-chicks, feed, medicines/vaccines, labour, other inputs and capital inputs costs are 0.0946, 0.6279, 0.6694, 0.0847, 0.0411 and 0.0452 respectively. All the input variables except other input cost variable are statistically significant with feed, medicines/vaccines and labour being statistically significant at 1%. The variable capital input is statistically significant at 5%. Day old chicks is also significant at 10%. The positive coefficients show that a 1% increase in any of these input variables will lead to their respective coefficient increase in layer output. The estimated gamma value of is 0.999 which is statistically significant at 1%, implying that 99.9% of the total variation in layer output in the study area is due to the technical inefficiency. The return to scale demonstrates that the production technology characterizing layer farms exhibits increasing returns to scale.

The findings also show that inefficiency is present in layer production among the producers. The analysis of profit efficiency levels revealed that profit efficiency ranges from 21.43% to 99.97% with an average of 54.23%. The implication of this finding is that there is a great potential for the average layer producer in the study area to increase layer output or profit without changing the existing level of technology, cost of production and resource endowment.

The study also demonstrated that gender, membership of Farmer based organization, contact with an extension agent, formal training in poultry farming and specifically the interaction between age and experience were negatively related with profit inefficiency. This implies that those variables significantly contribute positively to improving profit efficiency. Also the type of housing (meaning the battery cage other types except deep litter) users are more profit efficient than deep litter users.

High cost of feed, high cost of medicine and vaccines, difficulties in accessing subsidized yellow maize, high cost of day old chicks, poor quality of day old chicks and inadequate government incentives and policy, are further identified as the first six most pressing constraints to layer production in the study areas.

5.3 Conclusions

Following the findings of this study, the study concludes that the translog model best fits the data. The estimated indirect productivity of the inputs used indicated that four of the input variables; medicines and vaccines, feed, day old chicks, labour, and capital inputs (poultry houses/buildings, equipment and the land) have a positive impact on layer output meaning that a unit increase in any of the variables would lead to an increase in output. Results based on the coefficients of input variables and the overall productivity of layer production (RTS) indicate that producers are operating in stage one that is the increasing returns to scale region (inefficient stage), which suggests that, there is opportunity to expand output by increasing input use.

The price of feed and labour negatively affect the profit level of layer producers. Therefore for layer farmers to increase their profit level, they have to incur least cost of feed, and labour.

The results further show that layer producers in the study area are operating below the profit efficient frontier and this is largely due to the presence of inefficiencies in the production of layer. The average profit efficiency of 54.3% means that layer producers are not operating on the profit frontier, suggesting that substantial potential exists for increasing layer production with the current technology (housing and feeding systems) and resources available to producers. They can increase their profit by 45.7% through allocative and technical efficiencies.

The result also finds that there is the presence of profit inefficiencies among the layer producers in the study area which is influenced by layer producers contact with extension agents, formal training/education in poultry farming, membership of farmer based organization, gender, the type of housing the farmer is using and joint effect of age and experience of the layer producers. There is therefore a need for appropriate policy recommendations to ensure that layer producers use their available technology to improve upon their resource use in order to enhance their profit level.

The results from producers' rankings of constraints revealed that, high cost of inputs especially feed is the major constraint and high cost of utilities as the least pressing constraint.

5.4 Recommendations

The study recommends that layer producers should be trained by extension agents and other stakeholders to improve upon their efficiency level in order to achieve a higher profit.

It is also recommended that policies directed towards enhancing layer producers' contact with extension service must be pursued by government. The government should also allocate adequate funds to extension service to enable extension agents to undertake field demonstration for the producers and also to train more extension officers. The media (radio stations) should also be equipped through sponsorship to support the efforts of extension service agents.

The study also recommends that more training and workshop programs concerning layer production be organized by Ghana National Poultry Farmers Association and other stakeholders periodically for the layer producers so as to help them improve upon their skills to be more profit efficient. It is also recommended that government and other stakeholders equip the agricultural training colleges in the country. This will help train a lot of new skilled personnel and also build the capacity of the existing ones that would help boost the poultry production in the country.

It is recommended that, extension agents and other productivity enhancing NGO's such as MIDA, Ricerca and cooperative zone, Heifer International, Opportunities Industrialization Centre (OIC), Kindness International, World Vision, and German Technical Cooperation (GTZ) should intensify their services by educating and advising producers to form Associations or groups or cooperatives.

Government should provide an incentive package for the youth to go into layer production. This can be achieved by supporting the youth who are interested in layer production with all the needed inputs and initial capital to help sustain their operations. Also, the poultry section of Youth in Agriculture Programme should be resourced and sustained in order to attract more youth.

Policies that would improve men's access to productive inputs (land, capital and labour), credit and more education should be pursued to increase profit efficiency of layer production.

Producers must reduce mortality rate on their farms by paying critical attention to the bio security and safety measures on their farms. Veterinary officers who would go round periodically to advise them must be given incentive packages (Motorbikes and increase their monetary allowances). These officers should advice on periodic and timely removal of the old litter as well as suggest improved practices of housing system particularly with the battery cages.

The study recommends that policies specifically aimed at reducing the cost of feed, cost of medicines/drugs and cost of day old chicks must be enacted and vigorously pursued by government since this would greatly enhance the competitiveness and profitability of the layer production sector. Also layer producers are also advice by the study to consider alternative way of preparing quality feed at the cheaper cost.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

PROFIT EFFICIENCY OF POULTRY (LAYER) PRODUCERS IN GREATER ACCRA AND BRONG-AHAFO REGIONS OF GHANA

*This research is an academic exercise in a partial fulfilment of the award of the **M. Phil. in Agricultural Economics** at the University of Ghana, Legon. I would be very grateful if you could furnish me with all the necessary answers to the questions stated below. All information provided will be treated strictly confidential and will only be used for study purposes. Thank you.*

Introduction

Name of Enumerator:...................Date of interview........ /........./......District.............

Region: 01=Brong-Ahafo [ ] 02=Greater Accra [ ] Community/Village/Town:………

Telephone number: ……………… Serial Number:………

SECTIONA: Socioeconomics characteristics of the Poultry (Layer) farmer

Name of the poultry (Layer) farm.........................

Q1. Gender of the farmer: 01=Male [ ] 02=Female [ ]

Q2. Age of the farmer: ……years

Q3.MaritalStatus:01=Single[]02=Married[]03=Divorced[]04=Separated[] 05=Widowed[]

Q4. Religion:01=Christian[ ]02=Muslim [ ]03=Traditionalist[ ]04=Others[ ], specify……

Q5. What is your level of education: 01= No schooling [ ] 02=Primary school [ ] 03= MSCL/JHS [ ] 04=SHS/Technical/Vocational [ ] 05= Tertiary [ ] 06=Others [ ], specify…

Q6. Number of years spent to attain that (Q5) level of education........years

Q7. What is the size of your household........person(s)

(a)Adult Male.....person(s) (b) Adult Female… person(s) (c) Children (<18)....person(s)

Q8. How long have you been in the poultry (layer) farming business? ......year(s)

Q9. Have you ever had any formal training in the poultry farming before? 01=Yes [ ] 02=No [ ]

SECTION B: Basic information of poultry farm inputs

Q10. Is poultry (layer) farming your major occupation? 01=Yes [ ] 02=No [ ]

Q11. If No to Q10, which of the following is your major occupation: 01=Farming [ ]02=Trading [ ] 03=Salary Worker [ ] 04=Artisan [ ] 05=Others [ ] specify…

(a) How many days do you work in farm per week…days (b) How many hours per day do you spend working in the farm……

Q12. Did you ever have any contact with extension agents in 2011 production year? 01=Yes [ ] 02=No [ ]

Q13. If Yes to Q12, how many times did you have contact with the extension agent in 2011 production year? Number…

Q14. Did you apply for credit in the 2011 production year? 01=Yes [ ] 02=No [ ]

(a)If No to Q14, specify why you did not apply for the credit?.............

Q15. Did you receive any capital/cash credit (or loan) in the 2011 production year? 01=Yes[ ] 02=No[ ]

Q16. If No to Q15, what was the source of capital (credit) for your production activities? 01=Personalsaving[]02=EarningfromProperties[]03=Donation(Family/Relatives/Friends/ Church)[ ] 04=Others [ ], specify …

Q17. If Yes to Q15, then which of the following sources did you get your credit from? 01=ADB []02=Procredit []03=Commercial Banks(except ADB)[ ]04=Money lenders[] 05=Family/Relatives [ ] 06= Friends [ ] 07=Others [ ], specify…

(a) How much did you receive? (GH¢)…… (b) At what interest rate?........per month

Q18. Land ownership: 01=Purchase [] 02= Lease (rental) [] 03=Share cropping [] 04=Government [ ] 05=Others [ ], specify……

Q19. If Lease (rental) from Q18, how much did you pay as the rental cost of the land annually (GH¢)……

Q20. If Purchase from Q18, how much did you buy the land (GH¢)…… Size…acres

Q21. If Share cropping from Q18, please, indicate the type of the agreement ……

Q22. If Government from Q18, please, how much would you have bought the same piece of land? (GH¢)……

Q23. Ownership of the farm: 01=Solely owned (by farmer only) []02=Family [] 03=Association/Group/ Co-operative/Partnership (share farming) [ ]

Q24. Do you belong to any Association/Cooperative/Farmer Based Organization? 01=Yes [ ] 02=No [ ]

Q25. If Yes to Q24, state the nature of service(s) the FBO renders……

Q26. Which of the following types of housing system did you use in 2011 production year? 01=Battery cage [ ] 02=Deep litter [ ] 03= Both battery cage and Deep litter [ ]

Q27. How many weeks did it take the birds from time of day-old chicks to start laying? …weeks

Q28. What is the average weight of the bird at the first laying …Kg

SECTION C: Production Information on input used

Q29. What was your total stock of birds (number) in 2011………..

Day old chicks	Year bought	Number of birds	Cost per bird(GH¢)
1			
2			

ii.

Type of birds	Quantity(Number of birds)	Unit price (GH¢)
Broiler		
Cockerel		

Q30. What was the total number of your birds that died in 2011 production year?..........

Fixed cost items

Q31. Please indicate quantity (number), year of purchase, cost price, life span and salvage value of the following capital items.

Item	Quantity	Year of purchase	Cost price (GH¢)	Life span(year)	Salvage value(GH¢)	Share of layer production
Tractor						
Pick up						
Saloon car						
Wheelbarrow						
Feeder						
Drinker						
Van						
Coal pot						
Shovel						
Bucket						
Cylinder						
Headpan						
Cutlass						
Hoe						
Latern						
Boot						
Hammer						

others						

Housing cost

Q32. Which type of building did you use in 2011?01=Concrete [ ] 02=Wooden [ ] 03=Both Concrete and Wooden [ ]

Type of housing	Number of units	Unit size(m^2)	Capacity	Unit cost(GH¢)	Year built	Life span	Salvage value
Deep litter							
Battery cage							
Pen							

Q33. How many of these houses did you use in 2011 production year? Number………

Variable cost items

Q34. Feeding cost

i. Which type of feed did you mostly use to feed your birds in 2011 production year? 01=Only Commercial feed [ ] 02=Only Local (Farmer/self-prepared) feed[ ] 3=Mixture of both[ ]

ii. Commercial feed

Type	Weight per Bag(Kg)	Unit Cost per Bag	Quantity per day	Quantity per week	Number of weeks per month
Starter(day1-8wks)					
Grower					
Layer mash					

iii. Local (Self prepared) Feed

Type of feed	Weight(tons)	Cost per tons (GH¢)	Quantity per week	Week per season	Quantity per year
Layer marsh					
Others					

Q35. How long the birds did (layers) lay in 2011?......weeks/……years

Q36. Labour source: 01=Family [ ] 02=Hired Labor[ ]03=Both Family and Hired[ ] 04=Others [ ], specify……

Q37. Poultry activity and labour requirements for 2011 production year

Type / Role of Worker	No. of Worker(s)		Hours in a Day	Cost per Hour (GH¢)	No of days in a Week	Total Hours	Total Amount in a month
	Male	Female					
Hired labour							

Family labour							
Children(s) /Child							

Q38. Water

i Which of the following did you use to measure your water useage? 01=Yellow ('Kuffuor') gallon [ ] 02=Polytanks (600L) [ ] 03=White Tank (250liters) [ ] 04=others[ ], specify……

ii

Type of water	Gallons per day	Cost per gallons(GH¢)	Number of days in a week	Cost/day(GH¢)	Cost/week (GH¢)	Cost/month(GH¢)	Cost/year(GH¢)
Pipe borne							
Well/Borehole							
Rain water							

Q39. Energy

Types of energy	Cost per day(GH¢)	Number of days in week	Cost per week(GH¢)	Cost per month(GH¢)	Cost per year (GH¢)
Electricity					
Generator					
Charcoal					
Gas					

Q40. Veterinary

i. Do you use veterinary services in the production? 01=Yes [ ] 02=No [ ]

ii. If Yes, kindly fill the table below

Service	Number of times per week	Cost per week(GH¢)	Total cost per year(GH¢)
Drugs and Vaccines			
Others			

Q41. Transportation and Administration cost

Item	Unit cost(GH¢)	Cost per week(GH¢)	Total cost per year(GH¢)

Fuel			
Transport fare			
Telephone			
Stationery			
Taxes			
Others			

SECTION D: Revenue/Benefits information

Q42. Revenue from the sale of birds/chicken

Item	Number of birds sold -2011	Price per bird (GH¢)
Layers (spent layer)		
Family consumption		
Gifts (if any)		
Total		

Q43. Revenue from the sale of egg in 2011 production year

Size /grades of eggs	No. of crates of eggs produced/sold per day	No. of crates sold/year	No. of crates consumed by family/year	No. of crates gave out as a Gifts(if any)/year	Price per crate (GH¢)
Extra Large					
Large					
Medium					
Small					
Pullets					
Total					

Q44. Did you sell your poultry droppings or waste? 01=Yes[ ] 02=No [ ]

Q45. If Yes to Q41, how many bag(s) did you sell and at what rate?

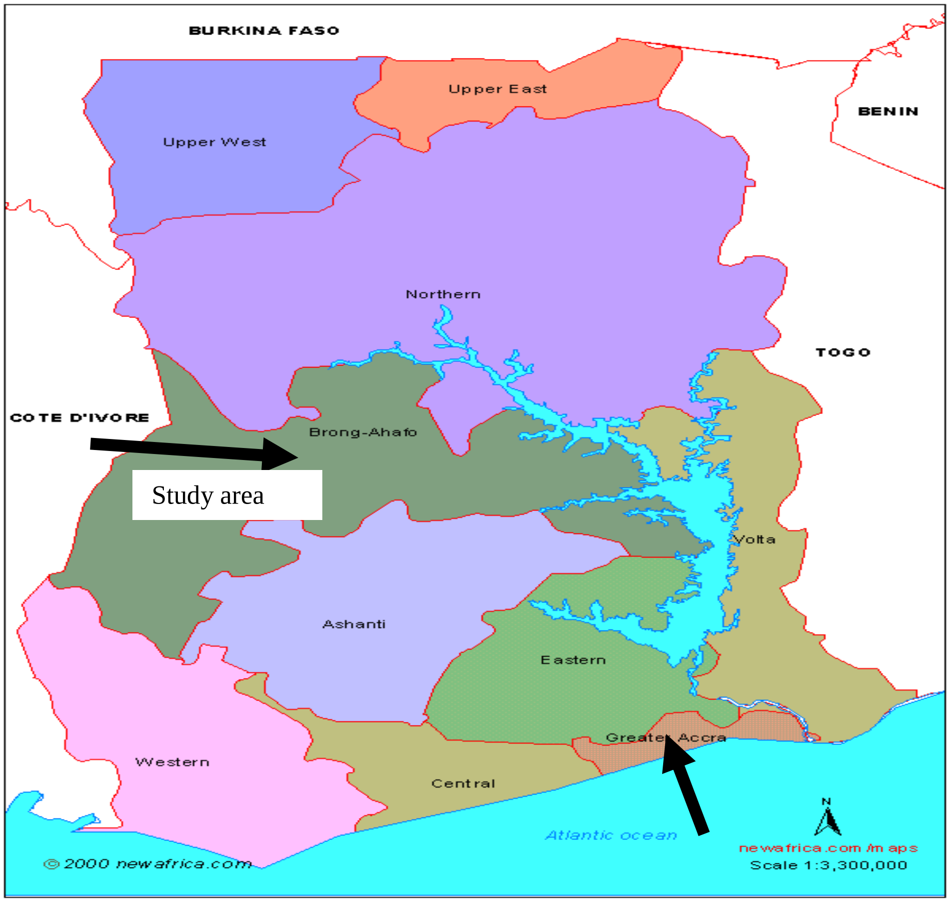
Poultry waste	Quantity(Kg)	Unit price(GH¢)	Total benefit(GH¢)
Feaces			
Feathers			
If Gift			
Self-usage			

SECTION E: Constraints

Q46. Please tick where applicable and rank in order of decreasing severity the constraints you face in poultry (layer) production.

Constraint	**Please tick (if applicable)**	**Position (rank 1, 2,...10 with 1= most severe and 10= less severe)**
High cost of Feed		
High cost of day old chicks		
High cost of medicine and vaccines		
High cost of utility bills		
Competition from imported poultry product		
Inadequate government incentives and policy		
Poultry diseases outbreak Poor quality of day-old chick		
Difficulties in accessing veterinary services		
Difficulties in accessing subsidized yellow maize		
Others(specify)		

APPENDIX 2: MAP OF GHANA



APPENDIX 3: T-TEST FOR PROFIT EFFICIENCY AMONG THE TWO REGIONS

```
----------------------------------------------------------------------------------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\Mawuli\Desktop\MAWULI T TEST.log
  log type:  text
. t-test BA_PE == GA_PE, unpaired

Two-sample t test with equal variances
------------------------------------------------------------------------------
Variable  | Obs   Mean       Std. Err.   Std. Dev.   [95% Conf.  Interval]
---------   +--------------------------------------------------------------------
   BA_PE | 162   54.85242  1.396677   17.7768    52.09425    57.61059
   GA_PE | 138   53.49405  1.509787   17.73598  50.50855    56.47955
---------   +--------------------------------------------------------------------
combined | 300   54.22757  1.024294    17.74129  52.21183    56.24331
---------   +--------------------------------------------------------------------
    diff |               1.358374    2.057116                 -2.68994    5.406688
------------------------------------------------------------------------------
 diff = mean(BA_PE) - mean(GA_PE)                        t =   0.6603
Ho: diff = 0                                degrees of freedom =      298
    Ha: diff < 0               Ha: diff != 0               Ha: diff > 0
 Pr(T < t) = 0.7452        Pr(|T| > |t|) = 0.5096     Pr(T > t) = 0.2548
. exit, clear
```