AN ECONOMIC ANALYSIS OF POULTRY PRODUCTION EFFICIENCY AND MARKETING IN RWANDA

BY

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A thesis

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DECLARATION

This thesis is my original work and has not been presented for the award of a degree in any other academic institution.

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DEDICATION

To my lovely wife, Ange!

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ABSTRACT

In developing world, poultry subsector has gotten prominence both as a means of livelihood, reduction of poverty and malnutrition. However, there sector does little less than to Rwandan economy. The share of agricultural to GDP is 34% but there is more consumption of eggs and poultry meat than the production. Poultry human population ratio is around 1:4 while it's around 1:1 to another developing world such as neighbors' country Kenya, Tanzania, Uganda. Poultry contribute around 5.5% to animal protein while the average is approaching 40% in the rest of the world. This study explores the poultry industry and evaluate production efficiency at farm level and factors that influence performance were assessed.

The study was conducted in 9 out 30 districts. One hundred and thirty-four (134) commercial poultry farmers were interviewed using a structured questionnaire. This study aimed at evaluating the poultry production given the market environment that farmers were operating in. The structure-conduct-performance approach was used to describe and analyze poultry market competitiveness while the stochastic frontier approach was used to estimate a self-dual Cobb Douglas production function, which gives estimates of technical and allocative efficiencies and also identifies the socioeconomic factors that influence observed efficiency.
The study reveals that 92.54 percent of reared chicks were imported and among sampled farmers, 52.20 percent of them imported chicks themselves. Commercialized chicks market was controlled by top 4 traders and educated farmers, at least up to high school, controlled poultry industry at 62.10 percent. The first populated district also accommodated 16 percent of national poultry farmers. The study concluded that higher financial investment and information were barriers to majority of population. Lack of local chicks' production and inadequate role of middlemen were also observed. Despite that the poultry industry was characterized by imperfections in different market segments, it is a growing industry; about 69 percent entered into industry one year before the survey. The sampled farmers' mean technical efficiency was 77 percent with an allocative efficiency of 99 percent. From the analysis of the factors that influenced the poultry production efficiency, it was observed that mainly economic factors influenced technical efficiency whereas socio factors influenced allocative efficiency. On one side, earning more income, getting information from documentation and supply output to input sellers increased technical efficiency. Chicks' input market alsowas among major determinants. On other side, for a farmer, being older and being male influenced negatively efficient resource allocation.
Easy access to credit and access to information shall contribute to low income and non-educated people to enter into poultry industry. Access to information shall be increased through quality inspection of input to be sold and diversified source of extension. This will improve market transparence and competition hence higher productivity and poultry industry development by increasing efficiency in the use of existing technology and encouraging the entry of diversified actors into the industry to enhance innovation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATION AND ACRONYMS

AE	:	Allocative Efficient
CD	:	Cobb-Douglass
DEA	:	Data Envelopment Analysis
DRTS	:	Diminishing Returns to Scale
EE	:	Economic Efficiency
FAO	:	Food and Agriculture Organization
FENU	:	Fonds d'Equipement des Nation Unies
GDP	:	Gross Domestic Product
IFRRI	:	International Food Policy Research Institute
LR	:	Likelihood Ratio
MDG	:	Millennium Development Goals
MINECOFIN	:	Ministry of Finance and Economic Planning
MINAGRI	:	Ministry of Agriculture and Animal Resources
MLE	:	Maximum Likelihood Estimate
RARDA	:	Rwanda Animal Resources Development Authority
BNR	:	Banque Nationale du Rwanda (Central Bank of Rwanda)
SCP	:	Structure Conduct Performance
SF	:	Stochastic Frontier
SFA	:	Stochastic Frontier Approach
SPSS	:	Statistic Package for Social Scientist
TE	:	Technical Efficiency
UNDP	:	United Nations Development Program
USAID	:	United States Agency for International Development
VRS	:	Variable Returns to Scale

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Livestock employs a vast number of low income population in developing countries. Freeman et al., (2007) and Stroebel (2004) argued that livestock is, among others, an important risk reduction strategy for vulnerable communities. In the last ten years, it has contributed more than 33 percent to agricultural GDP in developing world and 40 percent to global agricultural GDP. It is one of the fastest-growing subsectors in agriculture with a potential growth(Delgado et al., 1999 and Steinfeld, 2002 Stroebel and Swanepoel, 2010). Plucknett (1995) estimated the amount needed to be twice as much for milk and meat in the next 30-35 years. On supplier side, other authors such Stroebel and Swanepoel (2010), Anders et al., 2000; Mehta et al., 2003argued that the global livestock production is also expected to double by 2020.

The researchers have picked up poultry as one of the branch of livestock driving the perpetual growth of livestock products market that has remained for around the last 40 years. There have been speculationson causes of poultry increasing market, the role the subsector plays in development as well as its special characteristic.

On growth side, different authors such as Ackello (1976), Mehta et al. (2003) and Stroebel (2004) pointed out that the increase in demand for animal products is a result of population growth, urbanization, and most importantly, increase in income.

On economic development aspect economists such as Uswenge (2000) and Gafarasi (2009) argued that poultry has a socially, economically and nutritionally non-evaluated importance.

Some authors have gone far to qualify the subsector as the most important livestock for rural poor household because of its different advantages.Ojo (2003) and FAO quoted by Ackello (1976) pointed out theflexibility and the considerable range of substitution that exists between capital and inputs, its adaptability to varying climatic conditions, short life cycle and low initial investment cost as most advantage of poultry. In addition, the easy disposability, high acceptability by all religion and high divisibility characteristic of poultry products make the sector more important in human life.

This study analyses poultry sector in Rwanda following the paradigm of perfect competition. The fact that its assumptions (of the perfect market) are idealistic is taken into consideration. It is fact that in general farmersespecially in developing word operate more under uncertainty. The lack of either soft or hard market infrastructure such as insurance and adequate transport are constraints (Sadoulet and Alain de Janvry, 1995). Junankar (1989)Abedullah et al, (2006) have argued that input and output markets are not competitive, and the farm production can either be below or above the frontier.

Due to the fact thatfew scientific studies in the area have been done, especially on substantial resource utilization (economic efficiency); this study aim to tackle the input market structure as well as assess farm production efficiency.

1.2 Historical background of poultry production trends in Rwanda

Three decades ago, only local breedsof chickens were available in Rwanda. Its low production performance prompted the government to allow importation of highly productive chicken breeds mainly from Europe around 1980. Despite this policy, farmers did not get easy access to these exotic breeds due to some difficulties experienced in the supply of chicks and import licenses

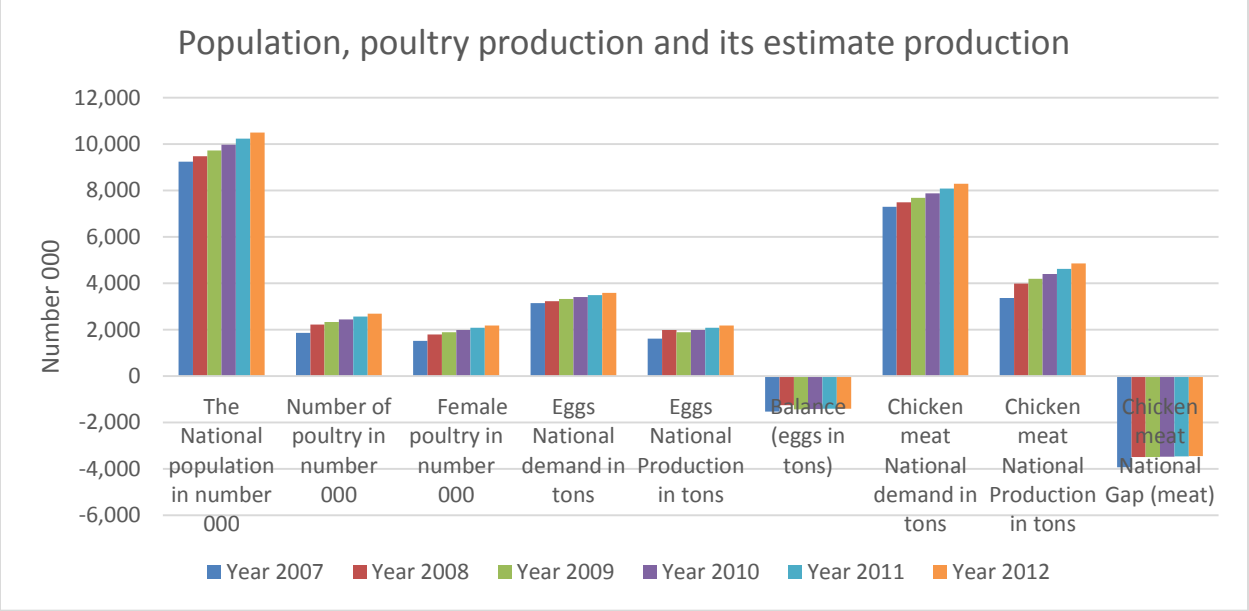
from the National Bank. It is in this regard that the national hatchery was built by the government in collaboration with UNDP/FAO/FENU under the framework of "Small Stock Development Project". The first production of one-day old chick was realized in 1988 when the national hatchery opened its doors. In collaboration with the Kingdom of Belgium, the National Hatchery was expanded in 1992. To date, national records show that more than half of one-day old chicks reared in Rwanda are imported and around 40 percent of national eggs consumption was imported in 2009 (MINAGRI, 2011).

1.3 Statement of the Problem

While poultry has proven effective in rural poor household, in Rwanda the experience is different. The subsector contributes disproportionately to the economy of Rwanda. The sector provides about 5.5% of national animal protein while according to IFRI, the average is approaching 40% in the rest of the world (RARDA, 2008, Anders et al., 2000). The country has low number of such kind of animals, poultry to human population ratio is around 1:4 in Rwanda while it's around 1:1 to other developing world such as neighbors' countries Kenya, Tanzania, Uganda (Uswenge, 2000; Gafarasi, 2009 and RARDA, 2010). The National Bank (BNR, 2009) ranks it fourth among livestock.

From the Figure I below, the population, the number of livestock, the production has been growing but the balance has not improved. The farming in Rwanda has not been able to respond to the increasing demand; there is more chicken meat and eggs consumed than produced in the country. that implies the country import to be able to fulfil its actual demand.

Figure I: Population, poultry production and its estimate production



Source: RARDA, 2010

Yet, there is progress in number of poultry population, the famers involved in industry and the production, the importation of both eggs and chicken meat have increased as well. The reasons farmers are unableto respond to the market opportunities are still mysterious. Are farmers unwilling to venture in poultry industry or are they constrained to increase their production? This study aims to put the light on the poultry from inner-farming. It explores the farm inputs' market. It also assesses the production efficiency in order to understand the competitiveness between farmers. Last, it identifiesthe factors that influence the level of individual production farm efficiencies.

1.4 The objectives of the study

The purpose of this study is to assess the production and the economic efficiency of poultry farming in Rwanda. The specific objectives of the study are:

- To analyze the poultry input market structure in Rwanda;

- To estimate the technical, allocative and economic efficiencies of poultry farming in Rwanda;
- To assess the social and economic factors that influence the technical and allocative efficiencies levels of poultry farmers in Rwanda

1.5 Hypotheses

In order to achieve the above objectives, the following hypotheses were tested:

- Farmers as buyer has little power on input the market;
- Poultry production in Rwanda is not economically efficient
- Poultry farms and farmers' socioeconomic characteristics do not influence the technical and allocative efficiencies levels of poultry farmers in Rwanda.

1.6 Justification of the study

A study on poultry is imperative given its importance to agriculture in the long-term Rwandan economic plan known as Vision 2020. It is also crucial given to its identified great role that agriculture is expected to play to meet the Millennium Development Goals target one (MDG1). Studies on the livestock sector are important due to the huge disparity between the huge employment that the sector offers to the Rwandan economy and its low contribution to GDP. In addition, it is justified by little improvement of free range Rwanda poultry production system which is incompatible with zero grazing policy that is being implemented in Rwanda.

Therefore, the outcome of this study will provide information that will enable effective measures to be undertaken for further improvement or adoption of suitable strategies on poultry input-output market and to improve the farmers' efficiency in poultry production.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The concept of market structure

The concept of market structure is central to both economics and marketing. It defines the market competitiveness, determines the extent and characteristics of competition and affects choice behavior among the actors. The degree of competition affects the consumer, the performance and behaviour of the company involved (Yadav, 1995; Varian, 2002). The Market structure is a relative concept. On one side, it describes the industry organization structure and on other side it consists of features of the market environment that influence rivalry among the buyers and sellers operating within the same market. The structure of industry is analyzed through its various aspects or components such as the number of buyers and sellers, barriers to entry of new firms, product differentiation, vertical integration, and diversification (Bized, 2006). The main different market structures are indicated below.

2. 1.1 Type of market structure

The type of market structure influences how a firm behaves in pricing, in supply determination, its decision and ability of entering industry, thereafter, its efficiency and competition. The different market structures are perfect competition, monopolistic competition, oligopoly and monopoly (Bized, 2006)

Neo-classical economists assume a competitive market in which the productive resources are allocated to their most highly valued uses and encourage efficiency. Homogeneity of products, numerous buyers and sellers, perfect information held by all market actors and free exit from and

free entry into the market are major characteristics of such kind of market. However, a competitive market situation in which agents are fully informed and rational and transactions are costless is still idealistic since the conditions may never simultaneously happen. Nevertheless, improving markets by approximating competitive condition ensures more general welfare or a socially desirable result (Bressler and King, 1970 and Klitgard, 1995). They argued that high degree of competition allocates resources to most efficient use and firms operate at maximum efficiency by equating price to marginal costs, supply and price are expected to be at their optimum. Therefore, the perfect competitive market theory has served as a benchmark measure since its existence in real world is unsure (Bized, 2006).

Though, the industry is characterized by many buyers and sellers and there is relative free entry into and exit from, products get to be highly differentiated. Thus, each firm may have a tiny 'monopoly' because of the differentiation of their product and may have some control over price. The examples are restaurants, professions, building firms (Varian, 2002 and Bized, 2006).

Oligopoly is a market situation in which there is competition amongst a few or a small number of large firms in a way that there is potential for collusion. As many firms may make up the industry and impose high degree of interdependence between firms, it may lead to high barriers to entry and result to the lack of both competitive price and optimal supply. The examples are industries such as supermarkets, banking industry, chemicals, oil, medicinal drugs and broadcasting (Varian, 2002 and Bized, 2006).

A monopoly is a market situation in which only one firm makes an industry. The same firm controls price or output (supply). The consumer choices become limited and there may be possibility of price discrimination. Market prices are not competitive and excess the marginal

cost but the entry of new firm is restricted because of several reasons such as high fixed costs of investment (Varian, 2002 and Bized, 2006).

2.1.2 Market structure appraisal

Harris (1982) advocates for the analysis of structural interrelationships between production, exchange and distribution in order to explain a market system. He argues for commodity behavior market analysis, the full study of its interrelationship with other commodity markets and its rate of convertibility in terms of money. As it has been used, Structure-Conduct and performance (SCP) framework is used to assess the structure of the market and how the market structure affects the behavior of sellers or buyers of different commodities and services (Harris, 1982; Okunmadewa, 1990; Onu, 1997 and USAID, 2008). Therefore, this study adopted SCP approach to analyze the market environment in which poultry farmers are currently depending on.

2.2 The concept of production efficiency

The production efficiency is a measurement of productivity performance; productivity performance of farm refers to its capacity to convert input into outputs. Coelli et al. (1998) states that performance is a relative concept: at farm level, at a given point of time, it can be measured relative to its previous performance at another previous point of time. It can be also measured relative to the performance of another farm; both performances at the same point of time. It is about decision making behavior of the producer. It is based on two different views: the input oriented and output oriented. The input-oriented address the question: "by how much can input quantities be proportionally reduced without changing the output quantities produced?" Alternatively, for output oriented, one could ask the question: "by how much can output

quantities be proportionally expanded without altering the input quantities used?" (Coelli*et al.*, 1998).

Farrell (1957) proposed that production efficiency of a firm consist of two components: technical efficiency and allocative efficiency; when combined, they provide a measurement of economic efficiency.

Technical efficiency refers to the measure of how available technology is used; it varies from zero to one. It means that the firm is producing on the frontier when technical efficiency is one. That is the largest proportional reduction in input that can be achieved in the production of the output. It can be interpreted as the largest percentage cost saving that can be achieved by moving the farm towards the frontier isoquant thought radial rescaling of all inputs (Chavas and Aliber, 1993 and Kehinde and Awoyemi, 2009).

According to Farrell (1957) and Farrell and Fieldhouse (1962), the allocative efficiency, on the other side, is a measure of the ability of a firm to choose its input in a cost minimizing way, it is the maximum proportion of cost that the technically efficient farm can save by behaving in a cost minimizing way. Like technical efficiency, allocative efficiency varies from zero to one.

Economic efficiency (EE) is given by the product of the technical efficiency (TE) and the allocative efficiency (AE); that is (TE*AE) =EE. It is assumed that economic efficiency varies from zero to one. In this study, poultry farming is both technically and allocatively efficient when economic efficiency (TE*AE) equals to one. Otherwise, (TE*AE) less than one implies that poultry farming is not economically efficient. [1 – (TE*AE)] measures the proportional reduction in cost that a poultry farmer can achieve by becoming technically and allocatively efficient (Kehinde and Awoyemi, 2009)

2.3 Linking market structure and production efficiencies

Industry organization (structure) is a concern to production economist analysts. Whether a producer is experiencing a competitive or uncompetitive market, he behaves accordingly and she or his production efficiency becomes relative. Hicks (1935) states that "people in monopolistic positions are likely to exploit their advantage much more by not bothering to get very near the position of maximum". It means that the more the industry tends to be monopolistic the more likely stakeholders especially producers tends to be inefficiency. Shepherd (1985) also pointed out that competitive market structure has the performance outcome of lower costs and lower prices. He argued that, on theoretical side, the argument is based on a set of analytical concepts about competition and monopoly. On practical side, the topic is about real markets, teaming up with the excitement and drama of struggles among real firms.

Although, the competitive paradigm takes over, the puzzle appears when linking market structure and industry development through production efficiency. The mystery is whether there is positive or negative correlation between market size (concentration) and cost for overall industry. Though, it has not been appropriate to regress R&D expenses on sales (since the effect of the former is not immediate and effect of substitution and externality is not captured), the results of analysis may differ according to whether analysis is based on cost such as advertisement or cost such as research and development (R&D)(Sutton, 2006).

Simon (1957) and Leibenstein (1987) argued that in presence of bounded rationality even production is bound to be inefficiency and undermine the performance. Therefore, it is in this regards that the market environment which tends to competitive market by ensuring information flow, without barrier to exploit that information shall enhanced individual firm technological

progressiveness, growth orientation of agricultural firms, efficiency of resource use and product improvement and maximum market services at the least possible cost (Miller, 1984; Scaborough and Kydd, 1992; Scott, 1995; Giroh et al, 2010).

As conclusion, the concept framework developed for guiding this study took into consideration market structure and production efficiency relationship by acknowledging that agriculture marketing is not separable to agricultural production especially in developing countries where market infrastructures and market institutions are weak. It is in this context that the concept framework is pictured in figure II.

2.4 Empirical literature review

The design, methodology, data collection and data interpretation were inspired by findings from papers of past studies. In the next paragraphs, a selection of researches on market and production provided an insight on keys finding that shall be expected from this study.

Kalirajan and Shand (1988) estimated technical efficiency for multiple outputs and multiple crops, where farmers rotate in growing rice for one season and maize the other next season. Using a stochastic translog production frontier for a sample of farmers operating in rain-fed areas of India; the results showed that levels of crop-specific and farm-specific efficiency varied widely among small farmers at high average, but on the whole only 24 percent of the sample was found to be technically efficient in growing all the crops. The causes of variation in technical efficiency at farm level were found to differ across crops. In the case of rice, farming experience and extension visits were found to be important whereas financial availability was the most crucial to maize production. The results from this study indicate that efficiency levels varied from crop to crop depending on various factors. The results and recommendation from studies on

crops might not be applied to livestock such as poultry in Rwanda however, the authors contribute to the body of efficiency knowledge especially for this study.

Sharma et al. (1999), in Hawaii USA, using the parametric and nonparametric frontier approaches estimated technical, allocative and economic efficiency for a sample of swine producers. Authors compared the efficiency estimates obtained from the two approaches, on average, the estimated technical and economic efficiencies are significantly higher in the parametric technique than in DEA for CRS models but quite similar for VRS models, while allocative efficiencies are generally higher in DEA than in the parametric method. The authorestablishedthe similarities and differences between two approaches. Though, the study did not introduce the market environment in which farmers operate, it is obvious that the farming conditions in Hawaii are different from Rwanda given the location, level of development, economic insitititions, the study objects: swine and poultry. The current study, after describing and analyzing the input market, it adopted parametric approach because of its statistical superiority to no parametric.

Mulwa et al. (2008) studied the impact of liberalization on efficiency and productivity of sugar industry in Kenya. The data for the period 1980-2000 were analyzed using two methodologies of efficiency estimation which are Data Envelopment Analysis (DEA) and the Stochastic Frontier Analysis (SFA). The authors pointed out that the policy of the Kenyan government's liberalization of the sugar industry introduced in 1992 had both negative and positive impacts on technical and scale efficiency. The SFA results show insignificant decline after liberalization while the DEA does not show that the policy brought any impact on efficiency and productivity of sugar industry. In addition, the study informed us on the main current approaches in production efficiency analysis. According to the authors, the study distinguished between formal

and organized market environments. Therefore, the study reveals weaknesses in result applicability to an unorganized and uncontrolled market such as Rwanda's poultry industry.

Ojo (2003), in Nigeria, drew and analyzed a sample of 200 poultry egg production farmers, using stochastic frontier production analysis, he found that technical efficiency scores varied among farmers but the average score was high. From that study, only location of farm positively affects technical efficiency, the other social economic variables such as age, experience and education negatively affected technical efficiency. The study gives guidance on an approach to be used and the choice of socio-economic factors influencing eggs production. However, some information on some factors like institution and environmental factors were not considered in the study; it is therefore not easy to know whether or not the results and recommendation from that study may be applicable to the Rwandan poultry industry.

Ismat et al., (2007) in Bangladesh, used Tobit analysis to assess the farm's human capital factors that explain the level of the technical, allocative and economic efficiency that estimated from the Data Envelopment Analysis (DEA) approach. Using farm level survey data from a sample of 100 poultry farmers, the result from the both CRS and VRS indicate that efficient of farmers are technically, allocativelly and economically different. Education, experience, training received, total farm size and poultry farm size are the main factors influencing efficiency. This study is useful for the current study in hypothesized factors identification of factors that might have influenced production efficiency. The Bangladesh production model started in 1980 and is very well managed by the government and other specific stakeholders through different policies. Therefore, applying the results and recommendation to the Rwandan poultry model may be inappropriate since it is not yet mature and controlled at the macro level.

From the paragraphs above, the factors that influence efficiency depend on individual farmers' characteristics, location, industry, and existing institutions that all of them characterize the market.

CHAPTER THREE

3.0 METHODOLOGY

The study estimates production efficiency of the poultry industry. The choice of factors influencing production efficiency to include in the models is based on the described market structure. The partial Structure, Conduct and Performance approach was adopted as it had been used to analyze market dynamics in several previous studies (Odhiambo et al., 2006; Nambiro et al., 2001; Oluoch-Kosura, 2010). The approach used is considered as partial, in this study, because it is limited only to the market structure analysis. The econometric model was more applicable to this study. Therefore, the Stochastic Frontier Analysis was adopted. It is expected the study to respond better to production efficiency analysis by first describing the market environment in which poultry farmers operate.

The chapter III describes the conceptual framework in which the design of the study is pictured. It elaborates the theoretical and empirical framework. It extends to method and procedure as well as the description of the study area.

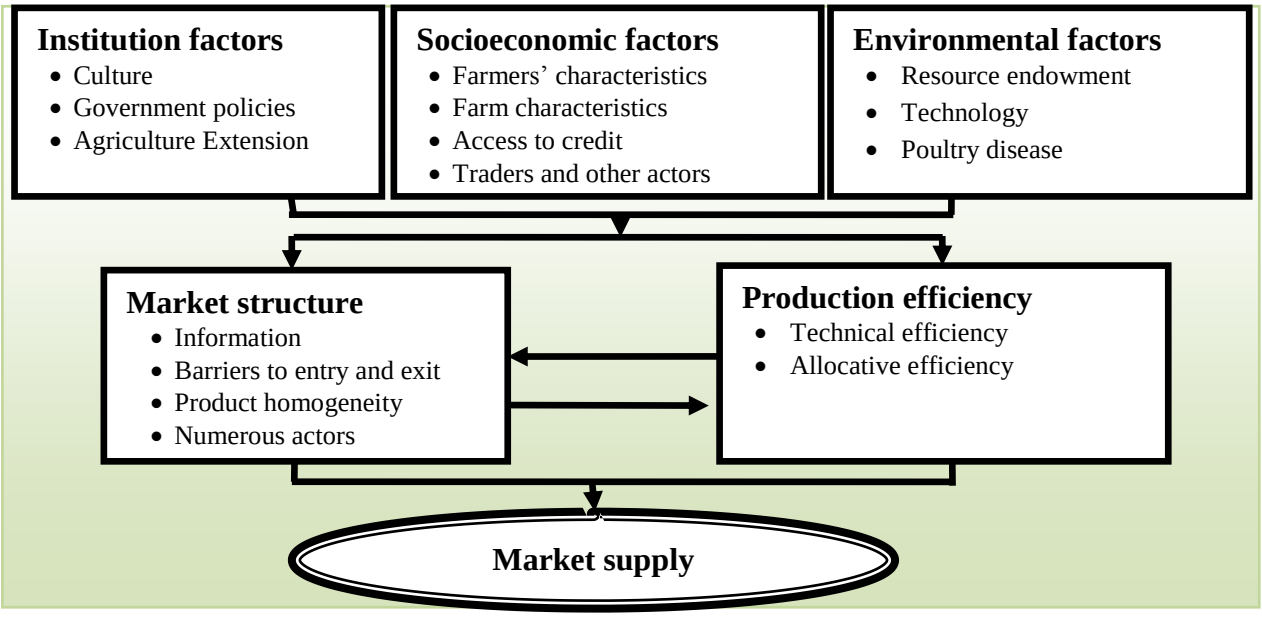
3.1 Analytical framework

3.1.1 Conceptual framework

The hypothesizes of the study is that the market supply depends on both the interdependence of industry production and its market structure. Competitive environment, with limited control over the price, information flow and the right to exploit that information, tends to promote the efficiency use of existence technology and the acquisition of the new ones. It ensures therefore the optimum market supply.

The conceptual framework presented in Figure II shows that institutional, farm and farmer socio-economic characteristics as well as environmental factors influence the input and output of poultry markets as well as the production efficiency. Market structure and production are inter-dependent; their efficiencies tend to produce maximum output by equating price and marginal cost. The determined level of demand and supply and their equilibrium lead to social welfare. This conceptual postulate guides this study throughout to the results.

Figure I: Conceptual framework



Source: author

3.1.2 Theoretical framework

The theories behind the concept framework above are derived from the theory of production and theory of market in its conduct and performance frame. Both theories are discussed in this study.

3.1.2.1 Genesis of stochastic production efficiency

Following Farrell's (1957) seminar paper in which he assumed that the ability of the firm to work on the frontier by maximizing output for a given set of resource inputs is not absolute, there

has been a proliferation of studies in the field of measuring efficiencies. As Farrell's founding and methodology had been applied widely with some refinements undergoing. The improvement is the development of the stochastic frontier model which enables to measure farm level technical and economic efficiency using Maximum Likelihood Estimation (MLE).

The stochastic frontier model was originally pioneered byAigner and Chu (1968) who proposed a composed error term. Building on that, Aigner, et al., (1977) and Meeusen and Van den Broeck (1977) independently improved the production function by specifying an error term consisting of two components. The improvement of that model is a decomposition of the error term and generation of a stochastic frontier model (Aigner, et al., 1977, Meeusen and van den Broeck, 1977, Battese and Corra, 1977). Their result is that the error term is assumed to have two additive components; one component captures pure random factors and the other one accounts for inefficiency error that is inability to maximize or work on stochastic frontier.

The primary production model previously was specified as follows:

$$y = f(x_i ß) exp\varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

provement which is the decomposition of error term leads to the following model:

$$y = f(x_i ß) e^{v_i - u_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Applying to this study as an example,$Y_i$is the poultry output, $f(.)$define the Cobb Douglas production function, x_i is a set of inputs, *ß*is a vector of parameters to be estimated and$v_i - u_i$ denotes the error term: vi is assumed to be independently and identically distributed (iid) as $N(0, σ\_v\^2)$ and represents external factors to the farmer; $u_i$is the second random component which accounts for technical inefficiency effects and it is stochastic as well as assumed to have a

particular distribution specification, that is, half-normal distribution, truncated normal distribution or exponential distribution (Battese and Coelli, 1996).

The maximum likelihood estimation of equation Eq. (2) provides estimators for β and variance parameters,$\sigma^2 = \sigma_v^2 + \sigma_u^2$

The subtraction of v_1 on both side of eq. (2) result to:

$$\bar{y}_i = y_i - v_i = f(x_i ß) e_i^u \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Where, $\bar{y}\_i$ is the observed output of the $i\^th$ farm. Note that the $\bar{y}_i = y_i$for an efficient farmer. For a given level of output$\bar{y}_i$, the technically efficiency input vector for the $i\^th$ farm $x\_i\^t$ is derived by simultaneously solving Eq. (2) and the input ratios$x_i/x_i = k_(i)$ $(i > 1)$, where $k_1$is the ratio of observed inputs.

On the assumption that the production function in Eq. (2) is self-dual, the dual cost frontier can be derived algebraically and written in a general form as follows:

$$c_i = h(w_i, \bar{y}_i ; \alpha) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where, c_i is the minimum cost of the $i\^th$ farm associated with output $\bar{y}\_i$, $w_i$is a vector of input prices for the $i\^th$ farm andα is a vector of parameters. The economically efficient input vector for the $i\^th$ farm $x_i\^e$is derived by applying shepherd's lemma and then substituting the farm's input prices and output level into the resulting system of input demand equations.

$$\frac{\partial c_i}{\partial w k_i} = x_k^e\left(w_i \bar{y}_{i_i} \psi\right) \; k = 1,2, \ldots m \; input \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where, ψ is a vector of input parameters. The observed, technically efficient and economically efficient costs of production of the $i\^th$farm are equal to $w'\_i\, x\_i,\ \bar{w}\_i\, x\_i\^tand\bar{w}\_i\, x\_i\^e$ respectively.

3.1.2.2 Input market analysis

Market organization studies the structure of /and boundaries between firms and markets and the strategic interactions of firms. It considers how firms are organized and further how they compete. Bressler and King (1970) argued that market structure assessment is more useful to production efficiency analysis when oriented with reference to a concept of ideal or perfect market. The analysis of market structure concern with market concentration, conditions for entry into the market and the managerial know-how and market integration.

Market concentration gives a picture of the absence or presence of market power (Bain, 1968). The market concentration ratio measures the cumulative market share of the largest number of farmers. It was used to establish the level of market control. Summarized in Table II, Bain (1968) characterize the nature of the market according to market concentration. Above 90 percent of total market share in hand of the first four big farmers and the 90 percent of the rest of the market share controlled by the other next four big farmers, the market is assumed to experience oligopoly market. Less than 30 percent of total market share in hand of the first four big farmers and the 45 percent of the rest of the market share controlled by the other next four big farmers, the market is assumed to be moderate with high competition.

Table I: concentration ratio and market structure

Category number	% share of the first 4 farms	% share of the first 8 farms	Number of farms	Description
1	>90	>90	Very few	Oligopoly
2	65-90	85-90	Few	High concentration
3	50-65	70-85	Few	Highly moderately concentrated
4	35-50	45-70	Large	Low moderately concentrated
5	<30	<45	Very large	Moderate with high competition

Source: adopted from Bain (1968)

For this study, Chicks' market concentration, feeding and vaccine market concentration and eggs market system were systematically assessed. It adopted a new marketing paradigm which is share of customers not market share as applied by Don and Martha (1995). For easy interpretation, input retails, producers as well as output retails were grouped in different categories depending on their market shares on the input output poultry market.

The force of potential new competitor and competitive relationships, with regards to the already established one, is determined by the condition of entry to an industry (Bain, 1968). Barrier to entry limit always the number of potential market participants. Dahl et al, (1977) argued that technical competence held by an existing competitor and costs of entry that are prohibitive are key factors that determine the degree of conditions of entry into the industry. It is assumed that only significant barriers prohibit new firms to enter a profitable business. In this study, the analysis of those factors took into consideration the chicks' procurement process, the average initial capital requirement, average farmer income and the assessment of managerial know-how through farmer education level, experience and main poultry farmer activity.

The degree of transparency is another aspect of market. It determines the degree of integration. Lack of information flow to encourage arbitration may result in low level of integration.

3.2 Empirical framework

3.2.1 Empirical framework for stochastic production frontier

The study adopted the production function based on parametric stochastic efficiency. Estimating the production function using Maximum Likelihood Estimate (MLE) procedures, may give consistent estimators for some parameters but with a biased intercept term. The biasedness arises from the fact that the error term of production function estimate is not zero by assumption. In

addition, instead of best practice frontiers that are minimal or maximal[1], OLS estimation provides the averaging parameters. Thus, the more appropriate approaches, DEA and SFA, were developed to derive efficiency measures.

DEA and SFA are two alternatives approaches for measuring poultry production efficiency. The first is a no-parametric method and the second is a parametric method. The two methods differ in two ways: on assumptions of the distribution of the error term that represents inefficiency and on the way that the functional form is imposed on the data (Coelli and Battese, 1996). On one side, DEA suffers from criticisms that it does not take into account of the possible influence of measurement errors and other noise that may incur in data. On the other side, SFA approach also imposes functional and distributional forms on the error term whereas the DEA method does not (Coelli and Battese, 1996).

Although, the imposition of particular functional form from using SFA approach associated with behavioral assumptions which may predetermine the shape of the frontier; especially when the functional form is incorrectly specified, SFA was more preferable to Data Envelopment Analysis for this study because of its acceptability and non-attribution of all errors in production to inefficiency. The motivations are that there is no defined way to acquire new technologies, the absence of specific policy on poultry subsector in Rwanda and the domination of free range farming system poultry while technology is improving fast in poultry industry. Therefore, a model which is flexible such as SFA was expected to fit better to this study.

The Cobb Douglas (CD) stochastic production is specified as follows:

$$lnY_i = \beta_0 + \beta_1 lnX_{i1} + \cdots + \beta_n lnX_{in} + \varepsilon \quad \ldots 6$$

[1] When we are dealing with production function, the intention is to maximize farm output and when we are dealing with cost function, the intention is to minimize farm expenses

where, i refers to the i^{th} farm in the sample, Y is output and Xs are input variables that are indicated in Table III and ε_i is the composite error term. The table III describes the variables to be included in this empirical model and their expected outcomes.

Table II: Poultry production model specification

Variable label	Variable definition	Unit price	Expected sign
Vaccine and chemical	Average cost of one units of vaccine or drugs given to chickens	Units	+ve
Housing size	Average cost of one unit of poultry house measurement	m^2	+ve
Assets function	Average cost of one unit of asset by function	Units	+ve
Assets (physical)	Average cost of one unit of asset	Units	+ve
Initial chicken	Average cost of one unit of chick bought by a farmer	Units	+ve
Current chicken	Current number of chicken kept	Units	+ve
Feeding intake	Average cost of feeding per unit of chicken per years	Kg	+ve
Hired labor	Average cost of man unit per day employed within the farm	Man/day	+ve
Family labor	Units of family human per day employed within the farm	Man/day	+ve

Source: Author

A single stage procedure was used to estimate a Cobb Douglas (CD) stochastic production. As suggested by Kumbhakar et al. (1991) and Sharma et al. (1997), this procedure combines the two-stage procedure into one and produces maximum likelihood estimates of the stochastic production function. The non-violation of the assumption that the inefficiency effects are independently and identically distributed makes the procedure superior to the two-stage procedure (Battesse and Coelli, 1995).

The corresponding dual cost frontier of the production function, under constant return to scale, is derived from Equation (6) by imposing the restriction that the sum of the output elasticities of inputs equals one. It is specified as follows:

$$lnC_i = \alpha_0 + \alpha_1 lnW_{i1} + \cdots + \alpha_n lnW_{in} + \alpha_{n+1} ln\bar{y}_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

where,i refers to the i^{th}farm in the sample, C_i is the minimum cost of production and Ws are input prices, $\bar{y}_i$is the output adjusted for equation (3) and α_s are parameters to be estimated. The table IV describes the variables to be included in the empirical models and their expected outcomes.

Table III: Poultry cost production model specification

Variable label	Variable definition	Unit price	Expected sign
Vaccine and chemical	Average cost of one units of vaccine or drugs given to chickens	Rwf	+ve
Housing size	Average cost of one unit of poultry house measurement per chicken	Rwf	+ve
Assets function	Average cost of one unit of asset by function	Rwf	+ve
Assets (physical)	Average cost of one unit of asset	Rwf	+ve
Initial chicken	Average cost of one unit of chick bought by a farmer	Rwf	+ve
Current chicken	Current number of chicken kept		
Feeding intake	Average cost of feeding per unit of chicken per years	Rwf	+ve
Hired labor	Average cost of man unit per day employed within the farm	Rwf	+ve
Family labor	Units of family human per day employed within the farm		

Source: Author

The single step estimation approach was also applied to the cost function. A self dual production "CD function" was used due to the fact that the cost of technical and allocative inefficiency (observation-specific) can also be derived analytically. The alternative was to use a cost system consisting of a cost function and the cost share equations, and also rely on duality results, especially when a flexible functional form was used. The weakness of cost system approach is to estimate the increased cost associated with technical as well as allocative efficiency since both may increase cost (Kumbhakar and Wang, 2004).

Production and cost model robustness test

The idea that if an econometric model is properly specified, one should not be able to find any additional predictors that are statistically significant except by chance, guided the choice of the variables to be included in production function. In order to choose an appropriate model for the production function to be maximized and the cost function to be minimized, the likelihood ratio LR test statistics of competing models from their relative independent variables were computed. Generally denoted in the form$LR = -2\{log[L(H_o)] - log[L(H_1)]\}$, where$L(H_o)$and $L(H_1)$denote the values of the likelihood function under the null $(H_o)$and alternative (H_1) hypotheses, respectively. The process acknowledged that the model with more parameters will always fit at least as well as it has greater log-likelihood; thus, nested model has been a requirement. So, a model by which, the more complex one can be transformed into the simpler model by imposing a set of constraints on the parameters. The models with the highest LR were 52.54 and 145.48 for production and cost function model respectively with Chi-square probability values equal to 0.0000 for each model. The models were therefore adopted for empirical analysis

In addition to the LR test, the linktestSTATA tool was used to ascertain whether the models were correctly specified or whether they could be improved if extra variables were added. The linear predicted value (_hat) and linear predicted value squared (_hatsq) as the predictors to rebuild the model were generated. The production and cost frontiers were then re-estimated by including the linear prediction and its square as explanatory variables. The variable (_hat) for each function was statistically significant at 1% while (_hatsq) was not statistically significant and the hypothesis that the model did not fit well the data was rejected. So, the hypothesis that some

variable (s) might have been omitted was rejected. The chosen parsimonious models are summarized in table IX.

3.2.2 Empirical framework for estimates of allocative and technical efficiency

The allocative and technical efficiencies were predictable in one step with estimation of cost function and production function. The models were specified as in Table V:

Table IV: Variables to be included in allocative and technical inefficiency models

Variable label	Variable definition	Expected sign
farmer income	The amount of money earned by a poultry farmer as income may be used in mitigating challenges by which may occur in poultry farming	+ve
Hh size	The larger the number of people living in the household, the larger the motivated labor pool available	+ve
Farmer educ.	The more the farmer is formally skilled the more he is more efficient in farming. the study took into consideration the year a farmer spent in school	+ve
Hatchery (source of chicks)	The producers or agents involved in chicks' distribution are informed on poultry farming and are supposed to advise their customers. In addition, the quality of chicks supplied to the farmer is expected to lower or increase efficiency	+ve or –ve
Meals prep.	Either a farmer is feeding manufactured meal or mixed by himself to his livestock might influence efficiency	-ve
Source of info.	either a farmer got information from Radio, neighbor and friends, extension agent visit or other publication might have influence inefficiency in different direction	+ve or –ve
Eggs market channel	Efficiency is expected to depend on which channel a farmer is using in supplying his production	+ve or –ve
Eggs buyers in specific model for	Home or other agent in channel are expected to play to role: First, the more the customers are available the more a farmer is selling	+ve

a famer	eggs at high price and get much money to spent for farming improvement. Ultimately, a farmer will invest exploiting existence technologies.	
Farmer sex	Either a farmer is female or male might have influenced the level of farmer farming efficiency	+ve or –ve
Farmer age	The more a farmer is old the less he can adapt new technology such as poultry farming technology change	-ve
Off-farm act.	Either a farmer is spending enough time taking care of his/her livestock or he/she has another off-farm activity on which he spends time	+ve or –ve
Access to credit	Access to credit may be provide means to be more efficient or less efficient in case of use credit at high cost	
Currents stock	The more reared chicken in number the more caring of them and more production per each unit of production and more fixed cost sharing.	+ve
Farmer exp.	Experience measured by months in poultry sector production by farm;	+ve

Source: Author

Inefficiency model robustness test

Before proceeding with the estimation of the multiple linear regression equation, it is imperative to check for the existence of multicollinearity among the hypothesized explanatory variables. This was done, for discrete variables, by generating the contingency coefficients and for continuous variables by applying the variance inflation factors *(VIF)* technique.

The contingency coefficients: The degree of association between the discrete variables is computed using contingency coefficients. The contingency coefficients are calculated for each pair of discrete variables using contingency coefficient test. $c = \sqrt{\frac{x^2}{n+x^2}}$

Where: c= Contingency Coefficient; $x\text{^}2$ = Chi-square statistic and n= total sample size

The *VIF* test: The variance inflation factor *(VIF)* technique was used to evaluate the degree of multicolinearity between the continuous explanatory variables. VIF is defined as: $VIF\ (x_i) = \left(\frac{1}{1-R_j^2}\right)$

Where: x_i= the j^{th}continuous explanatory variable regressed on the other explanatory variables.

R_j^2= the coefficient of determination in the (auxiliary) regression of $x_j$on the remaining regressors.

As a rule of thumb, if the VIF of a variable exceeds 10 (this will happen if R^2 exceeds 0.90), that variable is said to be highly collinear and it can be concluded that multicollinearity is a problem (Gujarati, 1995).

By looking at the results, some correlated factors were matched and at the end we concluded that there was no longer a problem of association among the variables as the respective coefficients were very low by less than 5% (Gujarati, 1995).

3.2.3 Empirical framework for market structure assessment

In economics, market concentration is a function of the number of farms and their respective shares of the total capacity of production. Industry concentration and Sellers or customers concentration are alternative terms.

For this study, the concentration ratio was more appropriate. The concentration ratio measures the cumulative market share of the largest number of traders and buyers at farmer level. It is summarized in formula: $CR_x = \sum_{i=1}^{x} S_i$

Where, CR_x= Concentration ratio at farm level,

A value close to zero indicates that the largest number of farmers deals with many traders and suppliers thus a small portion of the market share. A single supplier will supply 100% of the market share thus monopolistic behavior.

An alternative should be Herfindahl–Hirschman Index (also known as Herfindahl index or HHI), The Hannah-Kay (1971) index and Entropy index are commonly used for market concentration measures.

HHI calculates the output of the firm divided by the total output. This means the summing of the squares of market share of the firms in the market.

An index closes to zero means they are large number of equal size firms and a value of one means monopoly.

Other index like Hannah-Kay (1971) index is basically the same as the HHI except that market share is raised to the power and which denotes any number of firms. A value between the ranges of 0.6 to 2.5 is suggested to provide the most reliable result.

Entropy index indicates the market share weighted by the logarithm of the market share. A value of zero suggest that there is only one firm in the market, the maximum value in the case of firm with equal market share is the log value of the number of firm in the market.

3.3 Data analysis tools

STATA and Statistical Package for Social Sciences (SPSS) computer programs were used. SPSS was used in both data entry and computation of summary statistics used for the descriptive

analysis. The data were transferred from SPSS to STATA and the latter was used for econometric analysis.

3.4 Method and procedures

3.4.1 Data needs and sources

Primary and secondary data collection instruments were used to obtain both qualitative and quantitative data. A structured questionnaire was used to collect quantitative primary data from a representative sample of the poultry farmers. The primary sampling unit was the poultry farmer and its selection was probabilistic based. Multistage sampling method was applied to select the sample starting with selection of the district until the commercial poultry farmer was selected for interview,

Secondary data was obtained mainly from historical records of RARDA and also from publications, seasonal and annual reports of concerned organizations (NGOs or government entities).

3.4.2 Sampling procedure,the selection of sample unit and data collection

The study considered the information lag at high administrative units such as ministry, province or district about who is engaged in commercial poultry farming and where is located. So the study proceeded by collecting data on farmers and where to meet them. The question was: how many poultry farmers were there in each smaller local administrative (district) unit? The information was provided by either the sector's veterinarian or agronomist. In their absence, the executive secretary was called for assistance. In total, successful, the information was collected from 322 (77%) out of 416 sectors located in different districts all over the country.

Given that the most poultry populated districts are distributed to different parties of the country, that means all province represented. The second stage involved a purposive selection of nine most poultry populated districts. The selected districts represented 335 (67.54%) out of 496 national commercial poultry population keepers. A fraction to be applied in order to obtain a number of poultry farmers to be sampled from each district was determined according to the number of poultry farmers in each district. The sample size of 150 farmers representing 45 percent of all poultry farmers in selected areas and 30 percent of national poultry farmers was drawn.

The third stage involved snowball sampling of the commercial poultry farmer, the sampling unit to be interviewed. The farmers knew each other and therefore the first interviewed farmer informed the enumerator where other farmers in the same or nearest location are based and the process continued in that manner. Table VI shows the selected districts and the corresponding number of selected farmers.

Table V: Selected district and its poultry farmer population

District	Number of poultry farmers	Poultry farmers to be interviewed	Poultry farmers interviewed
Bugesera	43	19	19
Gakenke	26	12	9
Gasabo	38	17	14
Kamonyi	22	10	5
Kicukiro	27	12	10
Musanze	32	14	12
Ruhango	27	12	9
Rulindo	83	37	42
Rwamagana	37	17	14
Total	**335**	**150**	**134**

Source: Survey Data

From Table VI, a targeted sample of 150 out of 335 farmers was drawn. The number of farmers for each district expected to be interviewed and those effectively interviewed are indicated. The intention was to collect information from two different categories of farmers; layers and broilers commercial poultry farmers of different varieties of poultry. Among 134 poultry farmers interviewed, only 5 were rearing broilers. None was rearing other poultry variety apart from chicken. The 69.8 percent of sampled farmers had 14 months experience. Therefore, as output market, only eggs market was assessed.

3.5 Study area description

The study was undertaken in Rwanda, in 9 out of 30 districts located in different parties of the country. Since, the study area did not present particularities to the other parts of the country; the description has been general. Rwanda is a landlocked country located in Eastern and Central Africa between Burundi, Uganda, Tanzania and the Democratic Republic of Congo. It is among the most densely populated countries in Africa with a population density of 362 persons per Km^2 in 2008 on an area of 26,338 Km^2 (including water surface). The total number of rural households engaged in agricultural production is about 1,628,210 households on average size of family farm of 0.75 ha; The censuses done by MINECOFIN in 2002 and MINAGRI in 2005 reported that 50 percent of the families in Rwanda owned less than 0.75 ha of land and 40 percent have less than 0.50 ha (MINECOFIN, 2009).

About 66 percent of the total food production is mainly for subsistence not for business. It is noted that farmers do not produce enough and have to top up from the market to offset the deficit. It is further hampered by underdeveloped agricultural trade in rural areas (BNR, 2008)

The altitude is less than 1500 metres above the sea level in the eastern plateau but rising to between 1500 and 2000 metres in the west and north. Rwanda's soils are naturally fragile. They are a result of the physical and chemical alteration of schistose, quartzite, gneiss, granite, and volcanic rocks which form the surface geology of the country.

The mean daily temperature is close to 24^0 C (76^0F), the minimum night temperatures is around 10^0C (50^0F) and maximum day time temperatures is about 34^0C (94^0F). The seasons are mainly divided in four; two wet seasons and two dry seasons. The short-wet season lasts from October-November and the main rainy season last from mid-March to the end of May. The dry seasons lasts from December to mid-March and from June to the end of August.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

This chapter deals with the presentation and discussion of the results on poultry market structure and commercial poultry production efficiency**.** The chapter is divided into three main sections: The first section describes the household characteristics and farm characteristics assumed to influence poultry production efficiency. The second section analyses the poultry market structure; the possible factors assumed to influence the nature of competition and price within the market. The last section of this chapter looked at technical and allocative efficiencies in poultry sector. The factors influencing production efficiency among poultry farmers will be assessed.

4.1 Descriptive analysis

4.1.1 Household and farm characteristics

This study uses cross-sectional data collected from a total of 134 poultry household farmers from 9 out of 30 districts in Rwanda. During the survey period, the sampled area accommodated about 67.54 percent of national commercial poultry population keepers, which is 335out of 496 farmers. This study found out that poultry farming was a male dominated venture (81.4%). A majority of farmers worked either in public or private service or were businesswomen/men (67%) and; only 33 percent had on-farm as their main activity. Farmers who attained at least high school education were 62 percent of total sampled poultry farmers

From the table VII above, the age of poultry farmers ranged from 24 up to 70 with a mean age of 40 years, and a standard deviation of 9.09 years. The farmer average income was around

140thousand Rwandan francs, ranging from 5up to 810 thousand Rwandan frances and the standard deviation were 166 thousand Rwandan francs. The mean household size was 5.35, ranging from 1 up to12, the standard deviation was 2.23 people.

Table VI: Household and farm characteristics

Variables	Min	Max	Mean	Std. Dev
Farmer household size (number of persons)	1	12	5.35	2.23
Farmer experience (months)	3	132	14.84	20.23
Farmer average total income (RWF)	5,000	810,000	140,248	166,194
Age of farm owner (years)	24	70	40.78	9.09

Source: Field Survey Data

The farmer's experience was 14.84 on average, ranging from 3 up to 132 months; the standard deviation was 20.23 months. Other socioeconomic household and farm characteristics are described along the way in the coming sections.

4.1.2 Input-output descriptive statistics

As pointed out early in the introduction, two poultry farming models are mostly known in Rwanda; the free-range poultry and commercial poultry farming. The marketable and non-marketable inputs are used in both models. This part of the study is focused on the commercial poultry and the efficient use of marketable inputs at farmer level. The table VIII shows the captured inputs used by sampled farms aggregated in three categories; the labor, raw material and capital. The labor input consists of both family and hired labor. Feed, vaccine and other chemical products were considered as raw materials. Housing, other asset, livestock (chicken) were regarded as capital.

The labor in eggs production in Rwanda is supplied mainly by family members as well as non-family members from labor suppliers. The farm owner's family was the main source of labor; such that 34.1 percent farms were using only family labor in all farming activities. From the Table VIII, the sample mean of family labor was 1.77 with a standard deviation of 0.90 persons a day. The sample firms' hired labor in terms of person per day varied from 0 to 8 with a mean of 1.14 and standard error of 1.2 persons a day. The maximum labor cost was 240 thousand Rwandan francs per year. The mean was 23 thousand with a standard error of 40 thousand Rwandan francs.

Table VII: Input-output descriptive statistics

Variable	Minimum	Maximum	Mean	Std. Deviation
Hired labor units (man per day)	0.00	8.00	1.15	1.29
Family labor units(man per day)	0.00	6.00	1.78	0.90
Hired labor cost (Rwf)	0.00	240,000.00	23,170.54	40,740.27
Farm housing size (m^2)	3.50	1,540.00	102.03	193.34
Farm house cost(Rwf)	15,000.00	6,500,000.00	990,951.94	1,301,778.24
Initial chicken units	15.00	3,000.00	471.53	523.54
Current chicken units	12.00	2,990.00	429.37	494.07
Feeding intake per unit	290.00	200,224.00	24,543.57	29,272.45
Feeding intake per year per farm	24.17	118.86	56.73	17.42
Unit food price (Rwf/kg)	130.70	300.00	237.54	41.18
Total number of different assets	2.00	802.00	37.93	77.02
function Number of different assets	2.00	13.00	4.62	2.23
Vaccine units (number)	0.00	20.00	6.78	3.13
Vaccine (Rwf/unit)	0.00	360,000.00	32,526.81	34,928.79
Average farm eggs production per year (number of eggs)	1,080.00	3,564.00	2,157.82	410.59
Average eggs production per week per chicken (number)	3.00	9.90	5.99	1.14

Source: Field Survey Data

The considered significant raw materials in this study were feed, vaccine and other chemical products. Other factors such as labor for example were left due to their status of not being commercial sable enough. From the Table VIII, chicken feed intake (in kilogram) was ranged from 24.17 up to 118.6 kilograms with a mean of 56.7. The range of feed cost per kilogram unit, among sampled farm, was from 130 to 300 Rwandan francs. Farmers reported how many times (frequencies) their livestock had been vaccinated or received any drug or vitamins and how much they had spent on veterinary aspects. The mean vaccine and chemicals units received by each chicken unit are 7 with a standard error of 3, ranging from 0 to 20 units (frequencies). The mean expenses on vaccine and drugs were 32 thousand with standard error of 34 thousand Rwandan francs. The lower and higher expenses on veterinary services were 0 and 360 thousand Rwandan francs respectively.

The invested capital was captured through housing size, asset used and number of chicken kept by each poultry farmer. The housing size, in this study, was one of the measures of the fixed input used as capital asset. From the Table VIII, the range of housing sizes, among sampled farmers were from 3.5 to 1540, the mean was 102 and the standard deviation was 193 square meters. The mean cost of poultry housing was 990 thousand ranging from 15 thousand to 65 million Rwandan francs.

Other asset as Physical assets used for poultry production function in this study took into consideration the physical quantity and usefulness in terms of function (purpose: why asset was bought). Their relative costs in terms of physical quantity and purpose also were captured in cost function.

Poultry heads as the number of initial chicks for the farmer and current chicken reared chicken was expected to increase output. The higher livestock death controls the smaller differences between initial and current chicken units.

From the Table VIII, he maximum eggs produced per farm and livestock unit were 3564 and 9.9 respectively. The minimum eggs produced per livestock unit and per farm were 3 and 1080 respectively and the mean production per farm and per livestock unit were 2157 and 5.9 with standard errors of 410 and 1 respectively.

4.2 Analysis of the poultry market environment

Poultry market environment that farmers were participating in was assessed through the market structure analysis. The poultry market was divided into input and output markets. Each market presents many different sub-markets. For input market analysis, the study took into consideration the main sub-markets which are poultry feeds market, vaccine and other drugs market and chicks market.

In order to assess the poultry market structure, the first part of this section analyses the nature of market concentration. The second part describes the condition of entry in the poultry input trade and production delivery. The third part of this section investigates the market information flow within the market that may result into the concentration pattern.

4.2.1 Market concentration analysis

For chicks' market assessment purpose, the farmers reported that they bought the current stock from Belgium, Uganda, Netherlands, France and Malawi and only less than 7.46 percent chicks

were produced in Rwanda. It was observed that the local supply market was very narrow given the fact that; only two hatcheries were available for farmers; one of them is private and had started recently in 2011 while the other one is public.

The Figure II shows markets from which farmers sourced chicks:

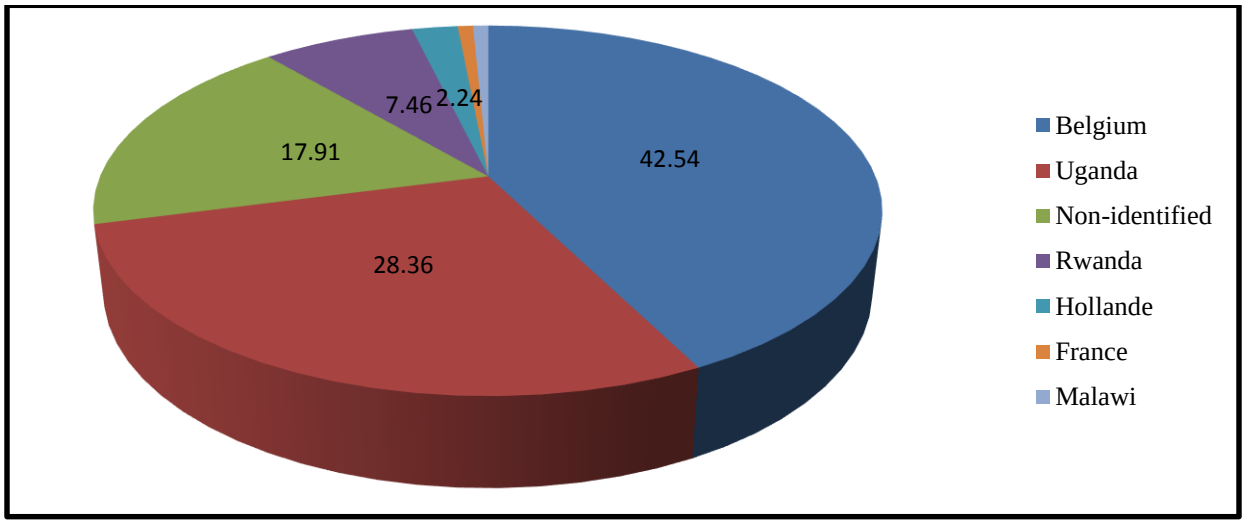


Figure II : Sources of chicks in Rwanda
Source: Field Survey Data

Since Rwandan poultry farmers generally import many chicks from foreign markets, the implication is that any policy change or other uncontrollable circumstance such as disease from exporter countries may affect the poultry sector in Rwanda.

Different chicks' market channels were identified in this study. In additional to lack of local chick market supply mentioned above, the inefficiency of retail intermediation (agents) role was observed. The sampled farmers reported 6 markets channels. Out of 134 farmers, 70(52.2%) farmers import for themselves and 13 (9.7%) farmers reported that they bought chicks from their neighbors[2] who are normally not professional traders (Figure III). Among 41 farmers who bought chicks from agent retailers, 51 percent reported they had have the same 2 first individuals

[2] Inter-trade has used to refer to trade between the farmer and his/her neighbor

as suppliers and 29 percent reported also that they had have the 2 second individuals as suppliers. This means that the chicks market was controlled by top 4 traders who had 80 percent market share.

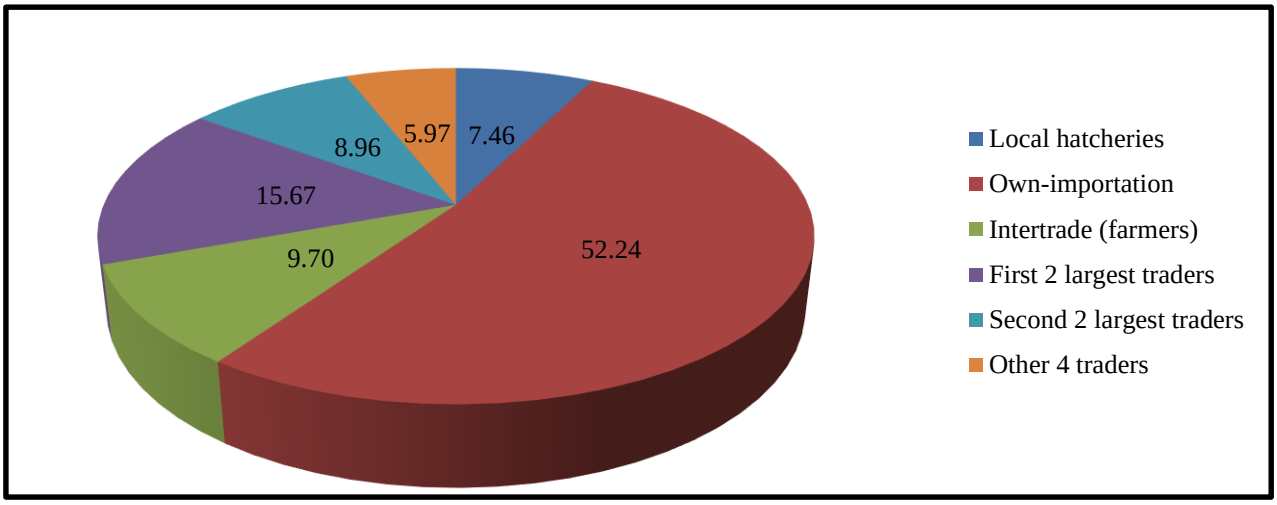


Figure III : Chick procurement market channels

Source: Field Survey Data

This implies that there could be market imperfection; chicks market tended to be slightly concentrated in a few hands.

Farmers also reported the possible sources of feed and other complement chemical product. It was observed that farmers have limited alternatives choices on the market.

Table VIII: alternative sellers of feeding and other complement chemical products available for a farmer

Number of alternatives sellers	Feeding Shop	chemical shop
	Percent	**Percent**
1	45.52	66.17
2	23.88	21.80
3	23.13	9.02
≥4	7.46	3.01
Total	**100.00**	**100.00**

Source: Field Survey Data

From the table IX above, it is shown that 45.5% and 66.17% of sampled farmers bought poultry feed and chemicals from one supplier. Only less than 7.46 percent had more than three options. Farmers revealed that they feared fake commodities and preferred to buy from one trader whom they trusted.

4.2.2 Conditions for entry into poultry production

In this part, the hypothesis that there is substantial barriers to entry in poultry production and hence on market was tested. Major problems facing farmers willing to join poultry production were identified. The entry barriers investigated were chicks' procurement process, capital requirements, managerial knowhow and physical facilities availability.

Chicks' procurement process in this study implies the time spent by each individual farmer from the first ordering day up to the reception of the commodity. The time spent in procurement process was investigated to determine whether or not this constituted a barrier to entry in poultry production.

The mean time spent was 28 days with a standard deviation of 16 days, the minimum time was 1 day and maximum time was 90 days. This indicates that the initial investment in time is unevenly distributed among farmers. To investigate the time spent further, according to the time that individuals spend in procurement process, farmers were grouped shown in table VIII:

Table IX: Classification of poultry farmers according to time spent in chick procurement

Classification	**Time**					
Average days spent in chick procurement process	1-10	10-20	21-30	31-40	41-50	over 50
% Number of farmers	7.00	18.00	46.10	10.20	9.40	9.40

Source: Field Survey Data

From the table X above, it is observed that the opportunity cost in terms of time and money may be different and the costs may be unevenly distributed among farmers involved in poultry industry. Farmers who want to quit other sectors in order to join poultry farming face different costs measured in terms of time and money. Therefore, the situation hinders the entry of new farms and reduces competition in the poultry sector. This implies that the time requirement to enter the poultry production was not in favor of a fair competition.

The capital requirement to start business was investigated to determine whether or not it constituted barrier to entry to the poultry production. The concern of capital requirement considered in this study includes the average sample initial investment per livestock unit, average sample initial investment per livestock farm, minimum units of livestock necessary for breaking even that had been estimated in previous studies and the general income and income per capita in Rwanda. Furthermore, farmers' accessibility to credit was investigated.

Table X: farmers' initial investment

Investment	**Minimum**	**Maximum**	**Mean**	
			Statistic	Std. Er.
Initial investment	62,000	9,138,000	1,765,794	(176,032)
Initial investment per chick	1,258	11,460	4,085	(180)

Source: Field Survey Data

Table XI indicates that the sample mean starting capital was about 1.76 million Rwandan francs with a minimum and maximum equivalent to around 62 thousand and 9.13 million Rwandan francs respectively. Investigating whether a farmer received credit to invest in poultry or not, it was found that only 12 (9.3%) out of 129 farmers used credit. The remaining 90.7 percent invested their own savings. However, it is argued that access to credit improves and alleviates

farmers' financial vulnerability and enhances use of agricultural inputs in production (Diange and Zeller, 2001; Demirguc-Kunt, 2004 and DFID, 2010). Credit facilities affected inputs acquisition especially among cash constrained farmers. Taking into consideration what has been reported in previous studies, the minimum number of livestock necessary for breaking-even in Rwanda was 100 chicks (Gafarasi, 2009); ignoring inflation and other changes, we found that the minimum investment was 408 thousand Rwanda Francs.

We investigated further how long an established individual poultry farmer might spend accumulating capital to invest by saving his or her monthly total own income. The minimum and maximum time was a half a month and 81 months for the highest and lowest income earner respectively. The average was almost 10 months and the standard deviation was 13 months. It implies that farmers had to rely on their own savings for starting poultry farming and their capacity to save was largely different. It is observed also that the majority of Rwanda population willing to invest in poultry could not because of relative high investment requirement according to the way the wage rate is highly skewed.

Therefore, the general observation is that, without access to credit, many different farmers willing to enter the poultry sector are somehow excluded. Poultry farmers are differently constrained financially; the means to compete did not allow fair competition.

4.2.3 Managerial know-how

Education, poultry farmers' main activities and experience were assessed as indicators to examine managerial knowhow.

Education may be an important factor in enhancing agricultural productivity. Despite that Kalirajan (1984) and Bravo-Ureta and Evenson (1994) point out that education affects farmers' efficiency negatively; the argument is that better education may be a source of other better opportunities outside the farm. Attracted by other opportunities educated farmers may pursue other income earning activities ultimately ignore farming activity. Other authors like Msuya and Ashimogo (2006) and Amos (2007) argue that well educated farmers may exhibit higher levels of efficiency. In this study, farmer education is hypothesized to have a positive effect either because the farmer being more competitive on the market by accessing capital requirement or in poultry farming by easily acquiring knowledge.

Considering farmers formal education level summarized in Table XII and the level of illiteracy in Rwanda. The formal education was evaluated in terms of years in school in general; no discrimination in regards of the subject such as agricultural education. The survey results are that most farmers are much more educated. Sixty two percent had finished at least high school.

Table XI: farmers' education level

Education level	**Percent**
No formal schooling	3.90
Attended primary schools	34.00
Professional schools and high school	43.50
Attended universities	18.60
Total	**100.00**

Source: Field Survey Data

This implies that poultry farming seemed to be for educated people. It implies that lack of education might constitute a barrier to enter the poultry market for the majority of population.

Kabede (2001) argue that increasing farming experience lead to better assessment of the importance and complexities of good farming decision including efficient use of inputs. Considering farmer experience, we found out that most farmers had not yet accumulated knowledge for a long time. Sixty nine percent had less than one-year experience and experienced farmers did not dominate the market in terms of number of livestock kept. Therefore, business experience was not seen as major factor that constrained farmers to compete within the market.

Based on the Rwandan economic context, the main activity was assessed. A majority of Rwandese live under poverty line and private sector is small; the dominant way to earn income and acquiring information was offering labor. Public officers are daily connected to internet and subscribed to newspapers. Their access to internet and other communication facilities might have contributed to knowledge acquisition. The lowest income earned for the one offered labor from public as well as private sector and for a qualified businesswoman or man is far higher than income per capita in Rwanda.

Table XII: farmer main activity

Farmer main activity	**Percent**
On-farm	33.30
wage offer	24.00
Business man or woman	7.00
Other activity	10.10
Total	**100.00**

Source: Field Survey Data

Classification of farmers according to the main activities, as summarized in Table XI above, showed that some farmers' background might have affected their level of knowledge acquisition. Only 33.3% of sampled farmers earned their livelihood through farming while 66.7% were

engaged in other activities. The latter category, given the nature of the other categories they engaged in, had easy access to information and new technologies.

4.2.4 Market integration and information flow

Vertical integration was depicted in different ways. The survey revealed that farmers presented little experience in poultry farming and there was inefficient information flow. The local importers and hatcheries were the first advisors to their customers in farming and livestock health and at the same time, in some cases, the sellers of different input such as drugs and vaccines. Farmers who imported chicks themselves have got advice from veterinaries or shop-owners. It was observed also that in some areas, the supplier of inputs such as feed and medicine products are also the buyers of eggs.

4.3 Poultry production and cost analysis

4.3.1 Production frontier estimate

From the Table XIV, most dependent variables were significant at high levels; indicating that each of the variables had a significant effect on eggs production. The investment in livestock and death control ratioexpressed in terms of current stock (chicks which are still alive) were positive indicating that the more investment in chicks and efficient death control had a positive effect on eggs production. The 10 percent increment of chicks in number might have increased production by 0.37 percent; an indication that the variable is experiencing an increasing marginal return to scale.

The labor was a key factor in production; hired labor and family labor were used and they contributed differently to production. Hired labor variable had a significant positive coefficient and family labor had a negative coefficient. The 10 percent increment in hired labor might have increased production by 1.1 percent while 10 percent increment in family labor might have decreased eggs production by 0.7 percent. This is an indication that family labor faces diminishing marginal productivity; hired labor was more resourceful than family labor.

Table XIII: MLE of stochastic frontier Cobb-Douglas production function: determination of technical efficiency

Variables	Estimated coefficients	Standard error	P-value
Vaccine unit	0.093	0.000	0.000*
Housing size	-0.020	0.000	0.001*
Asset function	0.054	0.000	0.003*
Asset units	-0.029	0.000	0.000*
Initial chicken units	0.037	0.000	0.000*
Current chicken units	0.132	0.000	0.000*
Feeding intake	-0.205	0.000	0.000*
Hired labor	0.115	0.000	0.001*
Family labor	-0.079	0.000	0.000*
Constant	8.857	0.000	0.000
Sigma –squared	0.097		
Gamma (γ)	0.990		

*; ** and *** imply significant at 1, 5 and 10 percent level of significance respectively

Source: Field Survey Data

The assets with respect to asset function had a coefficient with positive sign while the assets variable seen in terms of physical number of assets had a coefficient with a negative sign. In terms of asset function, the 10 percent assets increment might have increased production by 0.54 percent and in terms of physical number of assets; the 10 percent assets increment might have

decreased production by 0.29 percent. The 10 percent increment of housing might have decreased production by 0.20 percent. The results showed that farmer should diversify the assets rather than having many of them.

In contrast to the expectation that all inputs positively influence output, it is observed that production improvement might result from the adjustment of physical input resource allocation. From the Table IX, 5 out of 9 inputs positively influence output while 4 inputs reduce output. Four out of nine inputs were over used and their increment would have contributed negatively to output; in order words, the use of them has reached the maximum level and more use of such inputs beyond the current level would lead to yield reduction. Overall summation of the elasticities for the parameters revealed that the industry was experiencing diminishing returns to scale (DRTS) since the returns to scale parameter is less than 1, indicating, according to Chavas et al. (2005), that some inputs exceed the scale efficient point.

4.3.2 Farm cost frontier estimates

The variables in the cost function model were the cost of vaccine unit, the cost of housing per size unit, the cost of asset per function unit, the cost of asset per physical number unit, the cost of feeding per kilogram unit and the cost of hired labor per unit. The results of the Cobb-Douglas stochastic cost and production functions are presented in Table XV.

All variables with significant coefficients were positive except the one of the cost vaccine unit and the cost of asset per physical number; may be because some assets were costless. The cost increment of any other variable might have increased the farm cost in general.

Table XIV: MLE of the stochastic frontier Cobb-Douglas cost function: determination of allocative efficiency

Variables	Estimated coefficients	Standard error	P-value
Vaccine unit	-0.332	0.186	0.074**
Housing size	0.173	0.074	0.019**
Asset function	0.811	0.084	0.000*
Asset units	-0.671	0.110	0.000*
Initial chicken units	0.138	0.048	0.005*
Current chicken units			
Feeding intake (kg)	1.078	0.332	0.001*
Hired labor	0.059	0.015	0.000*
Family labor			
Constant	6.656	2.216	0.003
Sigma –squared	0.474		
Gamma (γ)	0.99		

*; ** and *** imply significant at 1, 5 and 10 percent level of significance respectively

Source: Field Survey Data

4.3.3 Testing the presence of inefficiency

From the maximum likelihood (MLE) estimates of the Cobb-Douglas stochastic frontier model indicated in table IX, the estimated parameters of the frontier model are estimated. The results are such that the error term is decomposed in (σ_u^2) and (σ_v^2) respectively explaining the technical or allocative inefficiency and the random shocks. The σ_s^2 explaining the total variation in the dependent variable due to technical or allocative inefficiency (σ_u^2) and random shocks (σ_v^2) together is also estimated. It is expressed as well in terms of the parameterization such that $\sigma\_s\text{^}2 = \sigma\_v\text{^}2 + \sigma\_u\text{^}2$. The hypothesis that there was no technical and allocative efficiency in poultry production, early indicated as H_o**:** γ = 0, has been rejected. The gamma expressed as $\gamma = (\sigma\_u\text{^}2)/(\sigma\_v\text{^}2)$ and $0 \leq 1$was different from 0. It was equal to 0.999 for technical

efficiency and 0.999 for allocative efficiency; indicating that almost 100 percent of variation in input-output is due to inefficiency, the effect of the random error is less than 1 percent.

On one side, the results indicate that technical efficiency levels differ profoundly. Technical efficiency ranged from 34 percent to close to 100 percent. The mean technical efficiency index was 77 percent; the standard deviation was 15 percent meaning that its distribution fluctuated much around the mean. Therefore, it was observed that on average output might be expanded by as much as 23 percent if appropriate measure had been taken to improve technical efficiency. On the other side, the results indicated that allocative efficiency was very high and the variations along the sample were very small. The mean allocative efficiency index was 99 percent and the standard deviation tended to 0; indicating that the cost might be minimized by as much as less than 1 percent if appropriate measure had been taken to improve allocative efficiency.

The efficiency indices distributions are summarized in Figure IV below. The economic efficiency ranges between 34 and 99 percent, the mean efficiency was 77 percent with a standard deviation of 15 percent.

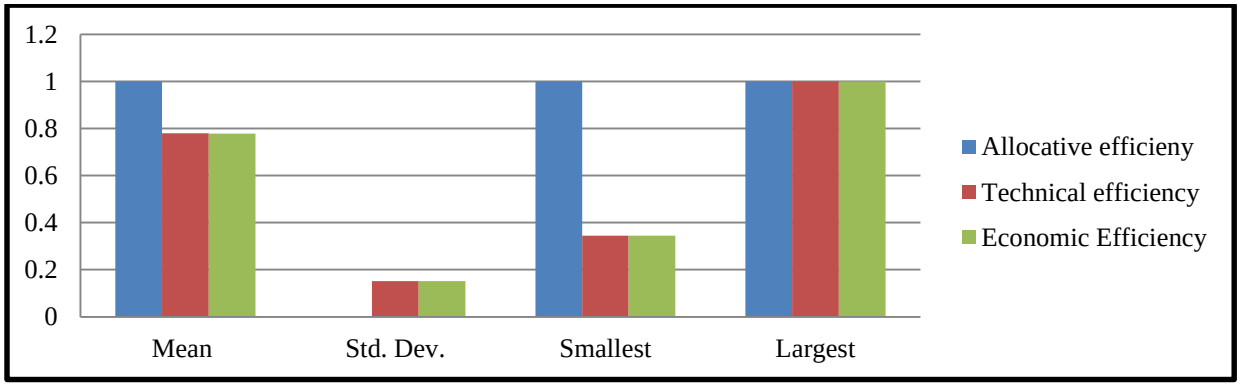


Figure IV: Technical, allocative and economic efficiency indices distribution

Source: Field Survey Data

4.4 Factors influencing production efficiency

The identified shortfall in potential output is interesting by itself, for policy purposes; therefore, it is crucial to isolate some of the determinants of technical efficiency (Croppenstedt and Abbi, 1996). The hypothesized factors were dictated by the general socioeconomic results from the past studies and the specific market environment of the poultry industry in Rwanda analyzed in the first section of this chapter. Using the single step estimation approach, results in table IX and table X were simultaneously derived.

Table XV: Estimates of factors influencing allocative and technical inefficiencies

	Cobb-Douglass technical efficiency estimate				**Cobb-Douglass allocative efficiency estimate**		
Variables	Estimated coefficients	Standard error	P-value		Estimated coefficients	Standard error	P-value
farmer income	0.000	0.000	0.023**		0.000	0.000	0.372
Household size	0.111	0.065	0.090***		-0.082	0.071	0.248
Farmer education	-0.119	0.085	0.16		-0.052	0.090	0.560
Chicks input market	-0.147	0.076	0.053***		-0.217	0.095	0.022**
Meals preparation	0.334	0.280	0.233		0.303	0.298	0.309
Source of inform.	-0.399	0.181	0.028**		-0.118	0.176	0.502
Eggs market channel	-0.318	0.128	0.013**		0.185	0.150	0.216
Home eggs	-0.067	0.043	0.121		0.010	0.039	0.790
Farmer sex	0.840	0.351	0.017**		-0.667	0.373	0.074***
Farmer age	0.005	0.014	0.714		0.037	0.016	0.022**
Off-farm activity	0.340	0.340	0.317		-0.161	0.387	0.677
Currents stock	0.000	0.000	0.789				
Farmer experience	0.009	0.008	0.286				
Constant	-3.466	1.234	0.005		-0.083	1.468	0.055

*; ** and *** imply significant at 1, 5 and 10 percent level of significance respectively

Source: Field Survey Data

Six and three explanatory variables, respectively for technical and allocative efficiency, were found to be statistically significant at less than 10 percent level of significance. In what follows the significant explanatory variables are discussed briefly.

Farmers' income

From table XIII, it is observed that the marginal effect on income was small but the variable was significantly positive at 5 level of significance. It was observed, from figure V that the TE increases as income decreases up to a point by which it starts to decrease. The middle-income farmers tended to be more efficient. It implies, as it indicated in first section of this chapter, that income is one factor which make poultry farmers different in both market (entry) and farming efficiency. On one side, income is seen as constraint for low income earners to enter the market and on other side, as a constraint for high income earners to farm efficiently.

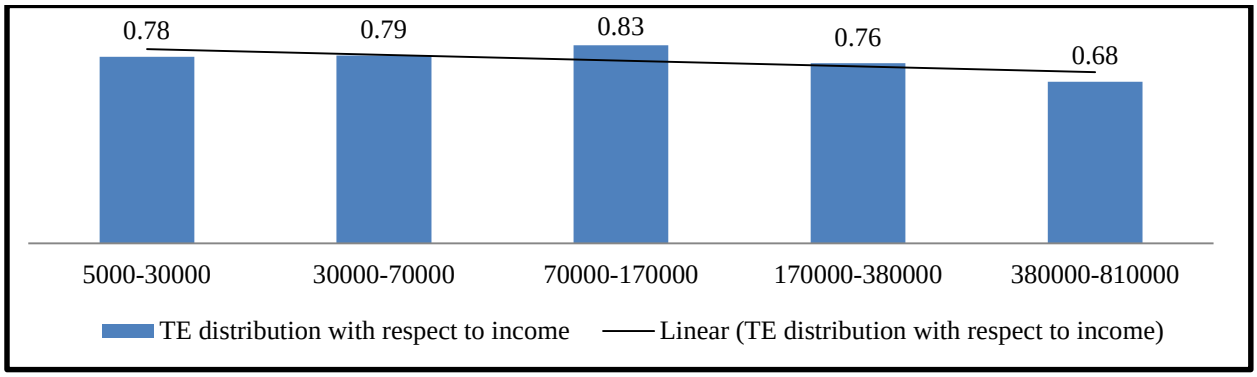


Figure V : Distribution of TE with respect to farmer income

Source: Field Survey Data

Household size

The household size may imply more labor endowment for business enterprise in Rwanda (Bizoza et al, 2007), this was confirmed by the fact that the results of this study revealed that labor used in poultry industry from family was costless.

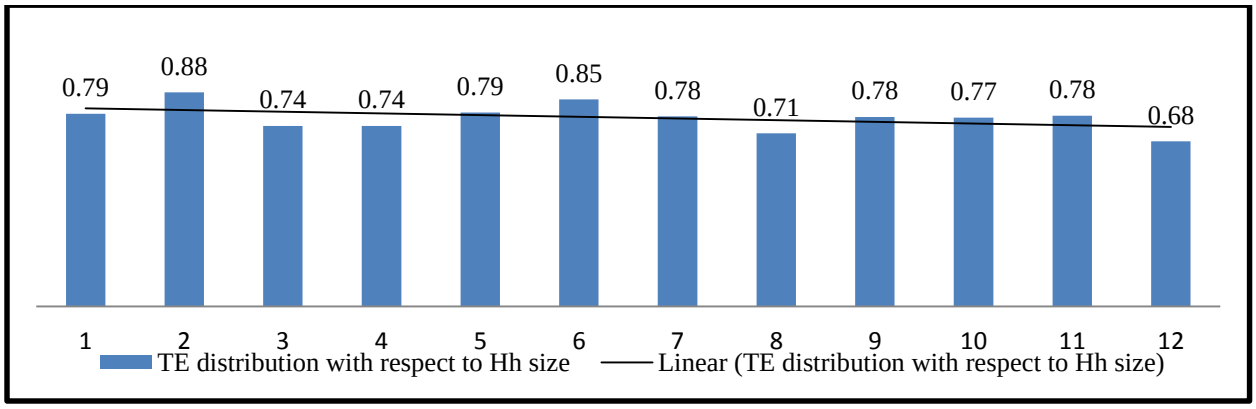


Figure VI : TE distribution with respect to household size

Source: Field Survey Data

However, in addition to its DRTS identified above in production and cost frontier analysis part, from the figure VI, the labor supplied from family or household was of low quality; more use of it increases inefficiency in poultry farming

Chicks input market

The study revealed that 91.5 percent of sampled farmers were not aware about the variety. However, from the figure VII, it is observed that the farmers are different efficient in resource allocation and in input use depending on where they bought chicks; the reason is still out of sight in this study.

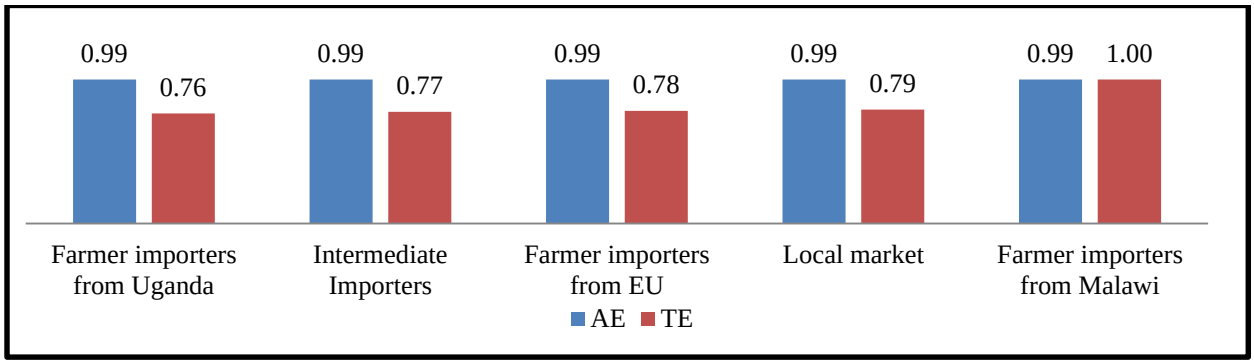


Figure VII : TE and AE distribution with respect to chicks input market

Source: Field Survey Data

Although, the Ugandan chicks dominated the market, they were less technically efficient. Only one farmer had imported chicks from Malawi and he was the most efficient among the sampled farmers.

Source of information

Farmers were asked the channel of information that they have been using. Four options were given to them but only three of them were reported. From the figure VIII, social network was much used at 68 percent but the users were less efficient. It is observed that radio, documentation and new source of information such as internet have played much as sources of information in poultry farming by increasing the efficiency of input use.

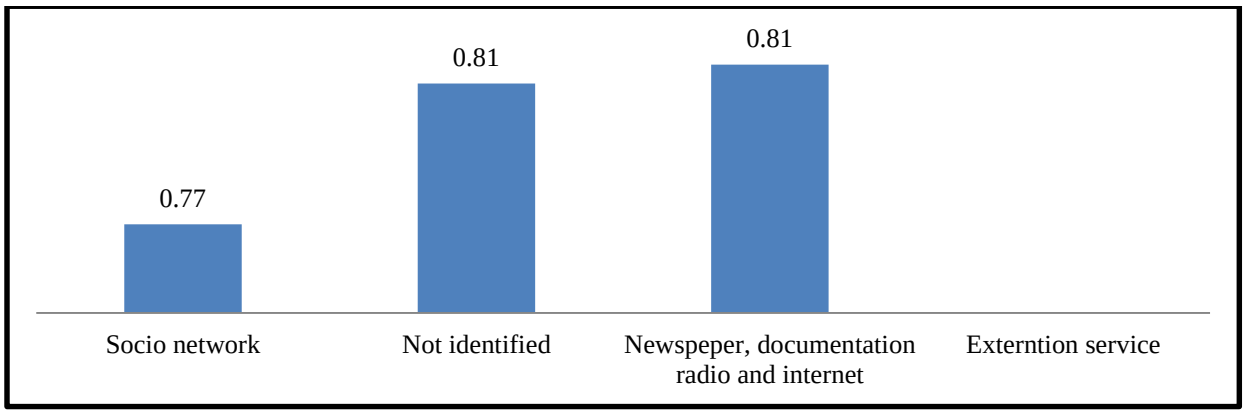


Figure VIII : TE with respect to source of information

Source: Field Survey Data

Output market channel

From figure IX, farmers' efficiency levels were categorized according to the market channels. Supplying output to input sellers greatly improved the technical efficiency of farmers.

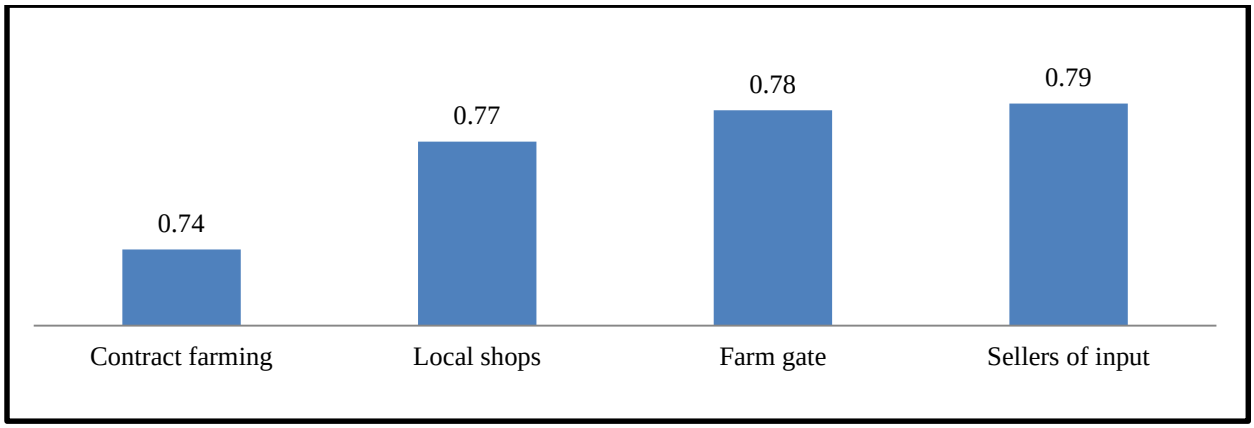


Figure IX : TE with respect to output market channels
Source: Field Survey Data

Farmers' sex

From figure X, males were found to be more efficient in the use of inputs. However, men and women are equally efficient in using money resources.

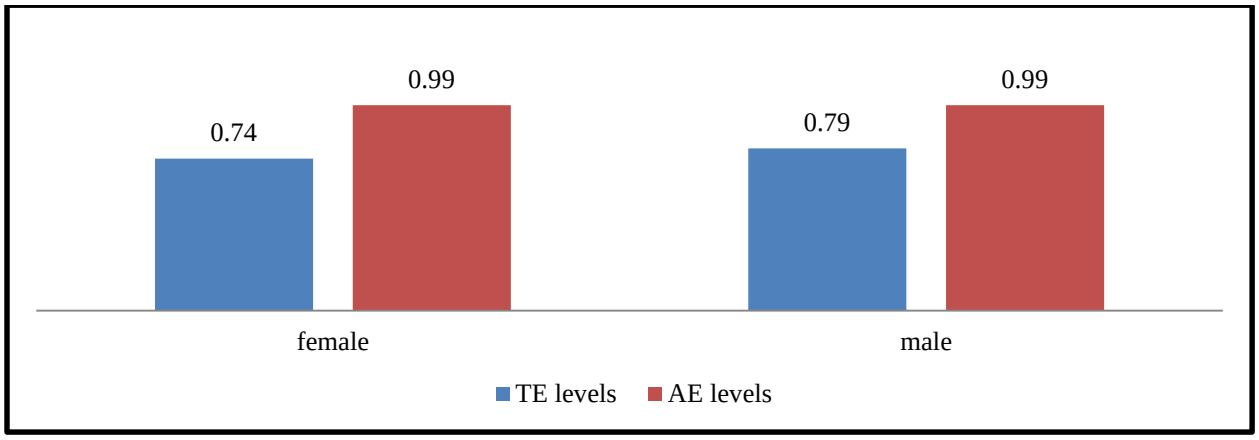


Figure X : TE and AE with respect to farmer sex
Source: Field Survey Data

Farmers' age

From the table XIII, the inefficient resource allocation increases as a farmer gets old. From the analysis of the factors that influence the efficiency of poultry farmers, it is observed, on one side,

that economic factors such as income, chicks input market, source of information, output market channel were dominant among factors that influenced technical efficiency. On other side, it was observed that socio-economic factors such as farmers' age, farmers' gender were dominant in the allocative inefficiency model.

CHAPTER FIVE

4.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

The study on an economic analysis of poultry production efficiency and marketing in Rwanda was conducted in 2011. Secondary and primary data were used. The field survey was conducted to commercial poultry farmers. The collected primary data were about farm and farmer household characteristics and input used in eggs production. Statistic and econometric approaches were used in analysis.

It was observed that the poultry population farmers were not equally distributed across the country. Out of 30 districts in which the study was conducted, only 9 out of 30 districts accommodated about 67.54 percent (335 out of 496) national commercial poultry keepers. Rulindo was the most populated district; it represented about 16 percent of commercial poultry farmers. Chick Eggs production dominated the subsector; among the 134 sampled farmers only 5 were broilers poultry farmers and none was rearing other variety than chicken. Poultry farming was a male dominated venture (81.4%) and agriculture especially poultryenterprise was mainly not the primarily activity to most farmers; most farmers (67%) worked either in public or private service or were businesspeople. Educated farmers, at least at high school level, were 62 percent of total sampled poultry farmers and their average income was 140248 with a standard error of 166,194 Rwandan francs. The mean age of poultry farmers was about 40 with standard errors of 9years and the household size was 5.35. Farmers' average experience was 14.84 months.

The farm owner's family was the main source of labor such that only 34.1 percent farms were using only family labor in all farming activities. The mean sample firms' hired labor was 1.15

person a day and the mean labor cost was 23170 Rwandan francs a month, the standard errors were 1.29 and 40,740 respectively. The mean chicken feed intake (in kilogram) was about 56.7 per year and the mean cost unit was about 237 Rwandan francs, the standard errors were 17 and 41 respectively. The mean vaccine and chemicals received by each chicken unit was 7 times across the sample at 32929 Rwandan francs unit cost with standard error of 3.13 and 34,928 respectively. The housing size, in this study, was one of the measures of the fixed input used as capital asset, its mean per farm was 102 square meters and the cost of farm housing unit was 990,952 Rwandan francs. The mean poultry heads as the number of initial chicks for the farmer and current chicken reared chicken were about 471 and 429 chicks respectively; their relative standard errors were 523 and 494 chickens respectively. The mean eggs produced per farm and livestock unit were 2157 and 5.9 with a standard error of 410 and 1 eggsrespectively.

For easy assessment, Poultry market environment was divided into input and output markets. For input market analysis, the study considered poultry feeds market, vaccine and other chemicals market and chicks market. On the other hand, for output market analysis, the study looked at eggs market.

The study revealed that Rwandan poultry market depends on foreign markets (only less than 7.46 percent chicks were locally produced). There is absence ofmiddlemen was inadequate. Out of 134 farmers, 70(52.2%) farmers imported for themselves and 13 (9.7%) farmers reported that they bought chicks from their neighbor farmers who are not normally professional traders. Top 4 traders controlled chicks market. The concentration ratio was 80%, that means that top 4 firms accounted for 80% of market share. The mean time spent by each individual farmer from the first ordering day up to the reception of commodity was 28 days with a standard deviation of 16 days.

The managerial know-how was assessed through business experience and farmer education. It was observed that about sixty two percent had finished high school and a portion of farmers had attended university. The study concluded that given to illiteracy rate in Rwanda, education might have constituted a barrier to enter into the poultry market for most of population. Sixty nine percent had less than one-year experience and experienced farmers did not dominate the market in terms of number of livestock kept. Therefore, the study concluded that business experience was not a barrier

The MLE of the stochastic frontier Cobb-Douglas production function revealed that some variables experiencing increasing marginal return to scale and other decreasing return to scale. Family labor faced diminishing marginal productivity whereas the hired labor was more resourceful than family labor. The housing sizes exceed the optimum; the 10 percent increment of housing might have decreased production by 0.20 percent. Some inputs exceed the scale efficient point and the overall summation of the elasticities for the parameters indicated that the industry was experiencing diminishing returns to scale (DRTS).

The mean Technical Efficient was 77 percent; the standard deviation was 15. On the other side, the mean Allocative Efficiency was 99 percent and the standard deviation tended to 0. The estimates of factors influencing Allocative and Technical Inefficiencies showed that Technical Efficiency increased as income decreased up to a point by which it starts to decrease. The middle-income farmers tended to be more efficient. Despite that family labor were experiencing DRTS, the study confirmed the Bizoza et al, (2007)'s founding that the household size is positively correlated to labor endowment for business enterprise in Rwanda; the labor used in poultry industry was mainly from family and was costless.The study reveals that 91.5 percent of

sampled farmers was not aware about the variety. However, the study revealed that according to which country chicks were imported from, Technicaland Allocative Efficiencies level were different.Four options were proposed to farmers but only three of them had been used as source of information; social network was much used at 68 percent but the users were less efficient. Radio, documentation, and new source of information such as internet have played much as source of information in poultry farming by increasing the efficiency of input use. None had received official extension agent.

4.1 Conclusion

Poultry production and market analysis revealed that there is much potential growth of the poultry industry in Rwanda. Commercial Poultry farming is concentrated in few district and characterized by gender discrimination. Initial capital, local unavailability of chicks' market and quality insurance on commercialized input such as feeding and vaccine was a constraint to established farmers. The industry is dominated by educated individuals while most of the country is not that much educated. In general,poultry farming is in early stage of development, sampled farmers have entered the market recently; the mean farmer experience was about 14 months.

It was observed that farmers were engaged in informal markets at different segments of markets; therefore, planning might not be favorable to industry stakeholders. Not only in general input market appeared to be informal, a small part of the formal market tended to be concentreted in hand of few individuals.

The hypothesis, that commercial poultry farmers were Technically and Allocatively Efficient, was rejected. The analysis of poultry production showed that 4 out of 9 inputs were over used

and the overall elasticity showed that the industry was experiencing diminishing marginal return to scale. Therefore, the hypothesis that each additional unit of input used had positive effect to production was rejected. The variation in input-output relationship was due mainly to inefficiency (at 99%) rather than the random shocks. The study revealed that economic factors such as income, chicks input market, source of information, output market channel were dominating among factors that influencing technical efficiency while socio factors such as famers' age and gender were most important among factors that influenced allocative inefficiency.

4.2 Recommendation

Improved quality inspection of inputs to be sold, increased access to credit, improving extension service and call attention to gender are recommended to policy makers. The analysis of market revealed education as a barrier to enter the market and the issue was confirmed by its negative sign to efficient; farmers who get information also from documentation and other improved technology such as internet were more likely to be efficient. Since source of information and education are things that can be complementally, a policy on information may focus on information availability and less need of much information at farmer level. Therefore, ensure the quality inspection to limit the fear of fake or sub-standard input such as feed, vaccine and drugs, guaranteeing the quality and standardization of input and training of extension officers (since commercial poultry farming was a new business not only to the farmers but also to extension agent). Although, lower income earners were constrained to join the poultry industry, they were more likely to be more efficient; therefore, with easier access to credit, less income earners may enter the business. The entry of low income earners shall have a positive impact on production

and productivity by increasing producers who are assumed to be more efficient. In addition, access to credit may not only have impact on less income integration but also on new local infrastructure such as hatcheries to shelter the nation from diseases and the effect of the policy changes from chicks' exporting countries by making local chicks market available. Even if farm gate users were dominate and more likely to be efficient, the output pricing might be discriminative and the price transmission within the all market industry and the transfer of excess demand from one market to another might be an issue. Therefore, the policy on modern marketing such as supermarkets model, grades and standards are needed. The policy on gender is also recommended.

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APPENDIX: QUESTIONNAIRE

HOUSEHOLD SURVEY QUESTIONNAIRE

A. SURVEY QUALITY CONTROL

QUESTIONNAIRE NUMBER _____

NAME OF ENUMERATOR _____

SECTOR _____

FAMILY NAME OF RESPONDENT _____

CELL _____

VILLAGE

CHECKED BY _ _____

DAY _____MONTH___ _____

DATE OF INTERVIEW: DAY_____ MONTH _____

ENTERED BY _____

DURATION OF INTERVIEW (MINUTES) _____MIN

DAY _____MONTH_____

B. SOCIO-DEMOGRAPHIC

Respondent name and number----------

1. Respondent sex. Male/Female 2. Head of household Yes No

3. How many are you in the household including non-biological? No ----------

4. Please, fill the following table with the information regarding the household.

Member of HH		Age(years) & sex[3]		Education level[4]	Main occupation	No. of years	income	Secondary occupation	No. of years	Exp.(poultry)
Nyiriubworozi?										
autres	1									
	2									
	3									
	4									

[3] Sex: Female= 1 and Male=0

[4]Education level**:** Never went to school=1, Not finished primary school =2, Finished primary school = 3, Professional school = 4, Not finished primary school =5, Finished secondary school=6, Not Finished university=7, Finished university=8

C. EGGS PRODUCTION

5. How many layers chicken do you have? ----------

6. How many layers chicken are they laying now?----------

7. How many groups (batch) or categories of chicken (accord to time you bought them) do you have in your farm?

Batch	Variety (races)	Where did you buy them?	When did you by them	How many	Do you plan to go back there?[5]	Where did you get information from?[6]	Do they lay from when?	How many eggs per week do you get from?	How are feeding them?[7]	What meals are you feeding them?[8]
1										
2										
3										

When you are going to by chicks, when do make an order?.....

When do you pay advance before you receive chicks?.....

[5] yes=1 and it is ok, if no ask why?
[6] Friends=1, extension officer=2
[7] According to their Age= 1, according to production=2, according to the variety=3, other=specify
[8] Meals bough from shops=1 and mixed by farmer=2

POULTRY (BROILERS) PRODUCTION

8. How many one year old chicks have you bough? ----------

9. How many groups (batch) or categories of chicken (accord to time you bought them) do you have now in your farm?

Batch	Variety (races)	Where did you buy them?	When did you by them	How many did you buy	How many are they now?	Do you plan to go back there?[9]	How many have you sold? When?	Where did you get information from?[10]	How are feeding them?[11]	What meals are you feeding them?[12]
1										
2										
3										

When you are going to by chicks, when do make an order?.....

When do you pay advance before you receive chicks?.....

[9] yes=1 and it is ok, if no ask why?
[10] Friends=1, extension officer=2
[11] According to their Age= 1, according to production=2, according to the variety=3, other=specify
[12] Meals bough from shops=1 and mixed by farmer=2

10. Feed in eggs and poultry production (feeds per batch)

	week	Chicken number?	Weight measurement (tools)	**Quantity per day per chicck**	Tot quantity per farm	Cost per kilogram	Tot cost
1. one batch • Zikiri imishwi • Zimaze kuba ibirwana • Zatangiye gutera	**1**						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						

Details on on feeding whether he mixe feed him self or not. When he change the mode of feeding	**Formula if he mixe feeed himself**		
	Blander	Kg:	Rwf:
	Soya	Kg:	Rwf:
	Torto	Kg:	Rwf:
	Indagara	Kg:	Rwf:
	Quoquille	Kg:	Rwf:
	Primex	Kg:	Rwf:
	Umunyu	Kg:	Rwf:

11. Vaccine

	(Code)	Administration date	Quantity per ?	Measurement Kilo=1 Litter= 2	Price kg	Total
Batch I						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Batch II						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

From how many shops can you buy feed, enumerate please?

1……

2……

3……

4……..

Are they different from where you buy vaccine? a) Yes (jyakumbonerahamwe)

b) No (subizaigikurikiye)

If they are different, from how many shops can you buy vaccine and drugs, enumerate please?

1……

2……...

3…….

4……..

5……

12. Other chemical products such as drugs, vitamins dewormers, ectopapasite use in poultry

	(Code)	**date**	**Quantity per ?**	**Measurement** **Kilo=1 Litter= 2**	**Price kg**	**Total**
Batch I 1 2 3 4 5 6 7 89						

13. Farm house and equipments

Housing	**Size**	**Ibisakajeinzu**	**Number of chicken**	**Housing Value**	
1.					
2.					
Other equipment	**number**	**Material**	**Number of chicken**	**Equipment price**	**Utility**
1.					
2.					
3.					
4.					
5.					
6					
7					
8					
9					

1.4 Who carried out the following farming activities last two months?

			Family labor						Hired labor		
Activity	How many person-days?	How many hours?			Children <18 years				person a day	The wage rate person a day	The total labourcost
					School going		Not going to school				
			Hsl Head	Spouce	male	female	male	Female			
Feeding and water											
Mixing food											
Procurement											
Veterinary service											
Ensure the right											
Selling eggs											
Selling chicks											

16. Do you belong to any Association, Cooperative of poultry production?Yes=1 No = 2

Which position do you have in it? Chairman =1 Secretary =2 Member only =3	
How the cooperative help you in poultry production? How the cooperative help you in poultry production?	

18. ACCESS TO CREDIT

Have you got credit to enhance poultry production? (1) Yes….. (2) No……

If yes, Please fill the table below:

Source of credit	Amount	Repayment period	Interest rate	Did the credit assist you?	How did you utilize it?

If no, why not**:** The banks and Micro finance institutions are far = 1 Have you lacked collateral =2 Is interest rate high for you?=3 Other=4

19. EXTENSION SERVICE

19.1 Did an extension officer visit you about rice production last season? Yes/No.

If yes, how many times last year? 1) Once a month 2) 3 times a month 3)Once in 6 months 4) Not at all.

19.2 If visited, what message did they carry?

Message----------

19.3 If they did not come, did you try to look for advice from extension agents? Yes/No

If yes, what type of information did you look for and from whom?

Type of information	Media (source)
1	
2	
3	
4	
5	
6	

19.4 Apart from extension agents how else do you get information on production of rice?

1) Radio 2) neighbor 3) newspapers 4) family and friends

19.5 What type of information did you get?

Type of information	Media (source)
1	
2	
3	
4	
5	
6	

D. MARKETING

20.1 In which form did you market for eggs and poultry meat last six season?

20.2 Last season where do you market it?

1) Traders came to my home 2) to the shopper 3) the seller of input 4) to the local market 5) Used any of the methods depending on convenience.

20.3 If traders came to your home, what price did you get per kilo or other unit on average?

1) Meat……..2) eggs ……..

20.4 How far is the market from your home? ----------

20.5 If you took to the market, what price did you get per unit (write the unit)?

1) Meat ----------

2) Eggs ----------

20.6 Are there times when you fail to market your eggs or meat? Yes/No.

If yes, what do you think are the reasons?

Table XVI: Poultry production and its estimate production

Year	**2,007**	**2,008**	**2,009**	**2,010**	**2,011**	**2,012**
The National population	9,238,626	9,478,830	9,725,279	9,978,137	10,237,568	10,503,745
Number of poultry	1,867,724	2,217,724	2,328,610	2,445,041	2,567,293	2,695,657
Female poultry	1,512,856	1,796,356	1,886,174	1,980,483	2,079,507	2,183,482
EGGS (tons)						
National requirements	3,151	3,233	3,318	3,404	3,492	3,583
Production	1,620	1,983	1,886	1,980	2,080	2,183
Gap	**-1,531**	**-1,250**	**-1,432**	**-1,424**	**-1,412**	**-1,400**
CHICKEN MEAT (tons)						
National requirements	7,296	7,486	7,680	7,880	8,085	8,295
Production	3,362	3,992	4,191	4,401	4,621	4,852
Gap	**-3,934**	**-3,494**	**-3,489**	**-3,479**	**-3,464**	**-3,443**

Source: (RARDA, 2010)