EFFICIENCY AND COMPETITIVENESS OF CHICKEN PRODUCTION IN MACHAKOS, KIAMBU AND UASIN GISHU COUNTIES, KENYA

By

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DECLARATION

I declare that this is my original work and has not been presented for a degree or award in any other university.

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DEDICATION

I would like to dedicate this work to my late mother, Beatrice Nduku who believed in me and insisted that I join university instead of pursuing accounting in local college. My two sons, Brian and Anthony have given me reason to work hard in everything I do.

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ABBREBIATONS AND ACRONYMS

AE	Allocative Efficiency
AKEFEMA	Association of Kenya Feed Manufacturers
CE	Cost Efficiency
CAPI	Computer Assisted Personal Interviewing
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Statistics
GDP	Gross Domestic Product
GoK	Government of Kenya
IAD	Institutional Analysis and Development
IC	Indigenous Chicken
KALRO	Kenya Agricultural and Livestock Research Organization
KNBS	Kenya National Bureau of Statistics
NABC	Netherlands Africa Business Council
NIE	New Institutional Economics
NBSC	National Bureau of Statistics of China
PAM	Policy Analysis Matrix
SME	Small and Medium Enterprises
SSA	Sub Saharan Africa
TE	Technical Efficiency

ABSTRACT

A company's or industry's competitiveness is its capacity to successfully compete in order to achieve sustainable growth and earn at least the opportunity cost of the resources used. The poultry sector is very important to the economy of Kenya and plays a key role in food and income security of majority of the producers who are mostly in rural areas. There has been high imports of poultry products from Uganda and China to the country in the past five years causing an uproar by local producers who complain of cheap products flooding the market and affecting their profits. In 2020, Kenya imported 1,000 MT of eggs with zero exports despite having a surplus in egg production. This study was therefore to assess the competitiveness and efficiency of chicken production in Kenya to determine the level of efficiency and ability to produce quality products at relatively lower costs. The specific objectives were; determine the technical, cost and allocative efficiency levels, assess the factors influencing these levels and investigate the competitiveness of improved indigenous chicken farmers in Kenya. Data were collected from 384 small-scale chicken producers across three counties of Kenya (Uasin Gishu, Machakos and Kiambu). A semi-structured questionnaire which had been uploaded on android phones was used to obtain data .A stochastic frontier analysis was carried out to determine the technical and cost efficiency of improved chicken producers in the three counties and factors influencing the efficiencies and a policy analysis matrix approach (PAM) was used to measure the competitiveness of the producers. Results indicated that majority of the farmers were middle aged women who had formal education. The major constraint of chicken production was cost of feeds which had driven some producers of the chicken enterprise. Results indicated that the producers attained an average technical efficiency of 58%,cost efficiency of 39% and allocative was 67%, which were low compared to efficiency scores recorded elsewhere. Some of the socio and institutional factors affecting the efficiencies included; household size, education level of household head, access to extension services, distance to input and output markets and distance to a tarmacked road. Results from the PAM indicated that they were competitive at social values but uncompetitive at private values. The study recommends that research institutions develop cheaper alternative sources of starch and proteins to cut down cost of feeds. It is also recommended that extension services are enhanced to improve farmers' knowhow on feed formulation, housing and disease management.

Key words: competitiveness, efficiency, egg imports, poultry and improved indigenous

CHAPTER ONE: INTRODUCTION

1.1 Back ground Information

According to FAOSTAT (2016), the number of poultry birds in the world now exceeds 23 billion, or roughly three per person. They are raised in a variety of farming methods and primarily provide meat, eggs, and manure for crop fertilization. Chicken products like meat and eggs are the best source of affordable and easily available protein that are required by millions of poor people globally. World production of eggs reached 73 million tons and that of poultry meat was close to 100 million tons in 2016 (GLEAM, 2016).

In the Eastern and Southern African countries poultry production has grown gradually over the past decades from a mainly backyard production system to a more specialized and commercial poultry value chain. This includes medium and large scale hatcheries, feed millers and suppliers, sophisticated housing equipment, veterinary services and abattoir facilities. The growth of the poultry value chain differs strongly from country to country. Countries like South Africa, Kenya, Zambia, Uganda and Zimbabwe have been the leading in poultry production.

Kenya's Agriculture sector contributes 25% to the country's GDP of which 30% is from the poultry sub-sector (NABC, 2015). Kenya has an estimated poultry population of 43.8 million and contributes 5.1 % of the total livestock value added (GoK, 2017a). According to the County Integrated Development Plans (CIDPs) of the three counties, Kiambu County had the highest poultry population of 2.5 million birds. It was followed by Machakos County with a poultry population of 1.5 million and lastly Uasin Gishu which

had a population of 0.7 million (CIDP, 2018). The poultry industry is very diverse, producing over 35,000 tonnes of meat and 1.6 billion eggs annually (FAOSTAT, 2019a).

Majority of local indigenous chicken are raised in rural settings while the exotic are reared mainly in Peri-urban and urban areas. Kenya is expected to experience an unprecedented growth in demand for food in the next 30-40 years. It is projected that the increasing wealthy and urbanized Kenyan population will consume more high protein food, such as meat, milk and eggs by 2050. Per capita consumption of meat is currently low, averaging less than 10kg for any type of meat while that of eggs is 36 eggs compared 200 in the world. According to world atlas 2019, Kenya produced 30,248 tonnes of poultry meat up from 24,000 tonnes in 2006 (Fig 1).

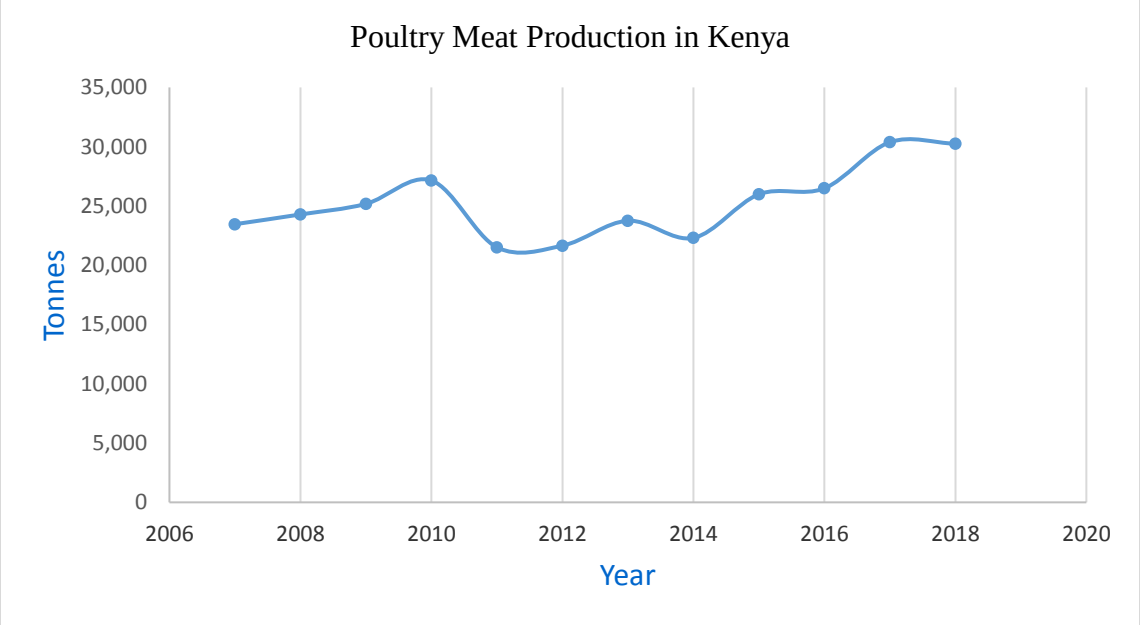

Figure 1.1: Poultry meat production in Kenya (World Atlas, 2019)

According to Knoema, egg production for Kenya was 98,544 tonnes in 2019 (World Data Atlas, 2019). It increased from 11,688 tonnes in 1970 growing at an average rate 5.1% annually (Fig 2).

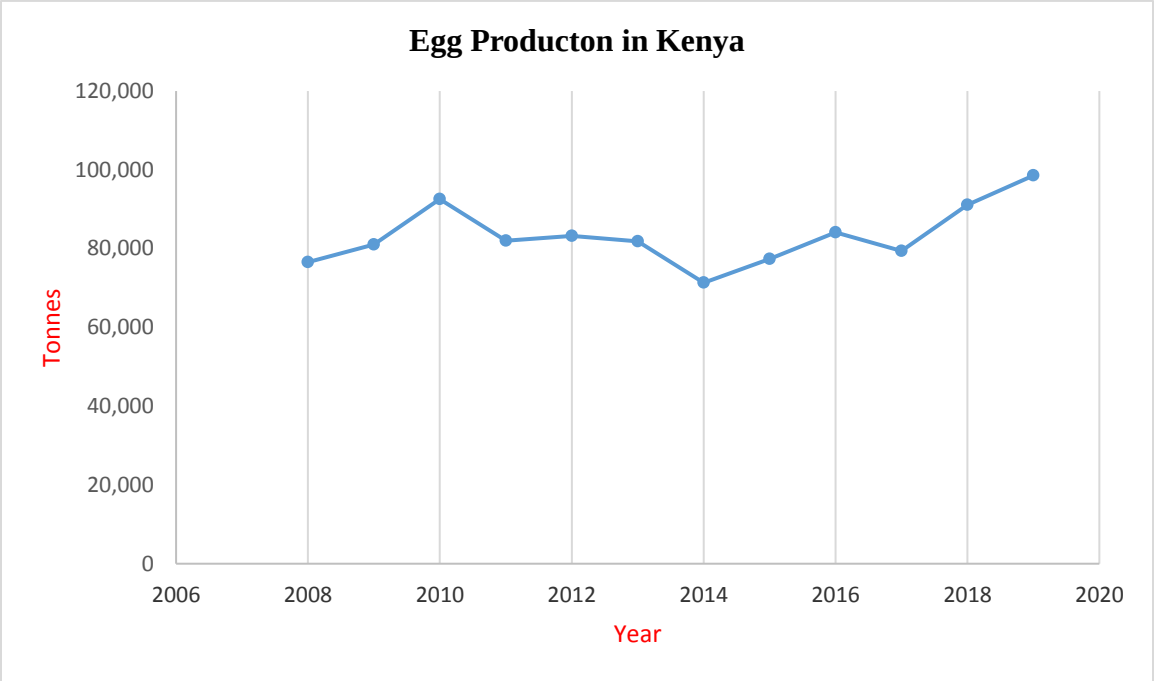

Figure 1.2: Egg Production in Kenya, 2008-2019 (World Atlas, 2019)

Chicken production is becoming increasingly popular in developing nations due to its compatibility with local production systems, its contribution to closing the protein availability gap and its ability to empower the resource-poor segment of society especially women (King'ori *et al*., 2010). In Kenya, the indigenous chicken kept by most rural families (>75%) accounts for 71% of the total egg and poultry meat produced, significantly impacting the rural trade, welfare, and food security of smallholder farmers (Nyaga, 2007). Chicken products are one of the best sources of animal protein, and help to improve food and nutrition security of millions of people who live in poverty

countrywide. Chicken production is also a reliable source of income and employment for majority of youth and women in Kenya (Ahlers *et al.*, 2009). Commercialized chicken production could be used as a strategy to address food and nutrition security among the rural poor. Despite the benefits derived from indigenous chicken production, farmers are faced with a myriad of challenges including; rising cost of feeds, drugs, water and electricity, high incidences of pests and diseases, limited information on both input and output markets and inadequate extension services (Abadi *et al.*, 2018 and Wambua *et al*., 2021). Government and non-governmental organizations have collaborated to reduce these obstacles and assist the industry in increasing its productivity and demand for poultry products (Baliyan and Masaku, 2017). Among the efforts is the introduction of the improved indigenous chicken which matures early and lays more eggs than the IC (KARI, 2008). Despite all efforts to improve indigenous chicken production and productivity among rural farmers, the enterprise continues to generate unsatisfactory returns (Kejela *et al.*, 2020). Agricultural policies tend to focus more on promoting productivity through technological change than through better utilization of existing technologies. However, there is need to shift the focus towards improving efficiency in this era of limited resources (FAO, 2017). Typically, agricultural productivity is thought to represent the effectiveness of the production process, although this is only true if the farm is technically efficient (FAO, 2017). Technical efficiency is the combination of a set of inputs that results in the maximum possible output. Therefore, the goal of this study was to evaluate the efficiency and competitiveness of improved indigenous chicken, a technology that already exists. Porter defines competitiveness as an enterprise's capacity for long-term success in comparison to rivals in other nations, regions, or clusters (Porter,

1990). According to Sachistra (2016), it is the capacity to sell goods that satisfy demand requirements (price, quality, and quantity) while also ensuring the company's long-term profitability. Key components of competitiveness are productivity, market share, and profitability. The European Commission considers productivity and efficiency as two most reliable indicators of competitiveness (European Commission, 2008). Productivity of a farm enterprise is attained through improving its performance. A farm that is efficient in production will realize higher returns, thus motivating the producer to sustain it (Ohajianya, *et al*., 2013).

1.2 Statement of problem

In Kenya, agriculture accounts for 33% of the national gross domestic product (GDP), with poultry sector accounting for 30% to the same (GOK, 2019). Approximately 68% of Kenyan households own at least one type of livestock, with 75% of these households owning chicken. Poultry keeping is one of the most popular livestock enterprises especially among women, due to its low capital and space requirements. Additionally, there are two to three million people employed in the subsector mostly smallholder farmers who depend heavily on it for income generation. Many diets include poultry, particularly chicken, which is a significant source of animal proteins. It also plays important social and cultural roles amongst poultry keepers (ILRI, 2020).

With an annual egg production per hen of between 80 and 100 and a very small egg size of approximately 46.5 grams, indigenous chicken productivity in Kenya is rated low in comparison to improved breeds, which have the potential to lay 280 eggs per year and have an egg size of 65 grams (KARI, 2012; Wambui *et al.,* 2018). To counter some of

these problems, KALRO, then KARI, bred an improved chicken which is early maturing and lays more eggs popularly known as KARI Improved Kienyeji. The improved indigenous chicken lays 200 to 280 eggs compared to 80-100 of the local According to Addisu *et al.* (2013), the manner in which the flock is managed in terms of nutrition, housing, breeding, and health management largely contributes to the variations in egg quality. It starts laying at the age of 4.5 months and does not brood (KARI, 2012). However, even with the introduction of the improved breed, farmers are still producing below average. A study by ILRI and SPARD in western and rift valley regions of Kenya indicated that the average annual egg production per chicken is 169 (ILRI, 2020). This raises key question:

i. Are poultry farmers in Kenya efficient in their production systems?

ii. What are the defining factors for the poultry farmers to achieve maximum output?

Globally, poultry sector has become very competitive due to improved technologies and innovations, product differentiation and cost management. According to the Kenya poultry business association, poultry farmers and entrepreneurs have been protesting the influx of eggs from Uganda and China, claiming that the high cost of feed and low returns are making it difficult for them to break even. (KPBA, 2019). This is despite the introduction of improved and exotic chicken breeds to improve productivity. This calls for a decisive analysis of the Kenya poultry sector competitiveness. Report by FAO (2017) observed that agricultural policies emphasize on enhancing productivity based on technological change rather than better use of available technology. However, re-focusing of poultry production strategies towards improving efficiency amid ever increasing cost

of production especially chicken feeds, is critical in maintaining high thriving and competitive poultry industry in Kenya.

A forecast based on the FAO projects that Kenya will import from Uganda 2,802 metric tonnes of eggs in 2026 up from 2,349 metric tonnes in 2022 (Figure 1.3)

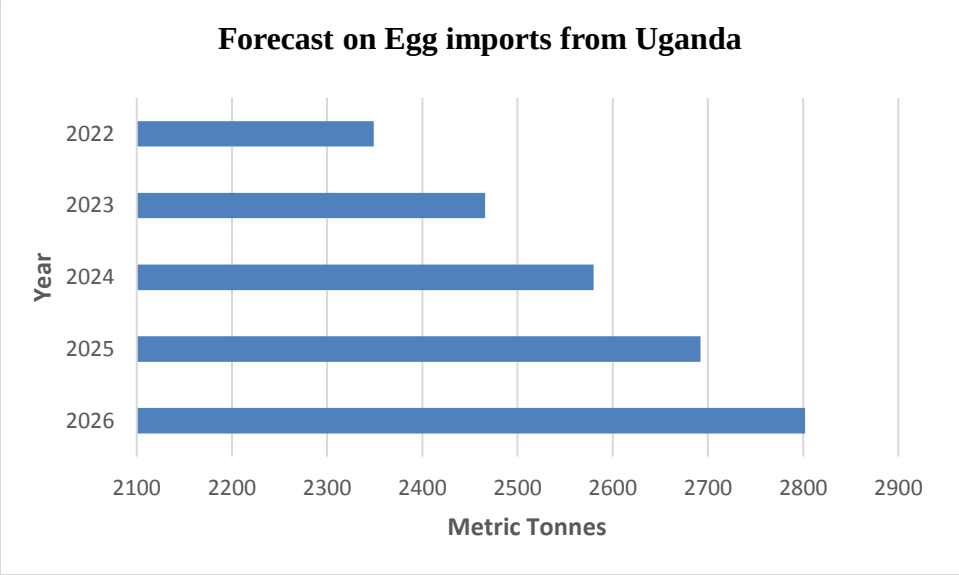

Figure 1.3: A forecast of egg imports from Uganda up to 2026 (ReportLinker, 2022)

1.3 Objectives

The main objective of the study was to evaluate the efficiency and competitiveness of improved indigenous chicken production in Kenya.

1.3.1 Specific Objectives

i. Determine technical, cost and allocative efficiency levels of improved indigenous chicken production in Kenya.

ii. Investigate factors that affect efficiency levels in improved indigenous chicken production.

iii. Assess the competitiveness of improved indigenous chicken producers in Kenya

1.4 Research questions

i. What are the technical, cost and allocative levels of improved indigenous chicken production in Kenya?

ii. What are the factors affecting production efficiency of improved indigenous chicken?

iii. Are improved indigenous chicken producers in Kenya competitive?

1.5 Significance of the study

Rising population, consumer awareness, and health consciousness has led to increased demand for eggs globally. In developing countries, the diet of city dwellers usually contain more animal protein compared to that of rural dwellers, mostly because urban people are more affluent and have a greater choice of foods at local markets. Increased human population has led to land subdivision hence making chicken an ideal enterprise since they require less space or area. Return to land and to labor are higher in chicken production than in most of all agricultural enterprises. Poultry industry creates opportunities throughout the value chain, not only in poultry production but also in grain production for feed manufacturing (the largest opportunity for small-scale farmers), job creation by larger companies and various Small and Medium Enterprises (SME) opportunities such as aggregators/traders, agro-input dealers, veterinary services, hatcheries, brooding units, mobile abattoirs, domestic and international retail outlets and eateries. The improved breeds mature faster hence contribute to meeting the high demand for chicken meat in institutions like hotels, schools, supermarkets and hospitals. Gender studies have shown women mostly own poultry in households. They are able to make decisions around production, marketing and home consumption hence improving the

welfare of the household. Both commercial and small holder chicken rearing play a key role in poverty reduction, improvement of household food, nutrition and income security especially now when the country is reeling from climate change effects. In addition, some of the study areas experience perennial droughts and this makes the area unsuitable for other agricultural activities that are rain fed. This makes chicken rearing an alternative since it is not climate dependent and chicken can tolerate harsh weather. This therefore makes chicken production a suitable enterprise for climate change mitigation and acts as a safety net.

1.6 Theoretical Framework

The current economic theory and the trade theory are the two theories on which this study is founded. The premise of economic theory is that consumers' or producers' behavior is always being optimized. The idea presupposes that producers maximize from both a technical and an economic standpoint. Not all producers are able to solve both kinds of optimization issues under all conditions. Performance at the firm or industry level, which is measured by the ratio of outputs produced to inputs used, can vary depending on production technology, process efficiency, and/or the environment in which production occurs (Fried *et al*., 1993). Due to differences in production efficiency, businesses or industries may exhibit varying levels of productivity even when technology and the manufacturing environment are identical (Korres, 2007). Therefore, it is crucial to develop a method for measuring the extent to which producers fall short of achieving maximum productivity or the deviation from the most possible level of technical and economic efficiency. Based on this common concept, the analysis of production frontiers,

a tool that has grown significantly in recent decades, is one of the primary analytical approaches to measuring efficiency.

The Stochastic Frontier Analysis (SFA) approach developed by Aigner, Lovell and Schmidt is the most frequently used parametric approach in efficiency evaluation (Blatnik, Bojnec, & Tušak, 2017). A composed error structure with a one-sided inefficiency component and a two-sided symmetric random component are integrated into the method (Aigner *et al.* 1977;; Jondrow *et al.,* 1982; Battese and Coelli 1992). The Data Envelope Approach (DEA) technique, in contrast, employs non-parametric analysis to evaluate the effectiveness of various decision-making units (DMUs). Two key benefits of the DEA approach for evaluating efficiency scores are: The exact functional form between inputs and outputs need not be assumed, and the inefficiency term's distributional assumption also need not be established. A drawback of the DEA is that the inefficiency component cannot be distinguished from statistical noise and/or measurement error due to its deterministic structure. In this study, the stochastic frontier approach which has a wide range of model specification and distribution options for the efficiency component's unknown variance was used.

We assumed a modified Cobb-Douglas specification and frontier production (Coelli and Battese (1996):

$$\ln(Y_{ip}) = \alpha_{o\ p} + \Sigma\beta_{jp} \ln(X_{ijp}) + \Sigma\alpha_{jp} D_{jp} + v_{ip} - u_{ip} \quad \text{..(1)}$$

$$\mu_{ip} = \delta_{0p} + \Sigma\delta_{kp} Z_{ikp} \quad \text{..(2)}$$

"The unknown parameters α_{o} p, β_{jp} and α_{jp} are postulated to be independently and identically distributed random errors with distribution $N(0,\sigma^2)$; the u_{ip} are positive

technical inefficiency effects that arise by truncation at zero of the normal distribution N (μ_{ip}, σ^2_u) where the unknown variance σ^2_u is defined by":

$$\sigma^2 = \sigma^2_u + \sigma^2_v \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\gamma = \sigma^2_u / \sigma^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

"The **γ** parameter's value lies between zero and one. When the logarithmic production frontier function is defined, the suggested technical efficiency measure for the i^{th} farm is as follows";

$$TE = exp\,(-\mu_{ip}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Trade theory, which holds that a nation's ability to produce the goods and services it excels in is what determines its economic well-being, serves as the foundation for the third objective of this study. This indicates that production must match a nation's comparative advantage for it to be globally competitive. Trade theory is classified into two categories namely; traditional (which has a neoclassical foundation) and new trade theory. Perfect competition, homogeneous goods, and fixed returns to scale in production are all aspects of traditional trade theory. This category includes the Heckscher-Ohlin and Ricardo trade theories, as well as any modifications or extensions of the latter.

The Ricardian theory focuses on general equilibrium model with the assumption of a common factor of production being fixed and available to only two countries producing two similar goods. The theory demonstrates a situation where a nation exports goods it can produce at the lowermost costs and imports goods it can produce at the maximum cost. It emphasizes that a nation without absolute advantage over its trade partners, in

terms of cost of production of goods, can enjoy the benefit of foreign trade with a relative advantage in another good if she exports her products. Heckscher-Ohlin theory is grounded on the principle of resource endowment with a foundation for basic understanding of exportation of capital-intensive goods by capital-abundant country and exportation of labour-intensive goods by labour-abundant country (Sen, 2010). This theory is often referred to as natural resource abundance theory and its proposition is that a country producing goods at a low cost will definitely export her products in exchange for goods for which she has less relative abundance. The emphasis in recent international trade literature has shifted away from traditional models based on perfect competition and fixed returns in production and moved towards the implications of imperfect competition and economies of scale. New trade theories have challenged the following underlying assumptions of traditional trade models:

i. the assumption of perfect competition that has been replaced by imperfect competition.

ii. fixed returns that were replaced with increasing returns to scale

iii. homogeneous goods, which was phased out in favor of product differentiation.

The new trade theory holds that it is not as simple as it looks to declare that free trade is the best course of action. On one hand, the presence of imperfect competition might necessitate additional competition (trade) in order to compel a reduction in profit margins. On the other one, the potential for industrial efficiencies of scale may make government intervention appropriate. In their model, Brander and Spence (1985) demonstrate how smart government intervention such as the giving export subsidies can result in the profitable utilization of excess capacity to boost output and, as a result,

enhance the domestic producer's share of the global market. Local producers are also favored (supported) over overseas rivals or competitors.

The theory also claims that comparative advantage is not solely determined by factor endowments, implying that a country's comparative advantage pattern can be altered through targeted interventions. Factors such as unforeseen events (wars, oil crises, sanctions) and previous government policies are very key in shaping a country's trade pattern. Imperfect competition and growing returns to scale are two models incorporated into the new trade theory. The actions and competition of oligopolists are still poorly understood by economists hence any modelling of oligopolistic behavior essentially tends to be extremely limiting therefore difficult to apply. Therefore, it is not surprising that the new oligopolistic behavior-based model of international trade lacks theoretical sturdiness and is particularly susceptible to assumptions about the number of firms and competitive behavior. The size of the excess profits assumed to be produced by oligopolistic firms, the partial equilibrium nature of the analysis, the identification of the market failure, and the instrument of choice are some additional economic criticisms. Furthermore, the normative prescriptions that result from it are subject to a slew of political economy criticisms, such as the risk of foreign retaliation, ineffective government intervention, policy capture by special interests, and the possibility of hostile redistributive effects. These criticisms severely limit the models' applicability to any country.

1.7 Conceptual Framework

This study’s main objective was to evaluate the efficiency and competitiveness of chicken production in Kenya. Demand for agricultural products has been on the rise in

the global market and this requires high levels of competitiveness in the sector to satisfy it (Yercan, 2006). According to Dlamini *et al*., 2014, unavailability of high skilled laborers, high cost of inputs, and incompetent public servants were some of the factors affecting competitiveness of agribusiness firms in Swaziland. In another study, Dziwormu found out that cost, experience and capacity utilization were the main factors that significantly affected competitive advantage for Ghana broiler chicken farmers. Efficiency has three components namely technical, allocative and economic (Abdulai and Huffman (1998). Several factors affect efficiency and eventually competitiveness of a farm. These factors can be categorized into: Productive, institutional and socio-economics. The framework below developed by the author is a guide on the various variables measured in order to determine efficiency and competitiveness among Kenyan chicken farmers.

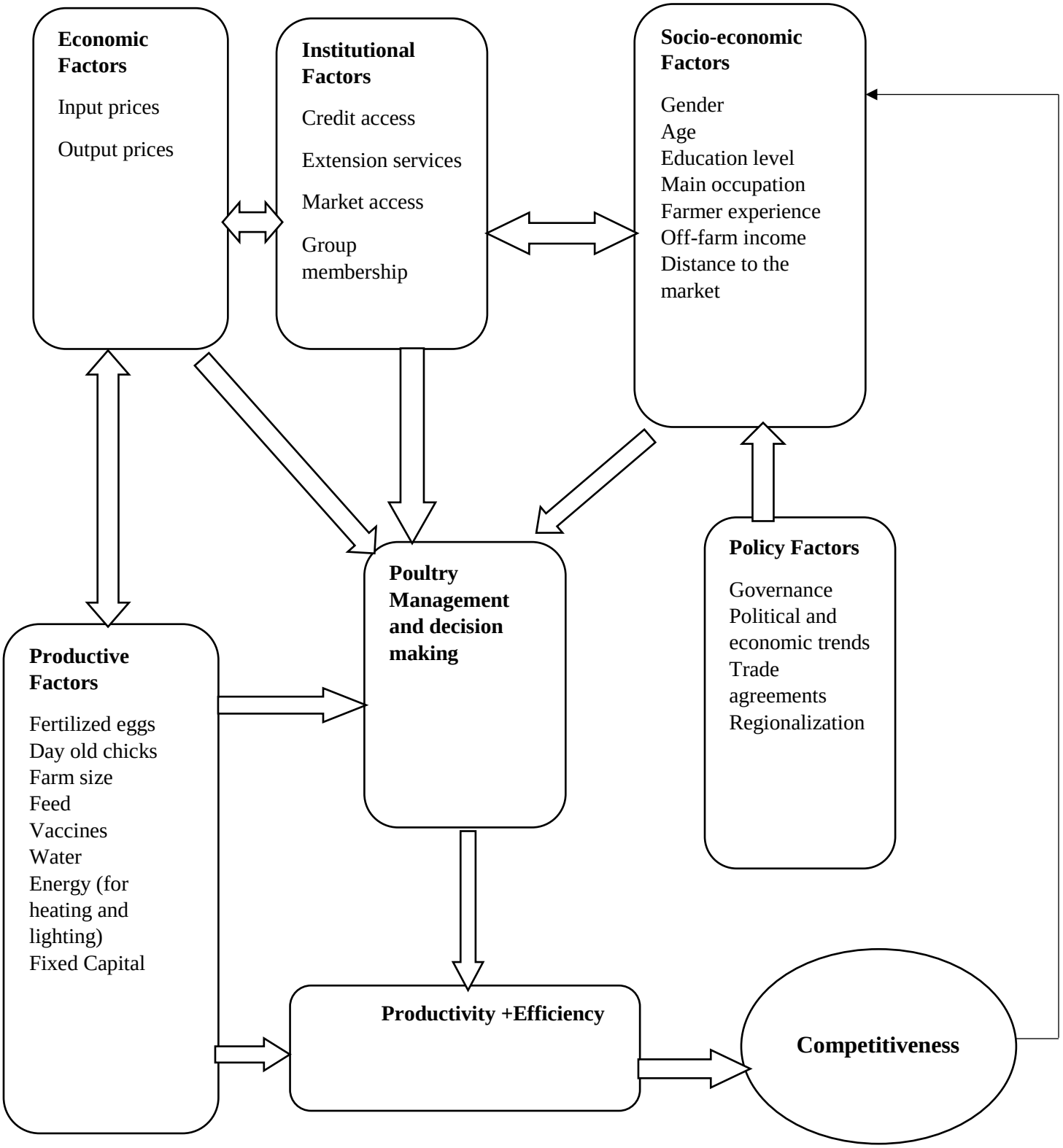

Figure 1.4: Conceptual Framework

Source: Author, modified from the New Institutional Economics theory

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter presents previous studies carried out by other researchers on the same or related issue and identifies gaps in research which need to be filled. Some of the areas of review include chicken production in East Africa, technical, cost and allocative efficiencies in chicken production, factors affecting these efficiencies and competitiveness of chicken enterprises.

2.1. Chicken production in East Africa

The poultry industry in East African nations has evolved from a backyard poultry keeping business to a more commercially focused structure, albeit still being underdeveloped (Vernooij *et al*., 2018). Despite several attempts to build a commercially intensive poultry production system, the majority of poultry are still raised by smallholder farmers in both semi-intensive and extensive systems, primarily using native chicken breeds (De Bruyn e*t al*., 2015). Smallholder farmers produce 80% of the region's poultry flock, which is an essential component of the livelihoods of rural and resource-poor households in sub-Saharan Africa (Birhanu *et al*., 2022 and FAO, 2020). Genetic improvement is the primary strategy to address the low productivity of local indigenous chicken. The introduction of exotic breeds into smallholder intensive chicken production in Sub-Saharan Africa has not been competitive due to challenges in management as well as high costs for feed, veterinary care, and energy (Tabler *et a*l., 2022). To counter these problems, several countries like Nigeria, Ethiopia, Kenya and Uganda introduced a dual purpose improved chicken breed which can adapt to tropical climate modest management practices. Dual-purpose breeds are easier to handle at the village level and produce eggs

and meat simultaneously (Mueller *et al.,* 2020), have strong scavenging abilities (Spencer, 2013), and are adaptable to a variety of agro-ecosystems (McDougal, 2019). These breeds are best suited for smallholder farmer production systems since they have reduced protein requirements, can be fed both conventional and non-conventional foods, and are less prone to common diseases like Gumboro. In order to improve meat and egg production, Uganda introduced the Kuroiler chicken breed from India which was superior compared to the indigenous one. They attained a body weight of 3kg in maturity compared to 1.5- 2.0 kg of the indigenous and laid 200 eggs compared to 40 of those of indigenous annually. Through the national agriculture research organization KARI, which is now KALRO, the government of Kenya developed a strategy to improve indigenous chicken productivity by evaluating the performance of various ecotypes. Research on Improved indigenous chicken which is a superior crossbreed of different indigenous chicken (IC) ecotypes from the various selected Kenyan communities commenced in 2002. This breed is dual purpose (meat and eggs) and produces more eggs, is early maturing and attains market weight faster (KARI 2011).

2.2 Technical, allocative and cost efficiency in chicken production

Bielik, 2011 defines technical efficiency as the ability of a farm to produce maximum output from a given set of inputs while allocative efficiency (AE) is described as the ability of a producer to combine the available resources while considering the market prices for maximum returns (Degla, 2015; Mutoko *et al*., 2015) for maximum outputs. Cost efficiency (CE) refers to a farm's ability to produce maximum output at the lowest possible cost while taking current technology into account for profit maximization. Aboki *et al*., 2013). According to the oxford dictionary, cost efficiency is the ability to give the

best possible profit or benefits in comparison with money spent. Cost inefficiency arises when resources are used in an inappropriate matter hence not achieving optimal profits. Assessing the efficiency levels of farmers is very vital in assessing profitability, because it demonstrates how a farmer distributes his/her resources to achieve maximum returns In a study in Nigeria technical inefficiency caused 69% deviation in the output of poultry egg production by (Ashagidigbi *et al.,* 2011). Results from a study carried out in Uganda indicated that the technical efficiency of layer poultry farmers was 81% with over 90% operating at TE levels above 50% (Obed, 2018). In a study carried out among rice producers in Burkina Faso to assess their economic and technical efficiency, results indicated that literacy levels of producers negatively influenced TE while farming experience influenced it positively (Ouedraogo, 2015). In the same study, AE was positively influenced by household size and farming experience. Another study carried out to assess the cost efficiency of farms in Burkina Faso found out that the mean efficient level was 64%. The household head's educational level, access to good roads, ownership of a radio, availability of credit, and lost work time from illness were some of the factors that led to cost inefficiencies (Combary, 2016). This concurred with a study carried out in Nigeria which indicated that there was a negative relationship between level of education and cost efficiency. This contrasted the assumption that high education level of farmers have a positive effect on the cost efficiency given their knowledge, skills and the ability to adopt new technologies which can minimize costs of production (Ogundari *et al.,* 2006)

2.3 Factors affecting chicken rearing enterprises productivity and efficiency

According to Sibiko, farm productivity is defined as the ratio of agricultural output to inputs (Sibiko *et al,* 2012). It depends on the scope of the operation, the environment in which it is conducted, the production technologies, and the operational effectiveness (Coelli, 2002). It is basically a measure of productive efficiency. A study to measure competitiveness and efficiency of pig and poultry production in Vietnam found out that longer distance, high cost of feeds, sex of household head and small flock size increased inefficiency in sampled households. Flock size, feed intake, and labor were all significant determinants of output, according to Ezeh *et al.* (2012). Farmers achieved an average technical efficiency of 75%, with scores ranging from 8% to 97%.

2.4 Competitiveness of chicken enterprises

Latruffe (2010) classified drivers of competitiveness into two categories namely; internal and external. Under internal drivers, farm size and social capital were discussed. Another driver assessed in previous studies is the effect of agricultural specialization on farm competitiveness with results indicating that it enhances competitiveness (Brümmer, 2001). There was a negative correlation between a farm manager's age and competitiveness given that older farmers had difficulties in adopting and implementing innovations (Brümmer, 2001; Hadley, 2006). However, other studies contradicted this and found out that age of farmers affected competitiveness positively , as older farmers utilized inputs more efficiently (Mathijs and Vranken, 2001; Chen *et al.,* 2009). Level of education of farmers and farm managers was another determinant found influence farm competitiveness positively since highly-educated farm managers may have high skills and grasp new technologies and innovations faster. Previous studies by Latruffe *et*

al., (2004) confirmed that years of schooling affected the technical efficiency of family owned farms in Hungary and Bulgaria. Gender of household head was another factor found to influence farm competitiveness and productivity. In a study in Nigeria, Timothy and Adeoti (2006) indicated that women farmers recorded higher technical efficiency compared to male farmers. This concurred with a study in Kenya on maize production which indicated that gender affected technical efficiency negatively with women having 9.6% TE levels lower than men farmers (Kamau, 2019). Main occupation of the farmer, i.e whether full-time or part-time is another key factor affecting competitiveness with Brümmer (2001) having observed that farmers whose main occupation is farming are more efficient than part-time ones. Agricultural policy was found to play a vital role in the agricultural sector and influenced farm competitiveness. According to Banse (1999) government interventions affected agricultural competitiveness negatively. Nivievskyi *et al* (2008) and Bezlepkina *et al* (2005) found a positive relationship between government subsidies and competitiveness in Russian dairy farms. A study carried out in Eastern Uganda found out that management practices (famers' experience, flock size and age of birds) and not the type of breed affected competitiveness (Kato, *et al*, 2008). Government support was identified as another important factor influencing competitiveness for small firms (Ismail, *et al*, 2014).

2.5 Measuring competitiveness using Policy Analysis Matrix (PAM)

Many researchers have used the PAM model, developed by Monke and Pearson, to assess the degree of government intervention, comparative advantage, and input use efficiency (Monke and Pearson 1989). The matrix measures the impact of investment policy on economic efficiency and comparative advantage as well as the impact of policy on farm

profitability and competitiveness. Previous studies have used PAM to measure competitiveness of farms in different countries of the world. In Nigeria, a study to measure the competitiveness of the broiler value chain reported that farmers were socially profitable and that they enjoyed government protection through subsidies and ban on importation (Kassali, *et al,* 2022,) . Elsewhere in Iran, a study to assess the competitiveness of shrimp production indicated that it was inefficient and that subsidies were higher than taxes through market distortions. Social profits were negative implying that the shrimp industry could not survive without government support (Esmaeili 2008). A study in Indonesia to assess competitiveness of chilli production indicated that it was both privately and socially profitable. On average, farmers' private profits were lower than their social profits implying that they face disincentives in chilli production. Another study in the same country measuring level of competitiveness of soybean production revealed that farmers were making private profits due to government protection through provision of input subsidies namely; seed and fertilizers. Government protection helps improve the private profits of farmers and this is evident in another study carried out in Malawi which measured the level of competitiveness of groundnut farmers. This study found out that groundnut production of improved varieties was profitable at both private and social prices. This was enabled by the seed subsidy program provided by the government hence reducing cost of production and eventually increasing profits (Longwe-ngwira *et al* 2012).

2.6. Research Gaps

The above review highlights a number of inefficiencies in the quest for researchers to assess the poultry productivity vis-a-vis policies and measures concerning the performance of the poultry industry.

First, employing cost efficiency concept, this study endeavors to bridge the gap that, it is possible for researchers to assess the ability to produce in terms of least waste of time, effort, and resources. The study provides an evidence that cost efficiency approach can be employed at chicken enterprises in rural areas as a strategy relating to reduction in the cost of production, and enhance productivity and to allow better decisions by assessing costs, benefits, and profitability.

Secondly, the study employing the concept of technical efficiency analysis, i.e. how well inputs are utilized, offers an agnostic and evidence-based assessment of production strategy, which is crucial in poultry farming against productivity concept which has been the focus of many studies in poultry farming. Efficiency which is better use of existing technologies is necessary especially in the context of resource limitation.

Thirdly, the study ingeniously applied the competitive analysis using the local level data to assess the ability of the poultry enterprise to provide eggs more effectively and efficiently against their competitors in the region. Using the farmers' resource endowments, technology and productivity levels the study endeavored to assess the competitiveness of the poultry industry in Kenya.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter highlights the key aspects of the techniques employed to carry out this study. This include; the study area, sampling design, sample size and data analysis procedures.

3.1 Area of Study

The study was carried out in Machakos, Uasin Gishu and Kiambu counties in Kenya. Machakos County is situated in the eastern part of the country with an average rainfall of between 500 mm and 1300 mm which is usually unevenly distributed and unreliable. The County had 862,592,000 indigenous chicken in 2019 (KNBS, 2019). Uasin Gishu is located north of the rift valley. In the last national census, the County had 93,611 sheep, 27,216 goats, 140,703 exotic birds, 400,000 local birds and 7,292 pigs. Kiambu County is one of the richest and 2nd most populated County (with 2.4 M people) in the Republic of Kenya (KNBS, 2019). Agriculture is the predominant economic activity and had 2.6 M poultry in 2009 (KNBS, 2009). The three counties were chosen to represent the different agricultural ecological zones (AEZs) and climatic conditions. Machakos is mostly semi-arid, though it has some areas with upper midland zones. The study was carried out in the upper and lower midlands of the three Counties where chicken is kept for both food and income security. The number of chicken kept in the three counties was another criteria used to select the counties.

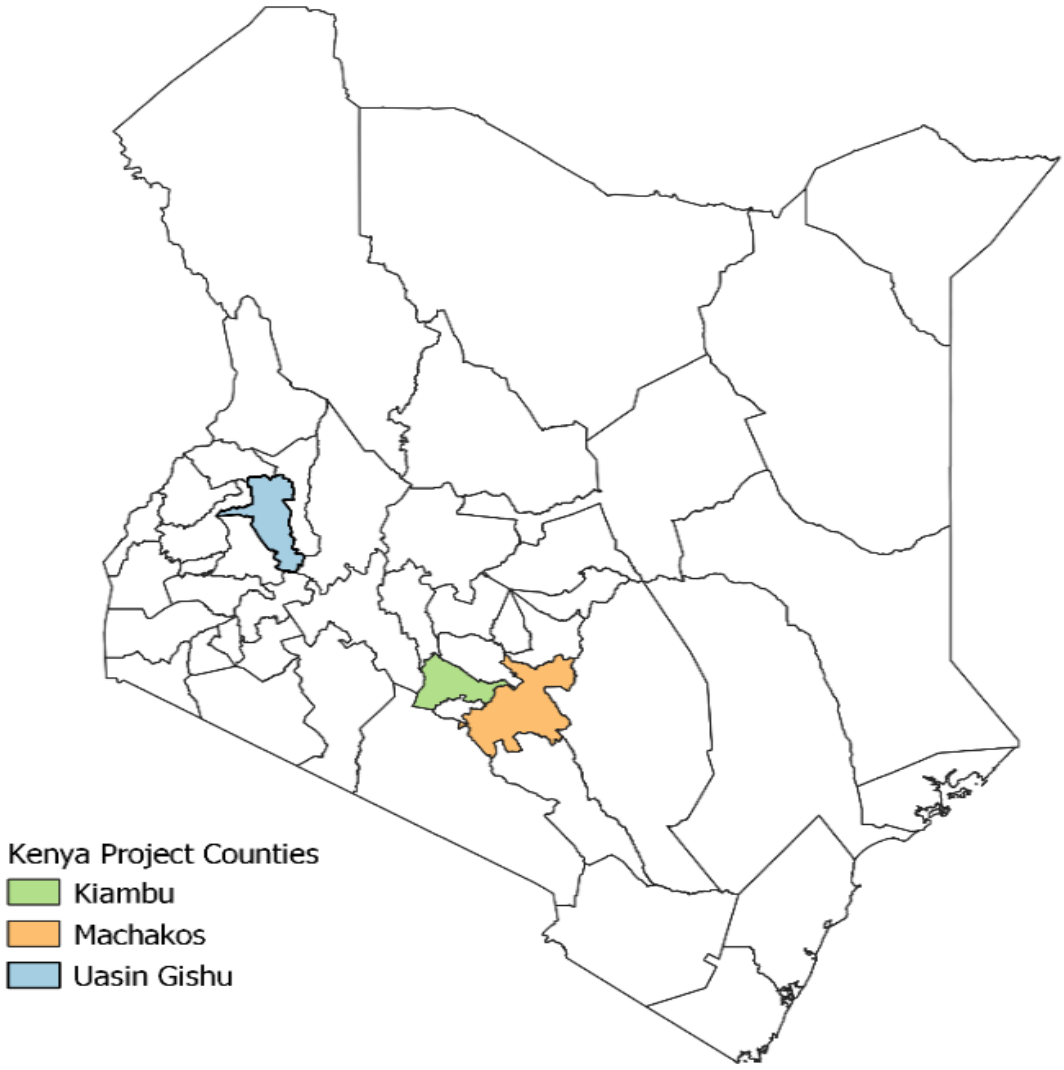

Figure 3.1: map of study sites

3.2 Research and sampling Design

A situation analysis was conducted to map out the targeted population within the respective target counties. The result from the situation analysis will be used to prepare a sampling frame to guide the study. Chicken farmers rearing indigenous and improved indigenous breeds were the target population. Purposive sampling was used to select the study areas in this case, counties. They were selected according to population size of birds (improved indigenous) which were obtained from secondary sources like County

Livestock reports and sales reports from KALRO Naivasha. For a farmer to qualify as respondent s/he must have been keeping 20 birds or more at the time of the study. Thereafter stratified sampling was used to select the different sub groups of farmers from the six KCSAP wards in Machakos and Uasin Gishu Counties after which simple random sampling was used to select respondents.

3.3 Sample Size

The population of chicken producers was unknown therefore the Cochran formula for infinite population was used.

$n_o = z^2pq/e^2$

where, n_o = sample size

z = selected critical value of desired confidence level

p = estimated proportion of an attribute that is present in the population

$q = 1 - p$ and e is the desired level of precision

The assumption is that the maximum variability is equal to 50% (p=0.5) at 95% confidence level with ±5% precision. The calculation will be as follows:

P=0.5 and hence q=1-0.5, e=0.05 and z=1.96

$n_o = (1.96)^2 (0.5) (0.5)/(0.05)^2 =$ **384.16** (Cochran 1977)

Table 3.1: Sampling Frame

County /District	**Improved Chicken producers**

Machakos	135
Uasin Gishu	101
Kiambu	148
Total	**384**

3.4 Collection and data types

Primary data were collected using structured questionnaires which were administered through face to face and telephone interviews. The questionnaires were uploaded into android cell phones via computer assisted personal interviewing (CAPI) method. This aided in reduction of errors by enumerators by ensuring that all questions in the questionnaire were answered. Location of farmer homes was also recorded through GPS data. Secondary data was collected through desktop reviews and statistics from the ministries of Agriculture and Livestock and Trade and Industrialization.

3.5 Data analysis

The first objective was determining technical, cost and allocative efficiency scores/levels of chicken producers in Kenya. The study applied the stochastic frontier approach to determine both efficiency and inefficiency scores of chicken producers. Following Farrell's pioneering work, theoretical and applied research in this area has grown richer as a result of the subsequent works of Aigner and Battese (Farrel 1957, Aigner *et al*, 1977 and Battese 1992). In the following frontier production and inefficiency models, which are variations of Coelli and Battese, we assumed a modified Cobb-Douglas specification.

$q = f(k, l) = A\, k\, \alpha\, l\, \beta,$

Where A, α, β are constants. The production function is presented as follows:

Input variable	**Type**	**Expected sign**
$lnYi = \alpha + \beta 1\ lnX1 + \beta 2\ lnX2 + \beta 3\ lnX3 + \beta 4\ lnX4 + \ldots\ldots\ldots\ldots\ldots\ldots B8\ lnX8 + \mu;$		

Table 3.2: Variables used in the Technical Efficiency model

Input variable	Unit of measurement	Type	Expected sign
Quantity of feeds	Kg	Continuous	+
Labour	Man days	Continuous	+
Quantity of water	Litres	Continuous	+
Housing cost	Cost in Ksh	Continuous	+
Breed of chicken	Local or improved	Dummy	+
Transport	Cost in Ksh.	Continuous	+

The second objective is determining factors that affect technical and cost efficiency of chicken producers in Kenya. The empirical efficiency function to be used is as follows:

$$R = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 \ldots\ldots + \beta nXn + e$$

Where: R= Technical Efficiency /cost efficiency

Sex of household head	Continuous	+/-
Age	Continuous	+/-
Education	Continuous	+/-
Farmer experience	Continuous	+/-
Main occupation of farmer	Categorical	+/-
Transport	Continuous	+/-
Distance to input market	Continuous	+/-
Distance to output market	Continuous	+/-
Credit access	Dummy (Yes or No)	+/-
Access to extension services	Dummy (Yes or No)	+/-

Table 3.3: Variables used in determining factors affecting TE and CE

The third objective of evaluating competitiveness, was examined using the Policy Analysis Matrix (PAM), which determines whether agricultural systems are competitive under current technologies and prices The policy analysis matrix is a double accounting technique that summarizes farm and post-farm budgetary data. .. It is calculated using both private and social prices. Matrices of revenues, cost and profits were constructed and used to calculate private and social profitability.

Prices that would prevail if there were no distortions (such as taxes and subsidies) or market failures are referred to as social prices. They explain how extra public investment in production processes might affect efficiency. Private prices are the actual prices at which goods and services were exchanged. Building a PAM for an agricultural system allows one to calculate private profitability or a measure of the system's competitiveness at current market pricing. A ranking of the competitiveness of agricultural systems at market prices is possible using similar evaluations of other systems. In the first row of the PAM matrix, the calculation of private profitability or competitiveness is done.

The PAM approach's second goal is to determine the social profitability of the agricultural system, which reveals if the outputs produced and the inputs used are valued at efficiency prices (social opportunity costs). Rankings of agricultural systems' efficacy are possible thanks to complementary evaluations of other systems. The second (middle) row of the PAM is used to calculate social profitability. The third goal of PAM analysis is to quantify policy transfer effects. The impact of a policy can be calculated by comparing revenues and costs before and after the policy's implementation. Policy effects on products and production factors (land, labor, and capital) are captured by the PAM method. The policy transfer effects are measured in the PAM matrix's third row.

A positive social profit indicates that the system uses scarce resources efficiently and contributes to national income, whereas a negative one indicates inefficiencies. This implies that production at social values is greater than import values hence the sector requires government interventions (Nelson and Panggabean, 1991; Keyser, 2006).

In this study, both primary and secondary data were used in calculating social and private profitability. To tabulate the matrix, I calculated gross margins using both private (actual market prices in Kenya) and social prices (import prices at the border). Data from Uganda was obtained from key informants (agrovets, Ministry of agriculture and animal industry and fisheries officials) and a poultry training manual for extension workers (MAAIF, 2019). From the data collected from Uganda cost of production was 25% lower than in Kenya. This percentage was applied to calculate social profitability. A kilogram (20 eggs) of improved indigenous eggs was retailing at Ksh. 280 at the border, while in Kenya it was retailing Ksh.320. These prices were used to calculate social and private revenue respectively.

Table 3.4: Policy Analysis Matrix

Item	Revenues	Costs		Profits
		Tradable inputs	Domestic factors	
Private prices	A	B	C	D=A-B-C
Social prices	E	F	G	H=E-F-G
Policy transfer	I=A-E	J=B-F	K-C-G	L=D-H

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Household characteristics of chicken producers

Table 4.1 presents the household characteristics of the chicken producers in the three study sites. The respondent in this study is the one who kept the improved indigenous chicken. On overall, 84 % of the respondents were female while 16% are male. The high percentage of female chicken producers could be attributed to the low capital required and cultural beliefs whereby chicken is considered a woman livestock. This concurs with a previous study in Western Kenya which found out that 75% of chicken producers were women (Justus *et al* 2013). Majority of the respondents (76%) were married in the three counties. Age of producers, household size and size of land were significantly different across the counties. Average age of the respondents was 51 for the 3 counties with the youngest farmer being 20 while the oldest being 89. Machakos County had slightly older farmers than Kiambu and Uasin Gishu. This contradicts the narrative that average age of a farmer in Kenya is 60. The average age of a farmer might differ in the different sub-sectors of agriculture. The fact that more youth and women are the major chicken producers could lead to the results obtained. Most of the respondents had attained

primary and secondary education in the three counties (73%). The adoption of new technologies is heavily influenced by the farmer's education level. Farmers that have a high degree of literacy can see the value of new technologies. They are additionally simpler to train with more technical training resources. Understanding the degree of education is crucial since it aids in developing vital messages in a way that farmers can understand. According to earlier research, farmers' education had a favorable impact on their decision to adopt new technologies. A farmer's ability to acquire, process, and apply information relevant to the adoption of a new technology increases with education level (Nwozuzu *et al*. 2021, Mwobombia 2016). Researchers in Nigeria discovered that a farmer's education level had a positive and significant effect on technology adoption (Okunlola *et al* 2011; Ajewole 2010). The average size of land is 2.6 acres with Uasin Gishu having the largest (4) and Kiambu (1). Land is an important resource in the chicken enterprise because the bulk of chicken feeds are plant-based.

Table 4.1: Household Characteristics in Kiambu, Machakos and Uasin Gishu Counties

		Kiambu	Machakos	Uasin Gishu	Overall
Gender (%)	Female	85	80	87	84
	Male	15	20	13	16
Marital status (%)	Divorced	0	1	0	1
	Married	76	76	76	76
	Separated	0	1	0	1
	Single	15	4	14	11
	Widow	8	13	10	10
	Widower	1	3	0	1
Education level (%)	Apprenticeship	1	2	0	1
	Higher Primary (Std4-8)	38	38	38	38
	Informal education	4	3	4	4
	Lower Primary(Std1-3)	2	2	3	2
	Secondary	37	34	34	35
	Tertiary	18	21	22	20
Main occupation (%)	Casual laborer on-farm)	1	2	1	1
	Formal employment	7	12	13	10
	Mixed farming (crop + livestock)	75	73	61	71
	off-farm/business	17	13	25	18
Household size		4	5	5	5
Age (Years)		50.6	53.8	47.6	50.7
Total land size (Acres)		1.0	2.8	4.0	2.6
Farming experience (Years)		43.8	17.7	3.0	21.5

4.2 Poultry production practices

4.2.1 Production systems

Farmers in the three counties kept the chicken under three systems namely; semi-intensive, intensive and free range/extensive (Figure 4.1). Majority of the famers (66%)

reared their chicken under semi-intensive system where chicken were kept in their houses most of the day but allowed to move out in a run to eat grass. They were mostly fed with both home-made and commercial feeds. Intensive system was practiced by around 22% of the farmers with Kiambu and Uasi-Gishu leading in the practice. In Kiambu, this phenomenon could be attributed to small sizes of land while availability of feeds could be attributed to the occurrence in Uasin Gishu. Free range was the lease practiced system in the three counties and this could be attributed to the training that advocates for rearing the chicken in an enclosed area to prevent the improved chicken mixing with the local ones and interbreeding and also for disease control purposes.

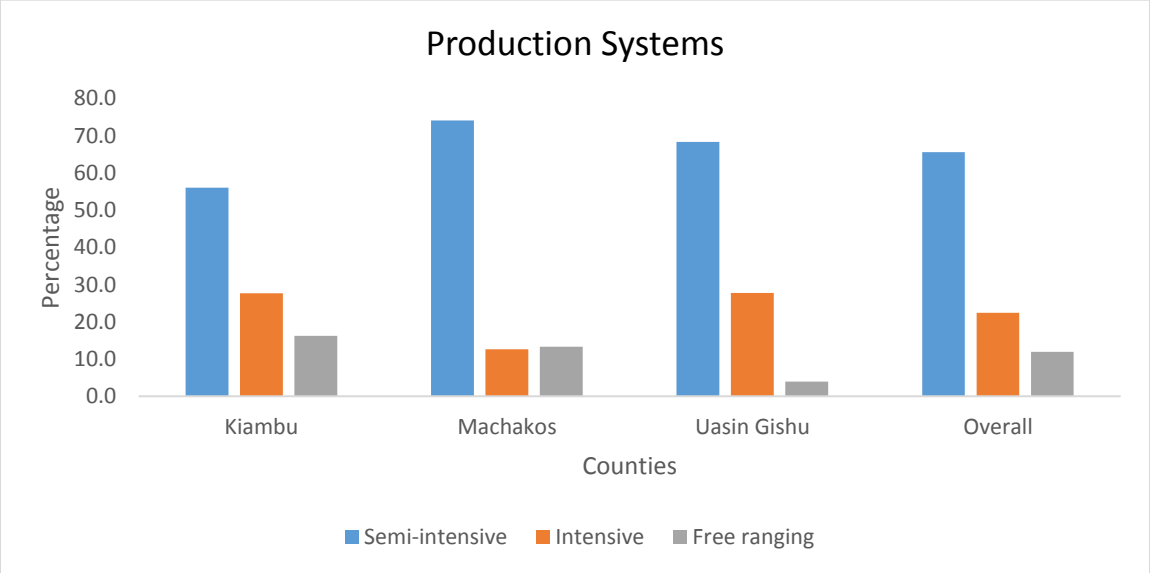

Figure 4.1: Chicken production systems in the three counties

4.2.2. Characteristics of sample chicken production per county

Table 4.2 presents chicken production characteristics of chicken producers such as flock size, inputs and revenue per county per year. Flock size per household differed in the two years (2020 and 2021) in the three counties. In 2020, Kiambu had the highest number

(71), Uasin Gishu (66) and Machakos (64). Out of these, twenty five were laying in Uasin Gishu and Machakos with Kiambu leading with twenty nine. There was a decrease in flock size in all the three counties in 2021. In Uasin Gishu, flock size per household went down by 38% while in Kiambu it reduced by 45% with Machakos having the highest decrement of 50%. This could be attributed to surging of cost of production especially feeds farmers cited in the constraints they faced**.** The average number of eggs collected per day were thirteen, fourteen and twelve for Uasin Gishu, Kiambu and Machakos respectively**.** On profitability, producers made losses in the three counties with an overall loss of (33, 381) annually. Cost of feeds and labour were the major contributors to the total cost of production. Number of laying hens was also very small given that some resources used like labour and energy did not consider the number of chicken but were paid monthly. Vaccines were wasted because a bottle usually serves 250 chicks but majority of farmers had less than 100. Flock size was found to have a positive effect on the profitability of improved indigenous chicken. This implies that the more the chicken, the higher the profits and vice versa (Masuku, 2013 and Njuguna, 2018).

Table 4.2: Characteristics of sample chicken production per County per year

Variable	Machakos	Uasin Gishu	Kiambu	Total
Value of output (KES)				
Meat (KES)	4,891,050	2,877,692	7,341,096	15,109,838
Eggs (KES)	3,456,000	3,070,400	4,277,200	10,803,600
Total revenue	8,347,050	5,948,092	11,618,296	25,913,438
Flock/herd size/farmer	85	96	82	263
Labour use/farm (KES	5321700	3363300	4978720	13663720
Feed use/farm (kg)	6200550	5676200	7213520	19090270
Veterinary cost (KES)	406620	186143	509120	1101883
Transportation cost	120825	138370	89984	349179
Energy cost	787050	830220	787360	2404630

Water cost	799200	547420	775520	2122140
Total variable costs	13635945	10741653	14354224	38,731,822
Gross margin (KES)	-5,288,895	-4,793,561	-2,735,928	-12,818,384
Gross margin per farmer (KES)	**-39,177**	**-47461**	**-18486**	**-33,381**

4.3 Group membership

Machakos County had the highest number of farmers (70%) who belonged to a farmer group while Kiambu had the lowest (43%). Groups enable farmers to access services like training, inputs and financial services easily. They have a management structure which can be reached easily in case a member defaults in the case of loans. It is also easier and faster to disseminate technologies and information to groups than to individuals especially when targeting to reach a large population. Access to training, credit and production inputs would be expected to improve management practices and eventually productivity. This is not always the case. A study carried in Ghana found out that group membership decreased adoption of improved varieties and this may be attributed to joy riders in groups who don't practice what they learn or even sell inputs acquired through groups (Ahmed 2019).

4.3.1 Type of groups

Majority of farmers in the three counties (78%) were in common interest groups (CIGs). Other groups where farmers belonged to included; vulnerable and marginalized (16%), Credit and savings (3%) and producer organizations (3%).

Table 4.3: **Types of groups which farmers belonged to**

	County			
Types of groups	Kiambu	Machakos	Uasin Gishu	Total
Common Interest group (CIG)	81.0	89.4	60.3	78.2

Vulnerable and Marginalized group	14.3	9.6	26.5	16.0
Credit and saving group	1.6	0.0	8.8	3.1
producer Organization	3.2	1.1	4.4	2.7
Total	100.0	100.0	100.0	100.0

4.3.2 Membership in Poultry production and Marketing groups

Results indicated that 59% of the respondents belonged to a poultry production and marketing group which Machakos recording the highest number (77%) and Kiambu the lowest (39%).

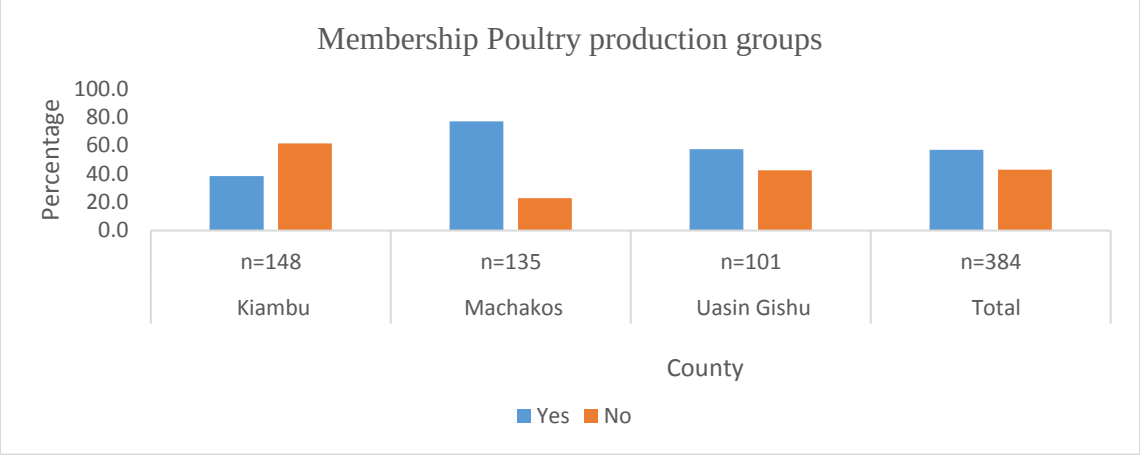

Figure 4.2: Poultry group membership

4.3.3 Benefits of poultry group membership

Majority of the poultry farmers indicated that through the poultry group, they received training and extension services (69%). Other benefits that farmers enjoyed due to group membership included; marketing of chicken products (38%), access to credit (32%), access to farm inputs (31%) and social welfare (25%). In Kiambu and Uasin Gishu, farmers cited table banking as one of the major benefits of belonging to a poultry production and marketing group.

Table 4.4: Benefits of group membership to chicken producers

	County			
Benefits	Kiambu	Machakos	Uasin Gishu	Total
Agricultural training and extension	75.4	78.8	44.8	68.9
marketing of chicken products	50.9	53.4	15.5	37.9
Access to credit	24.6	30.8	39.7	31.5
Access to farm inputs	15.8	27.9	51.7	31.1
Access to incubation services	21.1	41.3	8.6	27.4
Social welfare	28.1	21.2	27.6	24.7
Table banking	75.0	11.1	66.7	2.7
Farming practices training	0.0	44.4	0.0	1.8
Training on making feed rations at home	0.0	11.1	0.0	0.5
Sharing information on poultry diseases	25.0	0.0	0.0	0.5
Sharing experience on poultry farming	0.0	11.1	0.0	0.5
Purchase of household utensils	0.0	11.1	0.0	0.5
Merry go round to buy chicken feed	0.0	0.0	33.3	0.5
Total				100.0

4.4 Access to poultry production information

The main sources of poultry production and marketing information were other farmers and county government livestock extension departments (37%). Kiambu County recorded the highest number of farmers getting information from other farmers (52%) while Uasin Gishu had the highest number of farmers who obtained information from the County government (64%). (Table 4.5)

Table 4.5: Sources of poultry production and marketing information

	County			
	Kiambu	Machakos	Uasin Gishu	Total
Others farmers	52.1	30.3	26.4	37.2
County government extension	23.1	30.3	63.7	36.9
Media	38.0	34.5	30.8	34.7
KALRO/KOPIA	16.5	58.0	12.1	30.2
NGO	4.1	12.6	7.7	8.2
Private companies	9.1	5.9	8.8	7.9
Faith based organization	0.0	0.0	2.2	0.6
Universities	0.0	0.8	1.1	0.6

4.5 Farmer training on Poultry production and marketing

When asked whether they had attended any training on poultry production and marketing, majority (79%) indicated that they were trained in the three counties. Machakos County had the highest percentage (90%) of farmers while Kiambu had the lowest (54%) who had been trained on the aforementioned course. For improved productivity, access to production and marketing information is key. Training is key in catalyzing technology transfer and adoption. Farmers in the three Counties indicated that they had been trained on various areas of poultry management like feed formulation, disease and pest management, housing, brooding and incubation, farming as a business, marketing and vaccination. In a previous study in Kenya, findings showed that farmer training positively affected technology adoption. The marginal effect showed that a unit increase in training on improved indigenous chicken production increased adoption decision by 20% (Kamau 2018).

4.5.1 Source of Training

Almost half of the respondents indicated that they had been trained by the Kenya Agricultural and Livestock Research organization (KALRO) and county government services. This is expected given that the improved indigenous chicken is bred and distributed by the organization. Machakos County had the biggest percentage of farmers (75%) having being trained by KALRO while Uasin Gishu had the smallest (15%).

Table 4.6: Source of poultry production and marketing training

	County			
	Kiambu	Machakos	Uasin Gishu	Total
KALRO/KARI	35.0	74.6	14.9	47.1
County government extension officers	43.8	29.5	78.4	46.7
Farmers/ Neighbor	15.0	13.9	8.1	12.7
NGOs	6.3	13.9	6.8	9.8
Private Extension	5.0	3.3	10.8	5.8
Other Research organizations	1.3	1.6	6.8	2.9
Agrochemical stockiest	5.0	1.6	1.4	2.5
International institutions (e.g. FAO, KOPIA,ILRI)	1.3	1.6	2.7	1.8
Faith-based organizations	1.3	0.8	2.7	1.4
Farmer Cooperative society /Union	2.5	0.0	1.4	1.1
National Airport Services	0.0	0.8	0.0	0.4
Media	0.0	0.0	1.4	0.4
Financial Institution	0.0	0.0	0.0	0.0

4.6 Access to credit and savings to finance poultry activities

Majority of farmers in the 3 counties (79%) indicated that they had not accessed credit to finance their farming activities in the past year.

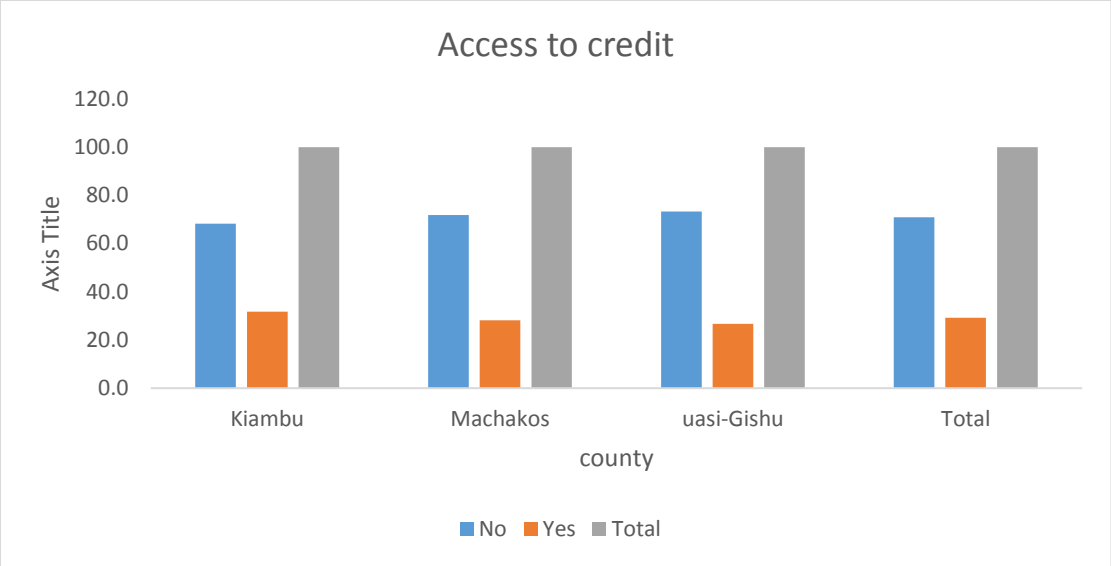

Figure 4.3: Access to credit

4.6.1 Sources of credit

Rotating and Savings and Credit Associations (ROSCAs) were the most popular source of credit in the 3 counties. This source seemed very popular in Uasin Gishu compared to in the other two counties. Self- help groups came in second while banks, money lenders and family members were very unpopular sources of credit. In Machakos County Self-help groups were cited as the most popular source of credit. This could be attributed to the fact that they are easily accessible and there is less bureaucracy in acquiring a loan. Farmers did not have to travel long distances to access financial services like savings and loans. Though the interest rates for borrowing in ROSCAs were much higher (10% per month) compared to those of formal financial institutions (1.2% per month), the terms and conditions were less and favourable. No collateral nor guarantors were required like in the case of formal financial institutions.

Table 4.7: Sources of credit and savings services for chicken producers

	County			
	Kiambu	Machakos	Uasin Gishu	Total
ROSCAS	38.3	18.4	63.0	37.5
Self Help Group	31.9	50.0	18.5	34.8
microfinance	12.8	15.8	22.2	16.1
Mobile Money	10.6	2.6	3.7	6.3
Cooperative	4.3	5.3	0.0	3.6
Banks	2.1	2.6	3.7	2.7
Money lender	2.1	2.6	0.0	1.8
Family members	0.0	0.0	3.7	0.9
Relatives	0.0	2.6	0.0	0.9
Friends	0.0	0.0	0.0	0.0
Neighbors	0.0	0.0	0.0	0.0
Total				100.0

4.6.2 Purpose of credit borrowed

Majority of the farmers indicated that they borrowed credit to purchase poultry feeds (81%). The other purposes for borrowing money from the different sources was to purchase improved day old chicks and drugs 25% and 22% respectively. Livestock feeds priced have surged tremendously in the last two years with some retailing at 40% more. This price surge could be attributed to unreliable rainfall in most of the country and import taxed imposed raw materials.

Table 4.8: Purpose of credit borrowed

	County			
	Kiambu	Machakos	Uasin Gishu	Total
For buying feeds	78.7	86.8	77.8	81.3
For buying improved day old chicks	21.3	18.4	40.7	25.0
For buying drugs	17.0	23.7	29.6	22.3
For construction of a chicken house	29.8	13.2	11.1	19.6
for paying utilities (electricity and water)	0.0	7.9	3.7	3.6
For buying fertilized eggs	4.3	0.0	0.0	1.8

4.7 Transportation of chicken products and inputs

Farmers especially in Machakos and Uasin Gishu travelled long distances to the input and output markets. The average distance to input markets is 4.8 km while that to output markets is 3.5 km. The average distance to the tarmac is 2.5 km. These long distances translated to high cost of transport hence affecting profitability especially for farmers with few chicken. Farmers reported that they had suffered losses due to egg breakage during transportation due to long distances and poor state of roads. The most popular means of transportation among chicken farmers is the motor bike (64%) with walking (39%) and use of vehicles being the other means used to transport both inputs and outputs in the study areas. Motor bikes have become a very popular means of transport in Kenya because of low cost and ability to ride on roads or paths where vehicle cannot.

4.8 Challenges and opportunities facing improved indigenous chicken farmers

High cost of feeds was cited as the most pressing constraint in chicken production in the three counties (table 13). The other important constraint in chicken production was disease and pest attack. Others challenges cited included price fluctuation (31%), high mortality rate (9%), Covid 19 pandemic (9%), poor quality feeds (8%) and inaccessibility to extension services (7%). Cost of feeds was the most important constraint cited by majority of the farmers who indicated that they had scaled down or stopped chicken rearing completely. Chicken feed raw materials like maize, soya bean, fish meal are mostly imported and over the last two years their price has increased by 15 to 65% making the chicken enterprise a loss maker. This concurs with (Wambua *et al.,* 2021) who reported similar findings in a study carried out in Kenya**.** A study carried out in

Nigeria in broiler farms found out that cost of feeds was a major constraint facing farmers forcing them to scale down or abandon the enterprise completely (Olorunwa 2018).

Despite the challenges, family poultry can be a tool for women's empowerment, particularly where women are vaccinators and poultry advisers. This brings more income for their family and prestige for them within the community**.** Another opportunity in improved indigenous chicken value chain is in incubation and sale of one day or month chicks especially by the youth. The fact that the improved indigenous hen does not brood presents an opportunity for women and youth to buy and provide hatching services. The demand for chicks outweighs the supply**.**

Table 4.9: Challenges farmers face in production and marketing of their chicken products

	County			
	Kiambu	Machakos	Uasin Gishu	Total
High cost of feeds	80.2	82.2	78.4	80.2
Disease and pest attack	82.2	70.4	70.9	73.7
Cost of drugs and vaccination	41.6	42.2	27.0	36.2
Market/price fluctuation	24.8	34.8	30.4	30.5
High mortality rate of chicks	6.9	11.1	8.1	8.9
Covid 19 pandemic	17.8	6.7	4.7	8.9
Poor quality feeds	9.9	3.0	11.5	8.1
Accessibility to extension services	14.9	1.5	6.1	6.8
Accessibility to affordable clean water	0.0	8.9	5.4	5.2
Difficulty in credit and loan access	8.9	3.0	2.0	4.2
High cost of labour	1.0	3.7	3.4	2.9
Accessibility and availability of quality day old chicks	5.0	0.7	2.0	2.3
Lack of incubators	4.0	1.5	0.0	1.6
Lack of quality ingredient for feed formulation	3.0	0.7	0.7	1.3
Theft	10.0	5.1	8.1	8.4
Predators	0.0	2.2	0.7	1.1
Limited space	1.0	2.1	0.7	1.5

4.9 Technical, cost and allocative efficiency of improved indigenous chicken production

Tables 4.10, 4.11 and 4.12 below show the distribution of TE, CE and AE levels for improved indigenous chicken producers in the three counties. Technical efficiency refers to the ability of the farms to achieve maximum outputs given a set of inputs. The results presented in table 6 indicate that the mean TE of the sampled and interviewed chicken producers was 58% with Machakos County having the highest (60%) and Kiambu the lowest. These results imply that on average, the farmers could only achieve 58% of the maximum output from a given mix of production inputs. To attain maximum productivity levels within a given set of inputs, they need to improve their efficiency by 42%. Majority of the farmers attained 41% to 50% technical efficiency levels (69%), while a negligible number attained TE levels of between 61% and 80%. This could be attributed the small flock size per household (64) and number of laying hens (25) which utilized similar resources as of 100 birds for example vaccines and labour. Studies elsewhere recorded similar results; for instance, a study carried out in Cross River State, Nigeria to analyze the TE of poultry farmers recorded a mean TE score of 58% (Bethel *et al*, 2016), which was attributed to the inefficient utilization of the resources at the current level of technology. Similarly, Otunaiya *et al* (2015), in their study Efficiency of Poultry Egg Production in Ibadan Metropolis, Oyo State, Nigeria, observed a technical efficiency of 58% which according to the study was attributed to inadequate quantity and quality of feeds. A study by Rogers *et al* (2021) while studying Technical, allocative and economic efficiencies of keeping newly introduced chicken strains among smallholder farmers in

selected areas of Tanzania, recorded a very low technical efficiency of 19.9% which was attributed to lack of technical knowledge in managing the new chicken strains.

The average TE level in this study is lower than those recorded in other similar studies. For instance, a study on layer productivity in Uganda recorded a TE level of 81% (Obed 2018) and another one in Turkey recorded 98 (Dogan *et al*, 2018). The mean cost efficiency score for the three Counties was 39.2%. County wise, Machakos had a slightly higher CE (39.9) compared to that of Kiambu (38.9%) and Uasin Gishu (38.7%). Majority of the farmers (91%) attained cost efficiency (CE) of below 40%. The minimum CE score is 23% while the maximum is 87% implying that if the most inefficient farmer (23%) would achieve maximum efficiency s/he would earn an additional profit of 74% (1-23/87). This contrasts a similar study carried out in Indonesia where the CE score was 86% (Hidayah *et al*. 2013) and another in Ghana where CE was 21% (Abukari and Alemdar 2019). This situation could be attributed to the ever-increasing cost of poultry feeds in the country. Cost of feeds in Kenya have spiraled to unimaginable levels in the past two years due to the Covid 19 pandemic and increased prices of raw materials (maize, soybeans, fishmeal). Inputs used in production of maize and soya beans particularly fertilizer increased by over 80% leading to increased prices of feeds. This increased the price of poultry feed by almost the same margin. According to the Association of Kenya Feed Manufacturers (AKEFMA) the prices of maize and soya bean increased by 30% and 200% respectively in two years (Business daily, 13, 2021). The price of chick mash increased by 15% from Ksh.3200 to Ksh.3700 with that of layer mash increasing by 15% to 20% in 2021. This is despite the prices of eggs stagnating at an average of Ksh. 12. Other costs which have surged include those of vaccines, drugs

and labour. As for allocative efficiency, Kiambu County recorded 69%, Machakos 66% and Uasin Gishu 65%. The mean allocative efficiency for farmers in the three study sites was 67% which implied that they were apportioning the available resources fairly although they needed to improve the same by 33% to operate at the frontier. This concurs with a study carried out in South Africa where the AE was 61.5% (Thabethe and Mungatana 2014) Allocative efficiency improves when the scarce resources are apportioned well to minimize costs and maximize profits at a given output price level.

Table 4.10: Mean technical, cost and allocative scores

County	Technical efficiency	Cost efficiency	Allocative efficiency
Kiambu	56.4	38.9	69.1
Machakos	60.1	39.9	66.2
Uasin Gichu	59.1	38.7	65.2

Table 4.11: Distribution of Technical efficiency scores for improved indigenous chicken farmers

Efficiency levels	Frequency	Percentage	Cumulative
0.00 - 0.4	7	1.83	1.83
0.41 - 0.5	262	68.59	70.42
0.51- .6	104	27.23	97.64
0.61 - .7	8	2.09	99.74
0.71 - .8	1	0.26	100
TOTAL	384	100	

Table 4. 12: Distribution of cost efficiency scores for improved indigenous chicken farmers

Efficiency levels	Frequency	Percentage	Cumulative
0.00 - 0.2	30	7.81	7.81
0.21 -0.3	208	54.17	61.98
0.31-0.4	112	29.17	91.15
0.41 -0 .5	25	6.51	97.66
0.51 - 0.6	6	1.56	99.22
0.61-0.7	1	.26	99.48
0.71 - 1.00	2	.52	100.00

TOTAL	384	100

Majority of chicken producers (96%) attained allocative efficiency of between 0 and 60% with most of the attaining 21 to 30% AE scores.

Table 4.13: Distribution of allocative efficiency scores for improved indigenous chicken farmers

Efficiency levels	Frequency	Percentage	Cumulative
0 - 0.2	30	7.81	7.81
0.21 -0.3	208	54.17	61.98
0-0.4	7	1.82	63.81
0.41 - 0.5	26	6.77	68.58
0.51 -0. 6	104	27.08	95.65
0.61-0.7	8	2.09	99.74
0.71 - 1.00	1	.26	100.00
TOTAL	384	100	

4.9.1 Stochastic Production Frontier Estimation- Technical Efficiency

Table 4.14 presents the Maximum Likelihood Estimate (MLE) results of the Cobb-Douglas stochastic frontier production function. Feeds, labour, veterinary, energy, and water have a positive influence on technical efficiency. This implies that these factors have a direct effect on the output (number of eggs laid in a month). Quantity of purchased feeds had a coefficient of 0.215 and highly significant at 1%. Another factor which was highly significant at 1% was labour (0.173). This concurs with previous studies carried out in Ghana and Nigeria which reported similar results (Ahiale, Abunyuwah, and Yenibehit 2019) and (Joshua Olorunwa 2018). The implication here is that the more

commercial feed used the higher the output. A unit increase in quantity of commercial feeds used caused a 21% increase the number of eggs laid. This could be attributed to the fact that commercial feeds contain a range of macro and micro nutrients for the different stages of growth. For egg production, majority of chicken are fed with layers which mostly boosts egg production. There was a positive and significant relationship between labour and the output. Majority of improved indigenous chicken are reared in semi-intensive production system which requires some amount of labour especially for feeding, cleaning, administering drugs and egg collection. Chicken diseases was one of the major challenges cited by farmers with some causing 100% deaths and others lowering productivity. The results here indicate that veterinary services positively affected TE of the farmers in the three counties. The implication is that as disease incidences reduced, the productivity of the chicken enterprise increased. Though not statistically significant, cost of transportation and chicken breeds (local and Improved) had negative coefficients implying that the higher the cost of transporting both inputs and outputs, the lower the TE. The price of fuel in Kenya has increased tremendously over the last two years leading to increased cost of transport. Chicken breeds kept by farmers seem to have a negative effect on technical efficiency and this could be attributed to the production system i.e whether on free range, semi-intensive or intensive. Majority of farmers in the three counties practiced semi-intensive system which could have resulted to wastage of feed and high incidences of diseases and predators hence affecting the productivity of the birds. This concurs with a study carried out in Ethiopia, Nigeria and Tanzania whereby poultry management practices under production different systems affected TE negatively (Birhanu *et al*, 2021).

Table 4. 14: Determinants of technical efficiency of chicken producers in Kenya

Production factors (TE)	Coefficients (TE)	Std Error
Constant	1.802 (0.000)	0.466
Total quantity of purchased feeds per month	0.215 (0.000)***	0.036
Total Quantity of un-purchased feeds per month	0.009 (0.745)	0.032
Labour days spent in production	0.173 (0.000)***	0.039
Veterinary cost	0.119 (0.002)***	0.040
Cost of transport	-.061 (0.125)	0.039
Energy and water cost	0.088 (0.018)**	0.037
Poultry Housing	0.065(0.021)**	0.028
KARI improved Chicken	-0.017 (0.528)	0.028
Local Chicken	-0.022 (0.471)	0.029
Machakos County	0.244 (0.441)	0.316
Kiambu County	0.339 (0.274)	0.310
Uasin Gishu County	0.281 (0.372)	0.314

The asterisks represent t statistics at different confidence levels *, ** and * i.e 1%, 5% and 10% respectively**

4.9.2 Economic and institutional factors influencing technical efficiency of improved indigenous chicken in Kenya

Table 4.15 presents economic and institutional factors that influenced the technical efficiency of chicken farmers in the sampled areas. They included education and age of the household, access to agricultural extension services, farming experience of household head, total land owned and distance to the tarmac road. These factors were statistically significant at different confidence levels (1%, 5% and 10%). Education level of the household had a negative coefficient and significant at 5%. This implies that an extra year in school increased the farmers' technical efficiency by 4.9%. This outcome concurs with several studies carried elsewhere where education level of farmers reduced technical

inefficiency of poultry farms (Ezeh *et al*. 2012), (Obed 2018) and (Ahiale *et al,* 2019). The reason could be that more educated farmers tend to get information on new technologies and innovations faster than the less educated. They are also able to access social and digital space where a lot of information is shared. When it comes to training, they grasp topics faster and might have capital to invest in trials of different techniques of farming. Some areas in poultry farming that require some knowledge include breed selection, artificial incubation, vaccination, disease management and marketing (digital). However, there was a contradicting result in a similar study carried out in Indonesia where higher education level contributed to increased technical inefficiency (Pakage *et al,* 2014). Farming experience (in years) had a negative coefficient and was significant at 1% implying that an extra year in farming decreased technical inefficiency. The more time one spends in an activity, the better they become in carrying out the same. Farmers with more years of rearing chicken are able to detect diseases faster, administer drugs easily and have wider market networks compared to the less experienced ones. They are also able to avoid mistakes and apply cost minimizing strategies to increase their profits. This concurs with similar studies carried out in different countries whereby farmer years of experience had a positive influence on technical efficiency (Dogan, *et al*, 2018 , Ullah *et al,* 2019, Ezeh *et al*. 2012) and Ahiale *et al,* 2019) . However, other studies found out that more experienced farmers were less efficient maybe due to routine which became boring while other farmers were rigid and did not want to try new technologies (Kodua, *et al,* 2022). In other studies, farmer experience did not influence their technical efficiency (Obed 2018 and Dogan, *et al*, 2018). Another factor which influenced TE of chicken farmers in the three counties was total land owned which was significant at 1%.

This concurs with a study carried in Nigeria, Tanzania and Tanzania (Birhanu *et al,* 2021) but contradicts a study carried out in Uganda which found out that total land owned did not influence the technical efficiency of farmers (Obed 2018). Land is key in production of crops which are used as raw materials for chicken feed. Some crops which are key in formulation of chicken feed include; maize, sunflower, cotton, soya beans, sorghum and vegetables. Majority of the farmers in the sampled areas indicated that they were formulating their own feed with some mixing some ingredients with the commercial feeds. As much as land is key for crop and livestock production it might not be necessarily true for chicken production with new innovations on construction of vertical/storeyed chicken houses in place. Intensive and semi-intensive production systems don't require large sizes of land to establish. Age of household had positive coefficient and was significant at 10% implying an extra year of the household head increased technical inefficiency in improved indigenous chicken production. Aged farmers tend to ignore new technologies and innovations and majority do not access digital farming platforms. This agrees with previous studies which reported that age increased technical inefficiency and that younger farmers were likely to be more efficient that the older ones (Ezeh *et al.* 2012), (Ahiale *et al,* 2019), (Hailu 2020) and (Obed 2018). However it contradicts studies which indicated that the older the farmer the technically efficient s/he is (Pakage *et al*. 2014), (Thabethe and Mungatana 2014), (Ullah *et al*. 2019) and (Ul Haq and Tariq 2020). Another institutional factor affecting technical efficiency of chicken farmers in the sampled areas was distance to tarmacked road which was significant at 5%. Farmers need to transport both inputs and outputs and the nearer the tarmac road the faster one can access the market. A kilometer less from the tarmac

road increased the farmers' technical efficiency and vice versa. This concurs with previous studies carried out in Bangladesh and Honduras which recorded a similar finding (Chandel *et al*. 2022, Taylor 2012 and Buckmaster *et al*, 2014) . Access to extension services had a negative coefficient and significant at 10% implying that the more a farmer accessed extension services, the more efficient s/he was. Extension services include training, introduction of new technologies and innovations, pest and disease management and market linkages. Chicken production is faced with many technical challenges hence the need for support from the extension staff. Some of the extension services required by farmers include feed formulation, vaccination, artificial incubation, disease management and market information. This result concurs with others obtained in previous studies which found out that extension contact increased the efficiency of farmers (Hailu 2020), (Chandel, *et al* 2022), (Adedeji *et al*, 2012), (Tenaye 2020) and (Ahiale, *et al* 2019). Studies elsewhere did not find any significant effect of access to extension services on TE of farmers (Obed 2018) and (Haruna 2020).

Table 4.15: Determinants of technical inefficiency for chicken producers in Kenya

Inefficiency factors	Coefficients	Std Error
Gender of the household head	-0.0002 (0.997)	0.045
Education of the household head	-0.049 (0.020)**	0.021
Age of the household head	0.913 (0.091)*	0.540
Marital status	0.004 (0.849)	0.022
Occupation of the household head	-0.022 (0.452)	0.029
Household size	-0.004 (0.378)	0.005
Access to extension services	-0.063 (0.067)	0.034
Member of a chicken farmer group	-0.007 (0.842)	0.036
Experience of the household head	-0.65 (0.004)***	0.022
Access to information	-0.015 (0.766)	0.049
Total land owned in acres	-0.028 (0.004)***	0.009
Distance to input market	0.009 (0.854)	0.047
Distance to output market	-0.023 (0.597)	0.045
Distance to the tarmac road	-0.079 (0.033)**	0.037
Constant	0.519 (0.245)	0.447

The asterisks represent t statistics at different confidence levels *, ** and * i.e 1%, 5% and 10% respectively**

4.9.3 Stochastic frontier model –Cost efficiency

Table 4.16 presents production factors that affect cost efficiency of the sampled farmers. All the variables in the model except energy and water cost had a highly significant positive effect on the total cost of production at different significant levels. Total cost of purchased and unpurchased feeds, cost of labour and equipment cost were significant at 1% while veterinary cost and cost of transport were statistically significant at 5%. The results clearly show that cost of purchased feeds is a huge contributor to the total cost of production. A unit increase in the cost of feeds would lead to 0.25% increase in the total cost of production while a unit increase in cost of un-purchased feeds led to a 0.09%

increase in total production cost. A unit increase in the cost of labour (a man day) would cause a 0.06% increase in the total production cost while a unit increase in cost of veterinary cost increased total production cost by 3%. Equipment cost which a fixed cost was a major contributor to the total production cost with a one shilling increase causing a 38% increase in total production cost. This model indicates that cost production is very sensitive to a slight change in cost of the production factors. This is reflected in the mean cost of efficiency (39%) which implies that majority of the farmers are cost inefficient. In the cost inefficiency model, several variables contributed to a farmer's inefficiency level. Distance to the output market had a negative coefficient and was significant at 1%. This implied that the less the distance to the output market, the less the cost hence it increased cost effectiveness of the farmer. Distance to the tarmac road was also significant at 5% and decreased the cost effectiveness of the farmer. Cost of transport is usually very high in the rural areas due to poor infrastructure. The situation is worse in rough terrains without tarmac which sometimes leads to exorbitant costs of transport. The nearer the tarmac road, the less the cost of transport and vice versa. Other factors that affected cost effectiveness of the sampled farmers were; household size and access to extension services which were significant at 95% confidence level. Distance travelled to the input market had a negative effect on cost efficiency at 90% confidence level. This increased cost inefficiency of the sampled farmers. The longer the distance, the higher the cost and eventually the higher the total cost of production. An extra kilometer in distance reduced cost efficiency by 4.9%.

Table 4:16: Determinants of improved indigenous chicken cost efficiency

Y= Total cost of production	**Coefficients**	**Std error**
Constant	1.41 (0.000)***	0.192
Total cost of purchased feeds per month	0.255 (0.000)***	0.014
Total cost of un-purchased feeds per month	0.091 (0.000)***	0.012
Cost of labour (man days) spent in production	0.066 (0.000)***	0.017
Veterinary cost	0.031(0.036)**	0.015
Cost of transport	0.039 (0.007)**	0.015
Energy and water cost	0.022 (0.121)	0.014
Local Breed	-0.020 (0.072)*	0.012
Total Output (eggs)	0.040(0.040)**	0.018
Equipment cost	0.386 (0.00)***	0.012

The asterisks represent t statistics at different confidence levels *, ** and * i.e 1%, 5% and 10% respectively**

4.9.4 Determinants of cost inefficiency amongst chicken producers

Table 4.17 presents determinants of cost inefficiency among chicken producers in the three counties. From the stochastic model, gamma parameter (γ) was 0.806 and significant at 5% implying that around 81% of the variation in the total cost of production among the sample farmers could be attributed the differences in their cost efficiencies. The mean cost efficiency score in the three counties was 39% which was very low. Several socio-economic factors were associated with the cost inefficiency levels recorded. These factors were; size of household, access to extension services, distance to both input and output markets and distance to the nearest tarmac road. Household size had a negative coefficient that was highly significant at 5%, implying that the larger a household (the number of members), the more efficient it became. This variable is also known as a "labor proxy" at times. This variable is sometimes dubbed as “labour proxy”.

In this case, production of improved indigenous which is mainly semi-intensive required quite some amount of labour especially during feeding, cleaning and egg collection. Results indicated that some amount of labour was provided by family members and this could have led decreased labour costs hence the reduction in cost inefficiency. In most households labour for poultry production is provided by household members for free. A previous study in Imo state, Nigeria contradicts this finding where results indicated that the size of household increased cost inefficiency (Ehirim and Nwachukwu 2019). Another factor which affected cost efficiency of chicken producers in the sampled cites was access to extension services. This variable was statistically significant at 5%. Agricultural extension services have been a major means of combating rural poverty and food insecurity. This is due to the fact that it facilitates the transfer of technology, supports rural adult learning, assists farmers in problem-solving, and integrates farmers into the agricultural knowledge and information system (Danso-Abbem *et al,* 2018). Extension services are key in poultry production given that animals need more attention than crops. These services usually include, feed, pest and disease management. Extension staff also offer advisory and training services on new technologies and innovations, feed formulation, vaccination schedules and marketing. These advisories help farmers to make sound production and marketing decisions which improve resource utilization and eventually minimize costs. A study in Ghana indicated that access to extension services improved crop yield and farmers' income by 10% *(*Danso-Abbeam, *et al* 2018). Another study recorded similar findings that access to extension services reduced the cost inefficiency of farmers (Etuah 2014). Distance to the input market had a significant positive effect on cost efficiency at 10% while that to the output market had a positive

effect on cost efficiency at 1%. This implies that the nearer the input and output markets the less the costs. Cost of transport has been on the increase over the past three years due to the ever surging price of fuel in the country and globally. Farmers usually use motor bikes to transport inputs like chicks and feed from the shopping centres. They also use the same means to supply eggs to retailers and individual consumers who are mostly located in urban areas. Due to high cost of transportation farmers are forced to sell their products at farm gate prices which are usually lower than those in urban areas. Distance to a tarmacked road also affected cost efficiency of farmers positively. Cost of transportation is usually lower in tarmacked roads than in rough roads. This is because it's faster to drive or ride in a tarmacked road and maintenance costs are also lower. Previous studies elsewhere showed that the longer the distance to the market, the lower the farm gate prices. A study in Honduras which indicated that the more distant a household was from the market, the less it was likely to sell its farm produce. A study in Ethiopia concluded that farm households found further away from market places were less likely to produce crops/livestock for the market since market prices deteriorate with physical distance (Chandel *et al* 2022, and Buckmaster *et al*, 2012).

Table 4.17: Determinants of cost inefficiency in production of improved indigenous chicken in Kenya

Inefficiency factors	Coefficients	Std Error
Gender of household head	-0.025 (0.130)	0.016
Education of household head	-0.005 (0.474)	0.008
Age of the household head	0.090 (0.645)	0.201
Marital status	0.0003 (0.970)	0.008
Occupation of the household head	-0.008(0.461)	0.011
Household size	-0.005 (0.016)**	0.002
Access to extension services	-0.015 (0.015)**	0.013
Member of a chicken farmer group	-0.015 (0.260)	0.013
Experience of the household head	-0.008 (0.263)	0.008
Access to information	-0.0008 (0.962)	0.018
Total land owned in acres	-0.002 (0.538)	0.003
Distance to input market	0.049 (0.095)*	0.017
Distance to output market	-0.055 (0.001)***	0.016
Distance to the tarmac road	-0.032 (0.011)**	0.013
Constant	0.331(0.163)	0.245

The asterisks represent t statistics at different confidence levels *, ** and * i.e 1%, 5% and 10% respectively**

4.10 Measuring the competitiveness of improved indigenous producers using Policy Analysis Matrix (PAM)

The table below presents the budget/gross margin analysis for improved indigenous chicken which is calculated per a kilogram of medium sized eggs (20 eggs in a Kg). Results indicate that the enterprise was socially profitable but privately unprofitable with the producers making a social profit of Ksh.62.05. This implies that chicken enterprises

in the sampled areas are not competitive and can't survive without incentives given that their private profits are lower than social prices (table 4.18).

Table 4.18: Private and Social budget for 1 Kg of improved indigenous eggs

Item	Quantity of eggs in Kgs	Private price	Total private value	Social price per Kg	Total Social price
Revenue	9366.00	320.00	2997120.00	280.00	2622480.00
Tradable					
Start-up flock	9366.00	4.85	45468.85	3.40	31828.20
Feeds -purchased	9366.00	189.90	1778603.40	132.93	1245022.38
Veterinary cost	9366.00	13.74	128656.00	9.62	90059.20
Labour	9366.00	11.85	110944.60	8.29	77661.22
Total	9366.00	220.34	2063672.85	154.24	1444571.00
Non-tradable					
Housing & equipment	9366.00	57.68	540276.00	40.38	378193.20
Transportation	9366.00	10.80	271310.90	7.56	70806.96
Energy and water cost	9366.00	10.37	97169.00	7.26	68018.30
Feed-unpurchased	9366.00	12.17	113950.00	8.52	79765.00
Total	9366.00	109.19	1022705.90	63.72	596783.46
Gross Profit	9366.00	-9.53	-89258.75	62.05	581125.55

4.10.1 Policy analysis Matrix for improved indigenous chicken production in Kenya

The policy Analysis Matrix is constructed using values derived from the budget above. The different entries are denoted by different letters, where:

A-Private revenue

B- Tradable input costs (eg DOC, feed, vaccine, drugs)-private

C- Non-tradable costs (domestic factors eg land, labour, housing)-private

D-Private profits

E-Social revenue

F-Tradable inputs (eg DOC, feed, vaccine, drugs)-social

G- Non-tradable costs (domestic factors eg land, labour, housing)-social

H- Social profits

I, J, K and L are divergences between private and social prices

Table 4.19: Policy analysis Matrix for improved indigenous chicken production in Kenya

Item	Revenue	Tradable inputs	Non-Tradable inputs	Profits
Private Prices	(A)2997120	(B)2063672.85	(C)1022705.9	(D)(89258.75)
Social Prices	(E)2622480	(F)1444570.99	(G)596783.46	(H)581125.54
Policy transfers	(I)374640	(J)619101.86	(K)425922.44	(L)(670384.29)

4.10.2 Measure of private profitability

Private profitability in PAM is measured by calculating private profits (denoted by letter D) from the budget. According to Eric Monke, it shows competitiveness of the agricultural system given the current technologies, output values, input costs and policy transfer (Monke and Pearson 1989). A positive private profit (D>0) implies competitiveness, D=0 is breakeven point while D< 0 implies non-competitiveness. The results of this study indicate that the enterprises recorded a negative profit of Ksh. (89,258 for 9366 Kgs of eggs or Ksh. (9.50) per Kg which implies that chicken producers are making losses at current market prices. This could be attributed to the high cost of production with cost of feed contributing the biggest percentage. Cost of feeds have surged by 30-40% in the past two years in Kenya. Private Benefit-Cost Ratio (PBCR) and Private Cost Ratio (PCR) are the other measures of competitiveness. A PBCR > 1 indicates the presence of competitiveness, PBCR = 1 indicates breakeven point while a

PBCR < 1 shows the enterprise is not competitive. In this study, PBCR was 0.97 implying non-competitiveness of Kenya improved indigenous chicken producers. PCR is the proportion of domestic factor costs to the value added to private pricing. A PCR>1 =Non-competitiveness and that <1=competitiveness. The PCR in this study is 1.10 indicating that the producers were not competitive.

4.10.3 Measure of comparative advantage

In PAM, the social profit, domestic resource cost, and social cost-benefit ratio are typically used to measure comparative advantage. The difference between social prices for revenue and social prices for costs is defined as social profit, which is denoted as (H) = E (F + G). Positive social profits (H) indicate there is a positive social valuation and thus the presence of a comparative advantage or efficiency. The social profit in this study is Ksh. 581,125 and implies Ugandan chicken producers have a comparative advantage over the Kenyan ones. The values used here were obtained from Uganda and which are much lower compared to the Kenyan ones.

Domestic Resource Cost (DRC): DRC = $\frac{\textit{non tradable inputs sp}}{\textit{outputs}-\textit{tradable inputs sp}}$ $\quad \textit{i.e}\ \frac{G}{E-F}$

A DRC< 1 indicates that fewer domestic resources are used to generate one more unit of foreign exchange, implying that it is cheaper to produce such a commodity locally than importing it.

This is an indicator that the country has comparative advantage in the production of that commodity. The DRC in this study is 0.60 implying chicken producers in the competing country (Uganda) utilize less inputs (costs and quantities) for their egg production than

Kenyan ones hence making them more competitive. This has led to exportation of cheap eggs to Kenya.

Socio Cost-Benefit Ratio (SBCR) ; this calculates how much each unit of investment produces.

The equation below is used to express it.

$$\frac{\boldsymbol{E}}{(\boldsymbol{F}+\boldsymbol{G})}$$

An SBCR>1 indicates that an enterprise is profitable while an SBCR = 1 denotes breakeven point and SBCR < 1 indicates non-profitability of an enterprise and should not be performed. In this study, the SBCR is 1.28 implying that the investment on Ugandan side is profitable. This could be attributed to relatively lower prices of inputs especially feeds. Uganda also has favorable climatic conditions hence she is able to produce most of the raw materials (maize, soya beans, sunflower, cotton seed) needed for manufacturing of animal feeds It also could explain the influx of cheap eggs into the Kenyan market.

4.10.4 Measure of government protection

Government protection and interventions are measured using different ratio namely; Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC), Profitability Coefficient (PC), Net transfer and Subsidy Ratio to Producers (SRP).

i. Nominal protection Coefficient (NPC)

This measure has an input and output component. The nominal protection coefficient output (NPCO) compares tradable private (input) costs to tradable social (input) costs to determine the efficiency of government protection.

$$NPCO = \frac{\text{private revenue}}{\text{social revenue}}$$

NPCI =B/F

A NPCO < 1 indicates that there is some tax (tariff) levied on output, an NPCO > 1 shows the presence of subsidy on outputs while an NPCO = 1 reveals the absence of intervention. On inputs, an NPCI < 1 implies that there is a subsidy on inputs and a NPCI > 1 indicates that there is a tax levied on inputs. In this study, the NPCO is 1.14 implying that consumers were paying 14% more for domestic eggs than for imported ones. NPCI is 1.43 indicating that producers are paying 43% more than social prices. The NPCO value could be attributed to a liberalized market and the premium prices paid for a "kienyeji" (local) egg. The law of demand and supply was at play after the government banning egg imports from the neighboring country Uganda. At the time of data collection, the government was levying import tax on chicken feed raw materials like cotton seed cake, soybean, fishmeal and yellow. These taxes coupled with the effect of Covid 19 led to a surge in cost of production especially that of inputs. In a previous study, cost of feeds was cited as the most important constraint facing chicken producers in Kenya (Wambua et al. 2021). Results from gross margin analysis carried out in this indicate that cost of purchased feeds constituted 85% of total variable and 57% of the total variable cost.

ii. Profitability Coefficient (PC)

The profitability coefficient describes the government's assistance to producers through incentive policy by adjusting the difference between producers' profit at market price and farmers' profit at a social price. A PC less than one means there is a distorting policy or market failure affecting the system while a PC greater than one indicates there is a subsidy in the system. The PC in this study is -0.15 implying there is a serious distorting policy mostly lack of incentives from the government. One of the distorting policy could be the tax levied on chicken feed raw materials which has tripled the prices of the feeds pushing majority of chicken farmers out of business. There could be a market failure due to increased inflation, Kenyan consumers are unable to purchase eggs at the high prices farmers set by farmers in an endeavor to break even.

Effective Protection Coefficient (EPC): Values for the effective protection coefficient (EPC) measures the net effects of subsidies, taxes, and exchange rate distortions on both the input and output markets. An EPC less than one indicates a negative effect of policy (eg tax) while an EPC greater than one indicates the presence of a subsidy. The EPC in this study was 0.79 implying a negative effect of a government policy. In this study chicken producers indicated that they had scaled down or completely abandoned chicken production due to increased cost of production. Taxes on fertilizer and seed have pushed cost of production of crops by 40%. According to AKEFEMA, prices of soybean went up by 53% in 2021 (AKFEMA, 2021).

iv. Net transfer (L)

This is calculated denoted by L and is the difference between private profit and social profit. If L is less than zero, there may be a policy that distorts the market or a market

failure; if L is greater than zero, there may be a subsidy; and if L is equal to zero, then there is no government intervention. In this study the net transfer is negative or less than zero implying that there is a distorting policy or market failure. An example of a distorting policy or failure would be the value of the shilling to the dollar. Because too little local currency is generated by exports or spent on imports, an overvalued exchange rate imposes an implicit tax on producers of tradable goods. In the absence of a commodities policy, a marketable good's domestic price is determined by its global market price. When the exchange rate is overvalued, the domestic price is lower than it should be and domestic producers are involuntarily subjected to a tax.

v. Subsidy Ratio to Producer (SRP)

SRP is a unified metric for measuring all transfer effects as well as an incentive indicator (Table 4.20). It is expressed as follows: SRP = L/E. A SRP > 0 indicates there is some subsidy on inputs while SRP < 0 implies the presence of a tax. The SRP calculated from PAM values in this study is -0.26 which is <0 implying there is a tax levied on inputs affecting farmers' competitiveness negatively.

Table 4:20: Competitiveness and policy indicators of improved indigenous chicken production in Kenya

DRC	0.60
SBCR	1.28
PBCR	0.97
PCR	1.10
NPCO	1.14
NPCI	1.43
EPC	0.79
PC	-0.15
Net transfer	-670384.30
Subsidy ratio	-0.26

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMEDATIONS

5.1 Summary of findings

This study aimed at evaluating the technical, cost efficiency and competitiveness of improved indigenous chicken in Kenya. The study was carried out in Machakos, Uasin Gishu and Kiambu counties where a total of 384 farmers were interviewed. Demographic characteristics were determined using descriptive statistics while technical and cost efficiencies were measured using the stochastic frontier function. Results indicated that majority of the producers (84%) were women with the average age of all respondents being 51 years. Majority of the respondents (73%) had attained secondary level education (12 years of schooling) and had a 22 year experience in chicken farming. The average flock size per farmer was 81 with an average of thirteen eggs being laid daily and an egg being sold for KES. 16. The two major challenges cited by farmers were cost of feeds and disease prevalence. The average technical efficiency score was58%, cost efficiency was 39% and allocative was 67%. Feed, labour, veterinary services and water had a significant positive effect on the quantity of eggs produced. Some of the economic and institutional factors affecting technical efficiency included; household size, access to agricultural extension services and distance to both input and output markets. Cost of feeds, labour, equipment, veterinary and transportation contributed to the total cost of production significantly. PAM analysis indicated that Kenya producers were not competitive and recorded negative private and social profits. Chicken producers were not getting government protection with taxes being levied on inputs like animal feed raw materials.

5.2 Conclusions

Results from the study indicate that majority of the improved chicken producers were middle aged women. Out the total producers, 71% indicated that they had been trained on chicken production and marketing by various organization. Results further indicated that majority of the producers did not access credit facilities for poultry production and for those who did, they sourced credit from the informal sector, ROSCAs being the most popular. Chicken producers from the three study sites also indicated that they belonged to farmer groups which helped the in obtaining inputs, training and markets easily. The two most cited constraints of chicken production were cost of feeds (80%) and diseases (74%).

Further, the study arrives at the following conclusions;

The mean TE was 58% implying that farmers could still attain maximum efficiency levels if they utilized available resources in an appropriate with minimum wastage levels. The mean cost efficiency level was 39% which implied that majority of the farmers were cost inefficient. The mean allocative efficiency was 67% implying that they were fairly apportioning available resources appropriately to maximize output.

Several production factors like feed, labour, vaccines, veterinary services affected technical efficiency of farmers while cost efficiency was affected by cost of feeds, labour, veterinary services, transportation and equipment. Socio- economic factors that affected TE were; education of the household, age of household head, access to extension services, farming experience of household head, total land owned and distance to the tarmac road.

Cost efficiency was affected by the following socio-economic and institutional factors; size of household, access to extension services, distance to both input and output markets and distance to the nearest tarmac road. Extension services and distance to the market stood out in both TE and CE.

PAM results show that production of improved indigenous chicken is not competitive at private prices with private profits being negative. Private profitability is shown by a PBCR of 0.97 and PCR of 1.10 which indicates non-competitiveness of Kenya chicken producers. The social profits were positive indicating that Ugandan farmers had a comparative advantage or were efficient in their production. This was confirmed by DRC of 0.60 and a SBCR of 1.28 showing the enterprise was profitable. On government protection, the NPCO is 1.14 implying the presence of a subsidy while the NPCI is 1.43 indicating presence of a tax on inputs. The PC in this study is -0.15 implying there is a distorting policy or market failure while the net transfer <0 indicating a policy distortion or presence of disincentives most likely a tax. The effective protection coefficient was 0.79 implying that there was a negative effect of tax on productivity of chicken enterprises in Kenya.

5.3 Recommendations

After estimating the efficiency and competitiveness of improved chicken producers, the study makes the following recommendations;

First, feed cost account for the highest proportion of the egg production budget and a key determinant of technical efficiency in poultry farming. Research institutions in collaboration with relevant stakeholders should develop alternative sources of starch and

proteins to reduce competition between livestock and human beings. This will reduce cost of feeds.

Secondly, public expenditure on extension and education and specialized training should be expanded as these have significant positive effect on efficiency through provision of up to date production and technological information to help the farmers improve their chicken farming skills. This can be enhanced even more if the farmers forms poultry farming groups to facilitate such information. In this regards, farmers should organize themselves into cooperatives and producer organizations which will enable them to purchase inputs in bulk and cheaper prices. They will also have a bargaining power when selling their products

Thirdly, because the results showed that poultry housing had a significant impact on technical efficiency, the study advocates for strategies to ensure good biosecurity practices and lighting management, both of which are important for housed chicken. For example, exposure to light for less than the minimum time required results in a drop in egg production. On the other hand, when chickens are exposed to too much light, they reach sexual maturity at an early stage and they lay very small eggs. Therefore efficient light management is key to ensure improved egg production.

Fourthly, efficient poultry management is critical to guarantee high productivity in the farms. This include ensuring clean and dry environment as much as possible and good poultry health management practices. For instance stress in layers is known to decrease egg production efficiency. Studies have shown that stress-free chicken is the one that lays the greatest number of eggs. Therefore, factors such as overcrowding, excessive

heat, poor feeding, unclean environment and others associated with chicken stress should be avoided at all cost.

Fifthly, PAM results indicated that Kenyan chicken producers are not competitive and this may be attributed to high costs of livestock feeds and raw materials making feeds very expensive and out of reach for majority of small holder chicken producers. This calls for a tax review (to reduce or remove taxes on inputs) in order to lower cost of production to improve farmers' competitiveness.

Lastly, since the chicken enterprise is not profitable and Kenyan producers do not have a comparative advantage, it is recommended that they drop the enterprise and go for a profitable one. The country does not have to continue producing eggs at a loss when she can import the same at lower prices.

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APPENDICES

APPENDIX I: QUESTIONNAIRE

ASSESSMENT OF EFFICIENCY AND COMPETITIVENESS OF CHICKEN PRODUCTION IN KENYA

Introductory statement

My name is _____. I am collecting data on behalf of Scolastica Wambua who is collecting data for her PhD thesis. This exercise aims to collect data from improved indigenous chicken producers to assess their efficiency and competitiveness in their production. You were randomly selected and your participation is voluntary, but important because you represent many other farmers in this County. I would like to request for your time to complete this questionnaire.

SECTION 1: INTRODUCTION

1.1. Name of Enumerator: _____

1.2. Enumerator Phone No._____

1.3. Date of interview: _____

1.4. Name of Supervisor: _____

1.5. GPS Readings: _____

1.6. County: 1. Kiambu, 2 = Machakos 3=Uasin Gishu

SECTION 2: HOUSEHOLD CHARACTERISTICS

2.1. Respondent name _____

2.2. Cell Phone number _____

2.3. Sex of HHH_____

2.4. Age of the HHH(years) _____

2.5. Are you the household head? 1 = Yes, 2 = No If yes go to 2.7 (*A household head is the person who makes major decisions on production, marketing and utilization*)

2.6. If no, how are you related with the household head? 1= Spouse, 2= Son/daughter, 3= Parent, 4= Son/daughter in-law, 5= Hired worker, 6= other, (specify) _____

2.7. Sex of the household head (*Observe and record*) 1= Male, 0= Female

2.8. Education (No. of years of formal schooling)_____

2.9. Main occupation of the HHH 0= Mixed farming (crop + livestock), 1= Formal employment, 2= off-farm/business, 3= Casual laborer on-farm)_____ (*tick one*)

2.10. Farming experience in chicken production (years) _____

2.11. What is current household size? _____

2.12. What is the total size of your farm? _____Acres

2.13. Composition of house hold members by gender 0=adult male___1=adult female 2=Youth male 3=youth female

2.14. Are you a member of a farmer group? 1= Yes; 0= No *If no go to Q2.16*

2.15. If yes which ones? 0 = Common Interest group (CIG) 1 = producer Organization, 2=Credit and saving group, 3=Community-based organization, 4 = (*Tick multiple response*)

2.16. What are the main benefits you derive from the groups you belong to? 0=Access to farm inputs, 1=Access to credit, 2= Social welfare 4=Purchase of household assets, 5=School fees, 6=Marketing of farm produce 7=Agricultural training and extension 8=others (specify) _____ (*Tick multiple response*)

2.17. What is the distance from your home to the nearest Input market (feed and vaccines)____Km,

2.18. Distance to the nearest output market (for birds and eggs)_____km

2.19. Distance from your home the nearest tarmacked road?_____ (Km)

2.20. What is the size of area under poultry production _____Acres

SECTION 3: INFORMATION AND KNOWLEDGE

3.1. Do you access information on poultry farming and marketing 0=No ,1=Yes (If yes, continue to 3.2,)

3.2. What are your main sources of information on poultry farming (*Tick multiple response*)1 = County government extension, 2 = KALRO/KOPIA, 3= NGO, 4 = Faith based organization, 5 = Universities, 6=Private companies, 7=Media, 8= Others farmers,

3.3. Have you ever been trained on production and marketing of chicken? 1= Yes = No *If No go to Section 4*

3.4. If yes, what were you trained on: 1= Incubation process; 2=Vaccination 3=Egg handling and management 4=Feeding 5=Pest and disease control; 6= Chicken Housing 7=Record Keeping; 8=Gross Margin Analysis; 9= Marketing; 10= Gender Awareness; 11= Agribusiness & entrepreneurship; 12=Post-harvest handling 13= other (specify)…….. *(Tick multiple responses)*

3.5. Who trained you? 1= Government extension officers, 2= Farmer Cooperative society /Union, 3= Private Extension, 4= KALRO/KARI, 5= Other Research organizations, 6= Agrochemical stockiest, 7= Farmers/ Neighbor, 8=NGOs, 9=Faith-based organizations, 10= Financial Institutions 11=International institutions (e.g. FAO, IITA, CIP, ILRI) 12. Others (specify)___*(Tick multiple responses)*

3.6. What was the duration of training?: 1= Less than a week; 2= More than a week; 3= More than a month; 4= Others (specify) (*Tick one*)

3.7. What was your level of satisfaction with the training you received? 1= Strongly satisfied 2= satisfied 3=Neutral; 4=unsatisfied 5= Strongly unsatisfied (*Tick one*)

3.8. How has the training helped you to improve your poultry farming? *(Tick multiple responses)* 1=Improved/acquired skills on value addition; 2=Access capital/credit 3.=Reduced losses; 4=Improved market access/ share; 5= Other (specify)_____

SECTION 4: IMPROVED INDIGENOUS CHICKEN PRODUCTION

4.1. How many years have you kept the KALRO improved chicken? _____

4.2. What was your initial breeding stock (*Tick appropriately)* 0= Fertilized eggs, 1 =Day old chicks , 3 = Month old chicks, 4 = Laying hens 5= Breeding cocks

4.3. What was the <u>main</u> source of your start up breeding stock for the KALRO improved chicken? (*Tick one)* 0 = From the group members, 1= KALRO, 3 = Other farmers 4 = NGOs 5=County government 6=Projects (KCSAP, USAID)

4.4. How did you obtain your start up breeding stock for the KALRO improved chicken? (*Tick one)* 1 = Purchased, 2 = Donation from project, 3 = Donation from Neighbours, 4 = Others (Specify)_____

4.5. If purchased, please provide the following information on breeding stock

	Initial breeding	Price (Ksh) per unit
i.	Fertilized eggs	
ii.	Day old chicks	
iii.	Month old chicks	
iv.	Laying hens	
v.	Breeding cocks	

4.6. Please fill the table on flock structure

		2020		2021	
		KALRO improved chicken	Local indigenous chicken	KALRO improved chicken	Local indigenous chicken
i.	Total Flock size				
ii.	Number of mature laying hens				
iii.	Number of mature breeding cock				
iv.	Number of pullets (young hens)				
v.	Number of cockerels (young cocks)				
vi.	Number of chicks				

4.7. Please fill the table on chicken production information

		2020	2021
i.	Age at first laying (hens)		
ii.	Age at first crow (for cockerels)		
iii.	Number of eggs laid per bird per month		
iv.	Laying percent per flock (number of hens laying of the total flock)		
v.	Number of eggs incubated per month		
vi.	Number of eggs hatched per incubation		
vii.	Number of chicks that survive to maturity		

4.8. Which method of egg incubation do you use 1 = Natural (using hens), 2 = Artificial incubator (*Tick multiple*)

4.9. Reasons for the methods used 1 = Hatching rate, 2 = Number of chicks hatched 3=only method available

4.10. Main causes of chick mortality 1=Diseases, 2 = Predators, 3=Poor handling, 4 =Congestion (*Tick multiple*)

4.11. Which production system is used for the birds 1= Free ranging, 2 = Intensive, 3 = Semi-intensive (Tick one)

4.12. How are chicken housed? 1 = Improved house, 2 = Cages, 3 = Main house, 4 = Kitchen house (Tick one)

4.13. Please fill the table on feeds and feeding

		Tick if used 1=Yes 2 = No	Sources 1= Own production 2= Purchased from the market 3 = Borrowed from Neighbors 4 = Collection from the market	Cost per month (Ksh)
i.	Layers mash			
ii.	Chick mash			
iii.	Growers mash			
iv.	Kienyeji mash			
v.	Kitchen waste			
vi.	Homemade rations			
vii.	Mixed grains			
viii.	Mineral supplements			
ix.	Vegetables			
x.				

4.14. Other costs (VC)

	Cost	Cost per month (Ksh)
	Labour per month	
	Vaccination cost	
	Veterinary services costs	
	Energy costs	
	Water costs	
	Transportation costs	
	Other	

SECTION 5: INFORMATION ON IMPROVED INDIGENOUS CHICKEN MARKETING AND CONSUMPTION

5.1. Please fill the table on chicken marketing and consumption information

		No.	Price per piece	Total
	Home consumption			
	Please indicate			
i.	Number of eggs consumed at home per month			
ii.	Number of birds consumed at home per year			
	Sale of poultry products			
i.	Number of eggs that are sold			
ii.	Who are the main buyers 1= Neighbours, 2 = Schools, 3= Local markets, 4 = Retail shops, 5 Hotels/butcheries, 6 = supermarkets			
	Sale of live birds per year			
i.	Number of mature hens			
ii.				

iii.	Number of cocks			
iv.	Number of pullets			
v.	Number of cockerels			
vi.	Number of chicks			

5.2. How are eggs/bird packaged for selling? 1 = Crates, 2 = Trays, 3 = Cages , 4 = Others (Specify)_____

5.3. How are eggs/birds transported to the market? 1 = Using bicycles, 2 = Using Motorcycles, 3 = Walking, 4 = Other (specify)_____

5.4. Who are the main buyers 1= Neighbours, 2 = Schools, 3= Local markets, 4 = Retail shops, 5= Hotels/butcheries, 6 = Others (Specify)_____

SECTION 6: HOUSEHOLD INCOME UTILIZATION

6.1. How the income from sale of chicken and eggs is utilized at the household?

	Income use	Proportion (%) per month
i.	Paying school fees,	
ii.	Buying food stuffs	
iii.	Construction of family house	
iv.	Construction of chicken house	
v.	Buying household furniture	
vi.	Individual savings	
vii.	Saving in groups (CBOs)	
viii.	Buying chicken feeds	
ix.	Entertainments	
x.	Donations	
xi.	Social welfare	

SECTION 7: GENDER ROLES IN INDIGENOUS CHICKEN ENTERPRISE

7.1. Who mainly performs activities in indigenous chicken management?

Activity	Who is involved?						
	Adult Women	Adult Men	Mainly joint (Men and women)	Male youth (18-35 years)	Female youth (18-35 years)	Boys (<18 years)	Girls (<18 years)
i. Feeding the birds							
ii. Cleaning and fumigating the chicken house							
iii. Collecting eggs							
iv. Cleaning, sorting and grading of eggs							
v. Incubating eggs							
vi. Management of hatched chicks							
vii. Giving drugs							
viii. Selling eggs							
ix. Selling of birds							

7.2. Who makes the overall decision on the use of income from indigenous chicken enterprise? 1 = Household head 2 = Spouse 3=Joint (Household head and spouse), 4= Children

SECTION 8: ASSET OWNERSHIP AND CONTROL

8.1. Do you own the following Assets;

Asset	Do you have 1=yes, 0=no	Who accesses the asset		Who controls the asset	
		Adult man	Adult woman	Adult man	Adult woman
1. Tractor					
2. Knapsack Sprayer					
3. Jembes/hoes					
4. Tractor					
5. wheelbarrow					
6. Axe					
7. Spade or shovel					
8. Water storage (Tank >1000lts)					
9. Ox/donkey-cart					
10. Pick-ups					
11. Cars					
12. Motorbike					
13. Bicycle					
14. Grain mill					
15. Water pump					
16. Radio					
17. Cell phone (mobile phone)					
18. TV					
19. Chaff cutter					
20=Other, specify…….....					

SECTION 9: ACCESS TO FINANCIAL SERVICES

9.1 Have you obtained credit for improved indigenous chicken farming activities in the past one year? 0=Yes; 1=No If No go to 8.4

9.2. If yes, what are the three main sources of credit for chicken farming? 1=Money lender; 2=ROSCAS; 3=Banks; 4=Cooperative; 5 = Family members; 6= microfinance; 7=Self Help Group; 8=Relatives; 9=Friends; 10=Neighbors;

9.3. For what purpose was the credit advanced? (*Tick multiple)* 1= For buying feeds; 2 For buying drugs; 3 = For buying improved day old chicks, 4 = For construction of a chicken house; 5 =for paying utilities (electricity and water) 6=For buying fertilized eggs

9.4. If No to Q 8.1, what are the reasons of not borrowing? (*Tick multiple)* 1 = Credit facilities not available, 2 = Credit is too expensive, 3 = lack of collateral, 4 = I did not need credit, 5 = long processing period 6 = lack of financial information

SECTION 10: ACCESS TO EXTENSION SERVICES

10.1 Do you access extension services 1=Yes, 0=No

10.2. If yes what kind of services? 0= vaccination services 1=disease management 2=monthly visits 3=feed formulation

10.3. Where do you get extension services from? 0=Private 1=County government 3 =NGOs 4= Others specify

10.4 Do you pay for extension services? 1=yes, 0=No

10.5 What is the frequency of extension visits 1=weekly, 2=monthly 3=when the need arises

SECTION 11: CHICKEN PRODUCTION AND MARKETING CONSTRAINTS

11.1. Which constraints do you face in the chicken enterprise? (Tick multiple) 1. Cost of drugs and vaccination 2. High cost of feeds 3. Poor quality feeds 4. Accessibility and availability of quality day old chicks 5. High mortality rates of chicks 6. Pest and diseases 7. High cost of drugs 7. High cost of veterinary consultations 8. High cost of labour 9. Unstable market prices 10. Lack of incubators

11.2. Please rank the constraints in the table below

Please rank the following key constraints affecting chicken production and marketing? (Response codes: 1= High, 2= Medium, 3= Low)		
	Constraint	Rating
	Cost of drugs and vaccination	
	Disease and pest attack	
	High cost of feeds	
	Poor quality feeds	
	High mortality rate of chicks	
	Market/price fluctuation	
	High cost of labour	
	Accessibility to extension services	
	Difficulty in credit and loan access	
	Lack of quality feed formulation raw materials	
	Accessibility and availability of quality day old chicks	
	Lack of incubators	
	Accessibility to affordable clean water	

Thank you for your time

APPENDIX II: NACOSTI PERMIT

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