

Full Length Research Paper

Evaluation of the resource efficiency of guinea fowl production in the Savelegu-Nanton District of the Northern Region of Ghana

Nanette Baimbill-Johnson¹, Kwabena Asomanin Anaman^{2*} and Ditchfield Amegashie²

¹Programs Lead, Innohub Growth Centre, 6 Nii Kotey Baale Avenue, East Legon, Accra, Ghana.

²Department of Agricultural Economics and Agribusiness, College of Basic and Applied Sciences, University of Ghana, Legon, Accra, Ghana.

Received 20 October, 2020; Accepted 27 April, 2021

Guinea fowl production offers an income source that could reduce the incidence of poverty of rural householders in Northern Ghana, considered one of the poorest regions in West Africa, due to its unimodal rainfall patterns that restrict the year-round production of crops. However, information on profitability and resource use in guinea fowl production in Northern Ghana is very limited. We assessed the resource-use efficiency of guinea fowl production in the Savelugu-Nanton district of the Northern Region of Ghana based on a random-sampling survey of 192 guinea fowl producers using data for the 2018 production year. The study revealed that the average flock size per producer was 82 birds; the average gross margin was about 1,499 Ghana cedis (GHS), and the average return on investment was 16.7%. High mortality rates of birds and frequent incidences of diseases were the most important challenges faced by the producers. We recommend that the government improves its extension services to farmers, especially in veterinary care services for detection and early treatment of diseases.

Key words: Guinea fowl, human capital, Ghana, poultry production, resource efficiency, risk aversion.

INTRODUCTION

Accelerated poverty reduction in Africa is an important objective of governments as they seek to improve the standards of living of their people and meet targets that they have agreed to achieve under the United Nations Sustainable Development Goals (SDG) by 2030. Given its importance in many African countries, the agricultural

sector is an area for expansion through improved delivery of services to farmers. In Ghana, the sector's contribution to the gross domestic product (GDP) averaged 20% over the period, 2013 to 2019 (Ghana Statistical Service (GSS), 2020). The sector is also responsible for the employment of about 42% of the workforce (GSS, 2013).

*Corresponding author. E-mail: kwabenaasomanin@hotmail.com; kanaman@ug.edu.gh.

The Ghanaian agricultural sector consists of four subsectors: (1) crops, (2) livestock, (3) fisheries, and (4) forestry subsectors. The livestock subsector produces varying animal products that are aimed at satisfying the protein requirements of the population. It is imperative that the livestock subsector is given increased attention to improve food security, both access and nutritional diversity in terms of adequate amounts of proteins in diets. This could lead to the country achieving broad-based socio-economic development and also help Ghana to achieve SDG2 which focuses on zero level of hunger.

Ghana's poultry production sector forms an important component of the livestock subsector and has been on a steady rise since 2000 (Food and Agriculture Organization (FAO), 2014; Kusi et al., 2015; Netherlands Enterprise Agency, 2019). The poultry industry serves as a form of security, remaining a significant source of liquid cash for emergency needs of households (MoFA, 2016). The share of the poultry industry of the GDP is thought to be increasing partly due to increasing numbers of young people getting engaged in the industry, and the increasing numbers of poultry produced since 2000 (Aning, 2006; Netherlands Enterprise Agency, 2019).

Problem statement

Ghana is administratively divided into 16 regions and 260 districts. The study area, Savelugu-Nanton district is situated in the Northern region, one of five regions in the northern part of Ghana. Much of the extensive poverty in Ghana is found in the five northern regions. This is primarily due to the natural restrictions imposed on all-year-round farming by the unimodal rainfall patterns of the area. Given the extensive poverty in Northern Ghana, several initiatives, by both government and non-governmental organizations (NGO), have been tried to improve living standards of the people in the area since Ghana gained independence in 1957. These initiatives have cut across economic sectors. In recent times, an important focus has been the promotion of income diversification activities, such as non-farm enterprises, and development of livestock production, including poultry farming (Salifu and Anaman, 2019).

Poultry is a generic term used to describe all domestic birds bred for their meat and eggs. This definition tends to be limited to the domestic chicken (*Galus domesticus*), which has dominated the attention of Ghanaian agricultural producers to the neglect of other species like ducks and guinea fowls. Guinea fowls can be raised extensively or intensively based on similar facilities used for chicken. In comparison with exotic chickens, guinea fowls are considered more suitable to the tropics because of their adaptability and greater ability to survive poor management conditions (Ministry of Agriculture (MoFA),

2016). Nevertheless, the bird has remained unimproved either for its meat production or egg-laying capacity.

Guinea fowl production offers a commercial opportunity for both rural and peri-urban farmers. To increase the quantum of guinea fowls produced to support the protein requirements and economic needs of Ghana, the productivity of guinea fowl enterprises has to be increased. However the adoption of new technologies tends to be expensive. Improvement in productivity through new technologies has therefore been limited. Given that not much research has been conducted into the economically-efficient production of guinea fowl, there is a need for more studies to be undertaken to provide enhanced information for producers (both current and potential), and also for extension officers of State and non-governmental organizations (NGO) to make them more effective in their work with farmers.

The main objective of this study was to establish the profitability and resource-use efficiency of guinea fowl production in the Savelugu-Nanton district, an important district for the production of the bird in Ghana. The district is considered the second largest guinea fowl producing area in Ghana (GSS, 2014).

LITERATURE REVIEW

Importance of guinea fowl production

Guinea fowls are domesticated birds that are usually managed under conditions similar to those of the domestic chicken fowl. They belong to the order *Galliformes* and family *Numididae* (Payne, 1990; Annor et al., 2012). Three major types of helmeted guinea fowls exist: the pearl, lavender, and the white helmeted (Payne, 1990; Annor et al., 2012). The pearl is the commonest and has a purplish-grey plumage dotted or "pearled" with white colour. The lavender variety has a pale purple colour with black shanks, pink slate or a mixture of pink and black shanks. The white variety is seen to be ordinary white in colour but possesses pink or slate shanks and white or pink wattles (Payne, 1990; Koney, 1993; Annor et al., 2012). The bird performs various functions among various areas where they exist according to literature, such as the provision of recreation, income and protein (Annor et al., 2012). Blackely and Bade (1994) reported in their research study that they have the potential to act as watch dogs on plantations, homes, and, in the control of insects on fruits and vegetable farms. According to Karbo et al. (2002), the guinea fowl particularly plays important roles in the creation of individual and social wealth generation. Its food products are considered as delicacies particularly to those from the southern zone and a quality protein source that contain less cholesterol and fats content (Ayeni and Ayanda,

1982; Okaeme, 1982; Biswas, 1999). The guinea fowl is also reported to have less taboo associated with its meat and egg consumption while the protein content (28%) of the meat is higher compared to that of the domestic fowl whose meat contains about 20% protein (Koney, 1993).

Culturally, inhabitants of northern Ghana use the bird for varying purposes such as in funeral celebrations, sacrifices, courtship, and, even as a token for settling disputes in some areas (Karbo et al., 2002; Naazie et al., 2007; Annor et al., 2012). Guinea fowls particularly play a central role during courtship and marriage as payment of dowries among the Mamprusis, Frafras and the Kusasis while the Gonjas celebrate an annual Guinea fowl festival (Naazie et al., 2007). They also play a central role in ensuring food security for people in the North as well as forming a line of defence for meeting immediate cash needs followed by sheep and goats in most households in Northern Ghana (Annor et al., 2012).

Theory of resource use efficiency

Since the popularization of the *poor but efficient smallholder farmer hypothesis* in the book entitled "Transforming Traditional Agriculture" published in 1964 by the American political economist, Professor Theodore Schultz, there has been an increasing interest in assessing the efficiency of smallholder agriculture in developing countries. The central arguments of Schultz were that traditional farmers were rational and efficient, and would undertake innovations given the right conditions. He argued that farmers responded rationally to price incentives. Improvements in human educational attainments, through formal activities, and expanded physical infrastructure by the State could transform traditional agriculture and generate considerable growth in the rural sector.

Sixty years ago, Schultz (1961) introduced the term "human capital" into the economic literature suggesting that direct expenditures on education, health, and migration were forms of capital that allowed for increased economic growth. Human capital has become a key component of the sustainable livelihoods concept of rural development in developing countries. Adapting the human capital concept of Schultz, several capital inputs variables have emerged in the literature dealing with human development issues. These capital variables include environmental and natural capital, financial capital, informational capital, physical capital, and social capital (Ellis, 2000; Anaman and Adjei, 2021).

Microeconomic theory suggests that resources are used efficiently when the minimum amounts are used for the production of a particular output level. This notion describes technical efficiency which is driven by existing technology and the resource constraints of a business. Technical efficiency is first of two components of

economic efficiency. A sustainable business must generate income to survive and pay for the inputs that its managers use to generate the outputs that are required by consumers. This leads us to the second component of economic efficiency, which is allocative efficiency.

Allocative efficiency, based on the view of British economist, Farrell (1957), who developed the concept, involves the manager optimally choosing input or factor levels once the prices of the inputs and prices of outputs are known. These inputs and output prices are assumed to be determined by markets for which an individual producer is unable to control. While the manager cannot set the prices of the factors of production, he/she can choose the amounts or levels that maximize his/her objective function for operating the business.

Given the competitive inputs and output markets, and an objective of maximizing the net returns or profits of a business, to ensure financial sustainability, the manager organizes the production of his/her business operations such that the additional value of output, also called marginal value product (MVP), is equal to the cost of the resources used to produce this additional output; this cost is also called the marginal factor cost (MFC), or the price of the input (Anaman, 1988). The MFC is the unit price of the input and it measures the addition to the total cost for an extra unit of an input used by the manager. The marginal physical product (MPP) refers to the variation in the total product quantity that results from a unit change in an input variable (Anaman, 1988). The MVP of an input is therefore derived as the MPP multiplied by the price of the output. The MVP to MFC ratio is the resource-use efficiency ratio; its value of 1.0 implies an efficient use of the resource.

Brief review of empirical evidence on resource use efficiency

Reddy and Reddy (2014) examined the resource-use efficiency of various agricultural input factors with particular emphasis on farm size. The Cobb-Douglas production function was employed in the study. The results of the analysis revealed that farm size affected both actual and potential output of a farm. There was a positive relationship between farm size and actual output. However, farm size was assessed as being an underutilized resource.

Adesiyun (2014), using stochastic frontier production function framework, established that the use of veterinary drugs positively affected the technical efficiency of poultry production in the Afijio Local Government Area of the Oyo State of Nigeria. However, family size and years of farming led to decreased technical inefficiency. Nmadu et al. (2014) conducted a study in Abuja, Nigeria on the profitability and resource-use efficiency of poultry egg production. In estimating their various resource-use

efficiencies, the Cobb-Douglas production function was used. The results of their analysis showed that labour, feed, medication, transportation and veterinary services were over-utilized resources, while flock size was underutilized. The authors established that poultry production was financially profitable even though several resources were over-utilized by farmers. Awunyo-Vitor et al. (2016) evaluated the resource-use efficiency for selected maize farmers in Ghana based on a random survey of 576 farmers. They established that there was inefficient use of several resources. Herbicide, fertilizer, land, seed, manure and pesticide were underutilized resources; labour was over utilized. Wongnaa and Ofori (2012) analysed the resource-use efficiency of cashew producers in the Wenchi Municipality of Ghana. A simple random method was adopted in the interviewing of 140 respondents with a structured questionnaire. Their results showed that farmers underutilized fertilizer, land and pesticides. Labour, on the other hand, was over-utilised.

METHODOLOGY

Study area

The Savelugu-Nanton district is located on longitude 9°24'N and latitude 0028'W. It shares boundaries with West Mamprusi on its North, Kumbugu on its West, Karaga to its East and the Tamale Metropolitan Assembly on its South. The average altitude of the Savelugu-Nanton district is within the range of 400 to 800 feet above sea level with an average population of about 139,283, according to a population and housing census that was conducted by the Ghana Statistical Service in 2010 (GSS, 2014). Out of this number, 67,531 are estimated to be males and the remaining 71,752 to be females (GSS, 2014).

$$\begin{aligned} \text{LnGREVENUE} = & b_0 + b_1 \text{LnLABOUR} + b_2 \text{LnFLOCKSIZE} + b_3 \text{LnFEED} + b_4 \text{VACCINE} \\ & + b_5 \text{LnAGE} + b_6 \text{LnAGESQ} + b_7 \text{LnEXPERIENCE} + b_8 \text{EDUCATION} + b_9 \text{SEX} + \mu \end{aligned} \quad (1)$$

Where Ln denotes natural logarithm. The variables are as defined in Table 1.

Variable definition and justification

The variables used in the model, their respective units of measurements, as well as their a-priori expectations of their effects on gross revenues of guinea fowl business are listed in Table 1.

Labour

Although guinea fowl production /in the area is predominantly extensive in nature, labour measured in man-days is a direct representation of the amount of time farmers and their households actually spend on production. The labour inputs include both family and hired labour, if any. In measuring the amount labour used, the

Theoretical framework of efficiency of resource use for this study

The basic theory underlying this study is the Profit Function theory that assumes the farmer is a rational producer with the main aim of profit maximization. The profit function incorporates both the production and cost function. Farmers derive satisfaction from the utilization of a combination of inputs that maximize their profit margins where their estimated Marginal Revenue (MR) = Marginal Cost (MC). The marginal value product with respect to input X is the addition to total revenue caused by a unit addition of input X while other inputs are held constant. Hence resources are optimally used at the point where

$$\text{MR} = \text{MC} \text{ or } \text{MVP} = \text{MFC}.$$

For a predetermined level of technology with varying prices of both production inputs and outputs, the yard stick used for judging efficiency of resources used is the marginal value of productivity (MVP) (Amaechina and Ebon, 2017). An available resource is considered to be optimally or efficiently used when there is no difference between the evaluated MVP and its very own unit price of the resource (MFC). The efficiency of the various inputs used in production is determined by computing the resource-use efficiency ratio (RUER) as:

$$\text{RUER} = \text{MVP}/\text{MFC}.$$

The underlying decision rule in estimating RUER is as follows:

When $\text{RUER} = 1$, resource is being used efficiently

When $\text{RUER} > 1$, resource is under-utilized

When $\text{RUER} < 1$ resource is overutilized

When $\text{RUER} > 1$, it implies that MVP is greater than MFC and the resource is under-employed. Increasing the use of the resource leads to an increase in profit. When $\text{RUER} < 1$, it implies that MVP is less than MFC and the resource is being excessively used; reducing the level of use of that resource increases profit. We used the log-linearised augmented Cobb-Douglas production function for the analysis of resource-use efficiency. The ordinary least squares (OLS) method was used to estimate a Cobb-Douglas production function. The empirical model is specified in Equation 1.

analysis assumed labour man-day coefficients of 1.0, 1.0 and 0.5 for adult male, adult female, and children less than 18 years old. Labour was expected to have a positive effect on gross revenues.

Flock size

The flock size variable captures the average number of birds that a farmer owns in the production season under study. It is assumed that the larger the flock size, which in this context represents a measure of farm size, the higher the output and revenues.

Feed cost

Feed is an important component of livestock production and should have a direct positive relationship with efficiency. It is assumed that the higher the cost of feed, due to increased quantity of feed dispensed to the guinea fowl, would lead to higher gross revenues.

Table 1. Variable description, units of measurement and a-priori expectations.

Variables	Description	Measurement	AA-priori expectation
GREVENUE	Gross revenue (dependent variable)	Ghana cedi (GHS)	
LABOUR	Labour	Man days	+
FLOCKSIZE	Flock size	Number	+
FEED	Feed cost	GHS	+
VACCINE	Vaccine usage	1 = Vaccine Use 0 = Otherwise	+/-
AGE	Age	Years	+
AGESQ	Square of age	Years	+/-
EXPERIENCE	Farmer experience	Years	+/-
EDUCATION	Educational level	1- educated 0-not educated	+/-
SEX	Sex of respondents	1- male 0-female	+/-

Vaccine usage

Vaccines are useful in guinea fowl production in the study area since it is highly extensive system and the birds are prone to high incidence of diseases. Administering vaccines to the birds is expected to be positively related with higher gross revenues.

Age of the producer

The influence that age of the producer or farmer (measured in years) has on output is not clear in the literature. A negative relationship would exist if relatively older farmers stuck to old inefficient methods of production. Another possibility could be that relatively older farmers would have acquired specialised information over time and were better conversant with the vagaries of nature and other hazards that could dramatically reduce outputs and hence would take pragmatic steps to ensure that minimum levels of outputs are achieved. The squared of the age variable is introduced to capture the effect of advancing age of the farmer on his/her gross revenue to ascertain whether a curvilinear relationship exists between the age of the farmer and business productivity.

Using the human capital concept of Schultz, the age of the producer embodies his/her biological capital stock, including his/her physical capacities related to the use of the five human senses of sight, sound, smell, taste and touch. The quality of the biological capital stock increases over time, through its proper maintenance, for example, through consumption of proper diets, regular exercises and effective management of stresses of life. The quality declines after a certain advanced age is reached.

Farmer experience

Farmer experience denotes the number of years of experience a farmer has in guinea fowl production. It is assumed that the number of years an individual spends producing guinea fowl has an impact on efficiency, which is likely to be positive, due to learning through mistakes. Experience is normally considered a form of human capital accumulation.

Educational level

This variable indicates whether a farmer has some level of formal educational attainment. The variable is specified as a dummy variable with zero (0) representing no formal education and one (1) representing acquisition of formal education, from primary school to tertiary level. Based on the human capital concept of Schultz (1961), education is expected to have a positive relationship with output since it is assumed that it is easier for an educated farmer to understand and apply better management practices which contribute to increased efficiency.

Sex

The effect of a farmer's sex on gross revenue can either be a positive or negative relationship. The literature is not unanimous on the nature and direction of this relationship.

Identifying and ranking challenges of guinea fowl production

The Kendall's Coefficient of Concordance (W) was used to test the level of agreements in the rankings of the respondents of the degree of importance of the challenges faced in the production of guinea fowl. Kendall and Gibbons (1990) provide a descriptive measure which allowed the concordance between rank orders within an individual rank structure to be assessed. This measure is a non-parametric statistic and is used to measure the level of agreement among several "adjudicators" who are made to assess a given set of objects. These "adjudicators" could be variables or characters.

Respondents during data collection were asked to rank in order of most pressing to least pressing challenges, a total of ten identified challenges on a scale of 1-10. The total score for each challenge was collated and subsequently their averages derived. The ranked challenge with the least score is assigned the most pressing challenge and that with the highest score, the least pressing challenge. The Kendall's Coefficient of Concordance (W) was represented as:

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

Where W represents Kendall's coefficient of concordance; T represents sum of ranks for each challenge; m represents number of rankers and n represents number of ranked challenges.

Data sources and their collection

The study employed the use of data from both primary and secondary sources. The study, however, made use of primary data more for the sole purpose of effective empirical analysis. Face-to-face interviews were conducted using a structured questionnaire. Data collected include background information on respondents such as their socioeconomic characteristics like their age, educational level, gender, household size, revenue and cost details among others while literature was sourced for secondary data with regards previous studies.

The use of a multi-stage sampling technique was used in the course of this study. Savelugu-Nanton district was purposively selected, reason being the high record of guinea fowl producers located in the area. The data on the 192 producers were collected based on a random-sampling approach using the scientific calculator to generate random numbers using a list of identified houses where guinea fowl producers lived and worked in various villages in the district. The number represented 96% response since 200 producers were selected for the face-to-face final interviews and eight were not available for the interviews.

To collect the data set, a structured questionnaire was developed and administered to the respondents. Prior to this an initial questionnaire was critically and thoroughly assessed by two data and research analysts to ascertain its ability to collect the needed information for purposes of assessing the identified objectives. The corrected questionnaire was then pre-tested with ten respondents in the Savelugu-Nanton district. The pre-testing was undertaken during the first week of January 2019. Data collection for the full study was carried during the month of February 2019 with data collected for the 2018 production year.

RESULTS AND DISCUSSION

Socio-demographic characteristics of the respondents

The majority of the sampled guinea fowl farmers are less than 35 years (52.6%) while 39.58% fall within the 36-60 years range. The study also recorded 7.82% of the respondents being above 60 years of age suggesting that guinea fowl producers in the study area can be regarded as relatively young. The mean age of the respondents, however, was 38.44 years with a minimum age of 18 years and a maximum of 85 years. These figures correspond with the GSS (2014) report in which the proportion of the district's population in the working age is more than half (51.2%) of the total population in the district. Most indigenes in the area are involved in agricultural activities for their sustenance and livelihoods. The survey respondents were predominantly male

made up of 144 people representing (75%) while the remaining 25% were females. These figures are similar to those reported by Nmadu et al. (2014) indicating the prevalence of males in the poultry business. The male dominance in the business is due to women finding it difficult to raise adequate amount of money as starting capital. This finding is different from that of Maphosa et al. (2004) and McAinsh et al. (2004) who asserted that women constituted the majority of rural poultry farmers in Africa.

Out of 192 respondents, 134 representing 69.8% had not received any formal education. Thirteen respondents indicated that they had received only primary school education. Thirty-three respondents, signifying the second largest subset of farmers, had completed formal education up to the junior high school level. Nine respondents had completed senior high school. The remaining three respondents had acquired tertiary degrees. One hundred and sixty-four respondents, out of a total of 192 in the study area were married representing 85.4%. The rest were either single (10.43%), divorced (0.5%) or separated (3.6%). Married respondents have the opportunity to use more family labour while executing their farming activities, invariably reducing the need to hire labour.

Grouping the household sizes into categories, the survey showed that 71 out of the 192 respondents were reported to have more than 25 individuals in their household representing 36.98%. This is followed by a 20.83% representation of respondents who recorded having a household size between 6 and 10 individuals. The remaining categories of household sizes: up to 5, 11-15, 16-20 and 21-25, apply to 12 (6.25%), 25 (13.02%), 26 (13.54%) and 18 (9.38%) respondents respectively.

The mean household size in the study area according to the survey is fifteen persons per household. This result also agrees with Adesiyan (2014) who reported that poultry production is naturally labour intensive and so requires a sizeable number of farm hands or labour. In rural settings, farm labour is provided by the family or household and so large family size could help reduce the need or cost for hired labour in production.

In terms of experience producing guinea fowls, the majority (54%) of the respondents had between one to ten years of experience. Only 4% of the respondents had over 30 years of experience. The remaining 42% had between 11 to 30 years of guinea fowl farming experience.

Profitability of guinea fowl production

The farmers are placed in categories based on their flock sizes with the average number of birds for the total sample of 192 respondents being 82. The main capital items used in the study area are: feeding troughs, water troughs and shovels. Some farmers prefer spreading

Table 2. Mean investment cost for producing guinea fowl per year by flock size.

Items		Up to 50 birds		50-100 birds		101-150 birds		Over 150 birds		Pooled	
		Amt	Dep	Amt	Dep	Amt	Dep	Amt	Dep	Amt	Dep
Feeding trough:	No.	2		2		2		2		2	
	GHS	33.90	3.39	33.90	3.39	33.90	3.39	33.90	3.39	33.90	3.39
Water trough:	No.	2		2		2		2		2	
	GHS	30.36	3.04	30.36	3.04	30.36	3.04	30.36	3.04	30.36	3.04
Shovel:	No.	1		1		2		2		2	
	GHS	15.42	1.03	15.42	1.03	30.84	2.06	30.84	2.06	30.84	2.06
Total cost (GHS)		79.68	7.46	79.68	7.46	95.10	8.49	95.10	8.49	95.10	8.49
Number of farmers		68		80		26		18		192	
Percent composition		35.42		41.67		13.54		9.38		100	

Amt denotes amount; Dep refers to depreciation; GHS stands for Ghana cedis.

Table 3. Mean variable costs for producing guinea fowl per year by flock size.

Item		Up to 50 birds	51-100 birds	101-150 birds	Over 150 birds	Pooled
Day-old chicks:	No.	50	61	66	68	61
	GHS	57	69	76.52	78.26	70.20
Labour:	man- days	134.36	143.28	147.90	168.46	148.5
	GHS	1,072.50	1,146.28	1,183.00	1,347.67	1,187.36
Feed:	kg	896.40	1,072.19	1,109.04	1,119.61	1,049.31
	GHS	1,792.80	2,144.36	2,218.08	2,239.22	2,098.62
Water:	Litres	855	855	1,710	1,710	1,710
	GHS	11.40	11.40	22.80	22.80	22.80
Vaccines:	kg	2	2	4	4	4
	GHS	45.00	45.00	90.00	90.00	90.00
Total cost (GHS)		2,978.70	3,416.04	3,590.40	3,777.95	3,468.98

their feed on the ground of the coop, or outside the coop, for the birds to freely peck the feed instead of investing in troughs. No permanent structures are specially constructed for housing the birds. Apart from shovels, where those producing a maximum of 100 birds use one shovel, while those producing more than 100 birds use two shovels, the quantities of all other items are the same for all categories of farmers. There is little variation in the total investment cost of a flock; this cost ranged between 79.68 Ghana cedis (GHS) and GHS95.10 (Table 2). One United States dollar was worth on average 4.59 GHS in 2018, the production year of the study.

Table 3 provides the mean annual quantities and costs of variable items used in the production of guinea fowls in the study area. The major cost component or item was feed for the sampled farmers. Feed is the most expensive cost item, and this is in accordance with research findings by Smith (1990). The least variable cost component according to the study was vaccines. The calculated net income for the various categories showed that on the average, no category had negative values meaning revenue always exceeded cost. The average net income was GHS1,498.36 which was exceeded when farmers had a flock size of over 100 birds.

Table 4. Summary of profitability ratios for producing guinea fowl by flock size.

	Up to 50 birds	51-100 birds	101-150 birds	Over 150 birds	Pooled
Number (No.) of farmers	68	80	26	18	192
Average No. of birds	32	73	117	256	82
Investment cost (GHS)	79.68	79.68	95.10	95.10	89.39
Revenue (GHS)	3,158.38	3,747.23	6,483.62	8,692.69	4,939.80
Variable cost (GHS)	2,978.70	3,416.04	3,590.40	3,777.95	3,440.77
Gross margin (GHS)	179.68	331.19	2,893.22	4,914.74	1,499.03
Less depreciation (GHS)	7.46	7.46	8.49	8.49	8.49
Net income (GHS)	172.22	332.73	2,884.73	4,906.25	1,490.54
Profit margin (%)	5.45	8.64	44.50	56.44	30.17
ROI (%)	2.16	4.06	30.33	51.60	16.67

Table 4 indicates that profit margin for the total sample is 30.17%. This ratio means that at the end of the production year, the farmer should be able to retain, on average, 30.17% of overall sale or proceeds made. The profit margin ranges from about 5.45% for flock size up to 50 birds to about 56.44% for flock size of over 150 birds. A higher profit margin implies the business venture is making more profit per cedi of revenue. A low profit margin may mean that, there could either be high running costs, low quantity of marketable birds or low pricing. Farmers producing the least number of birds (up to 50 birds) had a margin of 5.45% and this could be influenced by their running costs (since labour available will be under-utilised yet paid for. Those who produced between 51-100 birds made a margin of about 8.64%.

Results from the resource use efficiency regression analysis

A log-linearized augmented Cobb-Douglas production function model was estimated using the OLS method. The results of this estimation are presented in Table 5. The power of the estimated model was very high as measured by the R^2 of 0.834 and adjusted R^2 of 0.825. The model was adequately specified based on the Ramsey Reset Test p value of 0.242 much higher than the maximum critical p value of 0.10 used for the study.

The absence of significant multicollinearity in the model was shown by the very low variance inflation factor (VIF) of all the independent variable, below 2.0, with the exception of the two age variables, which was due to the square of the age. Yet, despite the relatively high VIF for the two age variables, both of them had strongly-statistically-significant parameters making the high VIF of the two variables an irrelevant issue in terms of multicollinearity. There was no significant heteroscedasticity using the Lagrange Multiplier (LM) test p value of 0.179.

The LM test involved regressing the estimated error term against the predicted value of the model.

Using the maximum significance level of 10%, seven out of the ten independent variables were statistically significant in influencing the gross revenues of guinea fowl producer (dependent variable). These seven significant variables are discussed. First, a positive significant relationship was observed between flock size and gross revenue. Based on the standardized regression estimates, also reported in Table 5, the flock size was the third most important independent variable affecting gross revenues. Given the parameter estimate of 0.758, one percentage increase in the number of flock size would result in an increase in gross revenue of farmers by about 0.758%. The positive influence of flock size on gross revenue identified in this study is supported by other studies by Effiong (2005) and Ohajianya et al. (2013).

Second, an increase in feed cost led to an increase in gross revenue with one percent change in feed cost led to 0.08% increase in revenue. This particular finding is similar to those reported by Chukwuji et al. (2006) and Ukwaba and Inoni (2012). However, Baruwa and Sofoluwe (2016) indicated an opposite finding, a negative influence of feed cost on revenue. This negative influence could be due the excessive use of feed.

Third, the influence of the age of the farmer on the total gross revenues was shown to be a quadratic relationship with a positive significant curve followed by a negative significant curve after a turning-point age level. This turning-point age level was calculated to be 48.3 years based on differentiating the revenue equation with respect to the (logged) age of the farmer. This result suggested that the youthful age of the producer helped to combine more inputs effectively leading to higher levels of gross revenues. However, beyond 48 years, the vigour and energy of the farmer would decline and that would affect gross revenues. This result corroborated the human

Table 5. Results of the regression analysis of the factors influencing the gross revenues based on the Log-Linearized Augmented Cobb-Douglas Production Function.

Explanatory variable	Regression parameter estimate	Standardised regression estimate	Student t value	Probability level of significance	Variance inflation factor
INTERCEPT	0.390	0.000	0.221	0.825	0.000
LnLABOUR	0.001	0.001	0.031	0.976	1.046
LnFLOCKSIZE	0.758	0.950	26.774	0.000***	1.371
LnFEED	0.080	0.082	2.673	0.008***	1.028
VACCINE	-0.003	-0.002	-0.055	0.956	1.130
LnAGE	2.063	1.151	2.149	0.033**	312.419
LnAGESQ	-0.266	-1.079	-2.025	0.044**	309.085
LnEXPERIENCE	-0.059	-0.085	-2.491	0.014**	1.273
EDUCATION	0.083	0.061	1.790	0.075*	1.268
SEX	0.034	0.023	0.724	0.470	1.150
OUTLIER	0.432	0.099	2.890	0.004***	1.280

*, **, *** represent significance levels of 10% (0.10), 5% (0.05) and 1% (0.01), respectively. OUTLIER: This caters for situations where the revenue falls considerably outside the range of gross revenues per flock size. This could be data errors for four out of the 192 farmers. R-squared: 0.834***, Adjusted R-square: 0.825***; Probability significance level of the Ramsey Reset Test for correct model specification based on the null hypothesis of adequately-correct model specification: 0.242; Probability significance level of Lagrange Multiplier (LM) test of no heteroscedasticity based on the null hypothesis of homoscedasticity or no heteroscedasticity: 0.176.

capital concept of Schultz (1961).

As expected, formal educational attainment led to increased gross revenues, possibly linked to increased management skills of educated farmers. This result also corroborated the human capital concept of Schultz (1961). The statistically negative impact of experience in guinea fowl production on gross revenues was not consistent with the initial expectation. However this result could reflect the increasing risk aversion of farmers with increasing experience. Increasing experience, being a good teacher, could tilt farmers towards enterprise activity levels with lower average incomes but with lower variability of incomes or risks.

This argument was plausible for guinea fowl production in the survey area given its high risks due to high mortality of birds and frequent occurrences of bird diseases. Assuming other things held constant, one would expect more experienced farmers, who would have observed high variability of income due to high bird mortality and severe occurrence of diseases, in past years, to currently opt for lower-level production or scale, which would generate lower incomes.

The outlier variable had a significant parameter, indicating that the four guinea fowl producers, who had unusually high levels of gross revenues, were not part of the normal pattern of behaviour. Finally, labour inputs, vaccine use, and sex of the producer were the three independent variables which did not have any significant impact on gross revenues. Increasing labour inputs did not have any effect on farmer gross revenues. This was probably due to labour inputs being generated mainly

from family and communal sources Vaccine use was specified as a dummy variable of use or non-use. Its insignificant parameter estimate reflected the relatively small amounts of vaccine used. The interpretation of the parameter estimate of the sex of producer variable was that there was no statistically significant difference in gross revenues between male and female farmers.

Tables 6 and 7 summarize the results of the resource-use efficiency analysis for flock size and feed. These two inputs had statistically significant parameters in the estimated production function reported in Table 5. Their MVPs were compared with their input costs to derive their RUIERs. The greater than one value of RUIER for flock size for our study is similar to the findings of Afolabi et al. (2013) and Baruwa and Sofoluwe (2016); these researchers also indicated that flock size in guinea fowl production was an underutilized resource. On the other hand, feed was overutilized based on its RUIER being less than 1.0. The overutilized value for feed derived from our study is also similar to the findings reported by Afolabi et al. (2013) and Baruwa and Sofoluwe (2016).

The elasticity is derived from the regression function in Table 5 and is based on the fact that the parameter estimate of a double logarithmic function is an elasticity measure. The MVP is derived as the elasticity multiplied by the average revenue-average input ratio.

Challenges faced by guinea fowl producers

Table 8 provides the ranked challenges faced by guinea

Table 6. MVP and resource use efficiency coefficients using mean resource values.

Resource	Mean	Elasticity	MVP	MFC	RUER
Flock size	81.44	0.758	31.10	20	1.56
Feed	970.48	0.080	0.28	2	0.14

The mean of dependent variable (gross revenue) is GHS 3,341.17.

Table 7. Resource-use efficiency ratios and their interpretations.

Resource	RUER	Interpretation
Flock size	1.56	Under-utilised
Feed	0.14	Over-utilised

fowl producers in the area under study. The analysis of these challenges was based on the computation of the Kendall W test value; this value was highly significant with a p value of 0.000 as indicated in Table 8. The Kendall's W value of 0.617 indicated 61.7% agreement among the farmers with the identified challenges. Further, the calculated chi square value (443.819) was greater than the critical chi square value (16.92) at the 1% level. Hence, the null hypothesis was rejected in favour of the alternate hypothesis that there was an agreement among the rankings of the guinea fowl farmers.

Ten challenges were identified by the farmers in the study area; high mortality rate of birds was ranked the greatest challenge, followed by high incidence of diseases, high cost of feed, lack of veterinary services, and lack of credit facilities, in the top-five group of constraints. The extensive nature of production in the study area means these birds scavenge for their own meals; feed provided on the farm is often not enough for the size of the flock. In scavenging for their food, the guinea fowls eat directly from the ground, digging up worms or ingesting materials leading them to ill-health. The extensive nature of production also means that communicable diseases spread faster among farms since the movements of the birds are not controlled. The very low veterinary officer to farmer ratio in the district makes the control of communicable diseases difficult. The second group of constraints ranked in order of importance are unavailability of day-old chicks, adverse weather conditions, unavailability of ready markets for produce, theft cases and high cost of transportation. The traditional living system in the district makes theft cases rare leading to respondents to rank it as the second least important challenge. The least important challenge was transportation cost; this was due to the availability of many buyers on market days who visit homes of farmers to purchase mature birds.

Discussion of resource efficiency and risk aversion of guinea fowl production

The pioneering work of the American economist, Professor Frank Knight, based on his book entitled "Risk, Uncertainty and Profit", published 100 years ago in 1921 (Knight, 1921), theoretically showed the linkage between risk and uncertainty, and the profits of a business firm. It is generally accepted that the efficiency of resource use by a producer is linked to his/her risk aversion characterized by his/her attitudes towards risks in production. The theory of risk aversion was formally introduced into the economic literature independently by American economists, Professor John Pratt (1964) and Professor Kenneth Arrow in 1965. The evolutionary origins of the behaviour of risk aversion have been shown to exist not only in human beings but across many non-human animal species (Zhang et al., 2014).

Based on the utility or satisfaction gained from earning income, three types of risk attitudes are observed for producers. These are (1) risk-loving, (2) risk-neutral and (3) risk-averse (Anaman, 1988). Risk lovers tend to undertake risky investments which have less than fair chance of succeeding, and are called gamblers. Risk-neutral individuals are neutral to the risks involved in the investments and behave as if the risks involved in the investments are either too small or unimportant. Risk-averse individuals are cautious in undertaking risky investments or accepting new technologies that they are not familiar with.

A risk-averse producer sacrifices a portion of the expected income in order to reduce the riskiness of production, often measured by the variance of income from the production. This sacrifice of expected income is called the cost of risk. Microeconomics textbooks have restated the major risk aversion insight developed by Professors Pratt and Arrow, that the cost of risk has a

Table 8. Challenges and constraints of production ranked by guinea fowl farmers.

Constraints	Mean rank	Position
High mortality rate of birds	2.19	1 st
High incidence of bird diseases	4.49	2 nd
High cost of feed	4.78	3 rd
Lack of access to veterinary services	5.31	4 th
Lack of access to credit facilities	5.42	5 th
Unavailability of day-old chicks	5.46	6 th
Adverse weather conditions	5.95	7 th
Unavailability of ready produce markets	6.68	8 th
Theft cases	7.05	9 th
High cost of transportation	7.67	10 th
N (sample size)	192	
Kendall's W test value	0.617	
Chi-square computed value	443.819	
Chi-square critical value	16.92	
Degrees of freedom	9	
Asymptotic significance level	0.000***	

direct relationship with the risk aversion attitude of a producer (measured as his/her absolute risk aversion coefficient), and the variance or riskiness of production income (Varian, 2014: 226-232; Thian, 2018: 239-248).

For the results obtained from this study in the Savelugu-Nanton district, which are summarized in Tables 5, 6, 7 and 8, it is clear that guinea fowl production entails considerable risks with farmers declaring mortality of birds and incidence of diseases as the two most important constraints that they face. It could be argued that guinea fowl producers in the survey area are generally risk averse given the inherently risky nature of production characterized by income variability over time arising from bird mortality and diseases.

Based on microeconomic theory, we should expect the estimated marginal value product to be greater than the marginal factor or the cost of the input. The difference is the marginal risk cost, which is always positive for risk-averse farmers, and leads to reduction of output levels to below to those obtained under riskless conditions (Anaman, 1988: 222). Hence, for risk-averse producers, resource-use efficiency ratio magnitudes would be over 1.0. For risk-loving producers, resource-use efficiency ratios would be less than 1.0 while a resource-use efficiency ratio of 1.0 would indicate risk-neutral producers.

The results from Table 6 indicate that using the mean values, the marginal value product for flock size is 31.1, and this is 56% greater than the marginal factor or price of flock size (20.0) by 56% thus yielding the average resource-use efficiency ratio of 1.56. This result would suggest that based on using average flock size, the guinea fowl farmers are generally risk averse. However,

risk aversion varies from individual to individual. Using flock size as a proxy measure of farm investment, numerical simulation analysis was conducted to establish the marginal value product and the resource-use efficiency ratio for all 192 guinea fowl farmers.

The results of the simulation analysis indicated that the marginal value product for flock size varied from 16.72 to 135.18 with an overall average of 36.16 (incidentally higher than the reported 31.10 in Table 6 which was derived using average flock size for all 192 producers). The resource-use efficiency ratio varied from 0.84 to 6.76 with an average of 1.81 (which is higher than the reported average of 1.56 based on the use of the average flock size). The proportion of guinea fowl producers who had resource efficiency ratios greater than 1.0, and would be deemed to be risk-averse producers, was 97.9%. The remaining 2.1% of the farmers were considered to be risk-loving due to their resource-use efficiency ratios being less than 1.0. None of the farmers was risk-neutral. In summary, the apparent underutilization of flock size was directly related to the farmers' levels of risk aversion that entailed carrying less investment burden associated with flock size in the hope of securing more stable income.

Conclusion

This study had the objective of determining the profitability of guinea fowl production in the Savelugu-Nanton district. The efficiency of resource use and the production challenges facing farmers were analysed based on cross-sectional data obtained from a multi-

stage random-sampling survey of 192 farmers in the district. The analysis indicated average profit margin of 30.17% and an average return on investment of 16.67%. High mortality rate and the incidence of diseases were ranked as the two most serious production challenges faced by the farmers.

Based on the findings of the study, we conclude that guinea fowl farmers in the study area are producing profitably but at different margins; these margins are influenced by the number of birds or flock size being kept at a time and the amount of time or labour dedicated for production activities. Feed was over-utilized suggesting that this resource was used inefficiently; this particular result suggested extension advice intervention to ensure greater efficiency in the use of feed, given the high costs of feeds which was indicated as the third most important production constraint by the farmers.

Flock size appears to be an under-utilized resource. However, the apparent underutilization of flock size would be a natural risk aversion management strategy of farmers in the study area given the high mortality rates of birds and high incidence of diseases which led to high variability of income across years. Using flock size as the size of investment, we established that the vast majority of the farmers (97.9%) were risk-averse and would sacrifice some portion of expected income to reduce risks of production.

This paper makes three contributions to the international literature on economics of poultry production, especially in Africa. The first contribution is that an “under-utilized” flock is not a sign of inefficiency but rather a form of risk aversion management strategy undertaken by farmers given the high mortality of birds in rural African poultry conditions. Birds are a form of fixed capital input and a rational farmer cannot hold on to too much fixed capital inputs that can be quickly destroyed by diseases. Farmers rationally “under-utilize” to eliminate a catastrophe of large income losses when a bird disease sweeps an area.

A second contribution of this paper is that it reinforces the role of human capital in the transformation of traditional agriculture advocated by Schultz (1964). We established that formal educational attainment was influential in improving revenues. More labour inputs used on farms do not necessarily translate into increased productivity. The quality of biological/human capital embodied in a person improves his/her productivity as a person ages. However, beyond a certain age, the quality of this capital declines and negatively affects business productivity. Therefore, ageing is a form of human capital. Individual farmers can maintain properly their health status through improved access to health care, clinics and health information allowing them to enhance their productivity as much possible with advancing age.

The third contribution of this paper combines the concepts of human capital and risk aversion. Theoretically,

experience could be considered to be a form of human capital formation as a farmer accumulates skills over time through learning from mistakes and learning from others. This accumulation of human capital would be expected to lead to increased productivity and gross revenues. Yet, as the well-known proverb says, “experience is the best teacher”. With regards to highly-risk production ventures, which have weak supporting systems, more experience in these production ventures would also have allowed farmers to have observed their high variability of incomes over time. For guinea fowl production in Northern Ghana, the reality of high variability of income due to high bird mortality and severe occurrences of diseases would have been more frequently observed by more experienced farmers. Such farmers would more likely opt for lower current production levels of guinea fowl production which lead to lower gross incomes, as observed in our current study. The increasing risk aversion that comes with more experience in handling highly-risk production ventures could offset gains based on human capital-induced productivity derived from increasing producer experience.

In conclusion, the three human capital variables – formal education, age, and experience in fowl production – gave varying results based on their impacts on gross revenues in guinea fowl production in the Savelugu-Nanton district. Improving the quality of human capital does not always lead to increased revenues or growth; a farmer may opt for increased stability of income based on more experience in a highly-risky venture.

Recommendations

First, the government of Ghana should invest in the guinea fowl industry through sponsoring research institutions to undertake more studies on the efficient utilization of resources by farmers as a means of reducing poverty in Northern Ghana. Such research works could include studies related to the establishment of government-supported insurance schemes for guinea fowl production given the high risky nature of the business. Second, guinea fowl farmers could be encouraged by the government to form farmer-based organizations to improve their overall wellbeing by pooling of individual resources. Given the relatively small sizes of operations of the farmers, pooling of resources through farmer-based organizations could allow the government to assist farmers through cost-effective programmes in the areas of animal husbandry techniques, business management principles and records keeping.

Third, there is a need for the State to deploy more veterinary officers in the districts to increase service contacts with guinea fowl farmers. The farmers indicated that the high mortality rates of the birds and the incidence of diseases were the biggest problems that they faced. Further, lack of access to veterinary services was

indicated as the fourth most important production constraint. The government needs to increase the number of veterinary officers engaged in direct extension services to farmers to help to reduce these problems. This could be done through the increased assignment of veterinary officers and technicians to the district.

Veterinary officers are at the frontline of State-led efforts in the early detection and treatment of diseases that jump the species barrier from animals to human beings (zoonoses), such as avian flu (from wild birds), coronaviruses (from bats), and Ebola (from bats). In 2015, avian flu outbreaks occurred in Ghana destroying many poultry farms. Zoonotic diseases have been increasing around the world due to increased efforts of human beings in extending their reaches across fragile natural environments resulting in close contacts with animals, and the fight back of the natural environment against human beings, with the release of disease-causing agents into human systems. Increasing the numbers of veterinary officers and technicians across Ghana could improve early detections and management of zoonoses.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

This paper is based on the Master of Philosophy in Agribusiness degree thesis of the senior author which was submitted to the University of Ghana, Legon in July 2019. The authors did not receive any funding for the study.

REFERENCES

- Adesiyun OI (2014). Technical efficiency of poultry production in Afijio Local Government Area of Oyo State, Nigeria. *Developing Country Studies* 4(20):74-78.
- Afolabi OI, Adegbite DA, Ashaolu OF, Akinbode SO (2013). Profitability and resource-use efficiency in poultry egg farming in Ogun State, Nigeria. *African Journal of Business Management* 7(16):1536-1540.
- Amaechina EC, Eboh EC (2017). Resource use efficiency in rice production in the lower Anambra irrigation project, Nigeria. *Journal of Development and Agricultural Economics* 9(8):234-242.
- Anaman KA (1988). *African Farm Management: Principles and Applications with Examples*. Ghana Universities Press, Accra.
- Anaman KA, Adjei KD (2021). Income diversification and economic welfare of rural households in the Volta Region of Ghana. *Research in World Economy* 12:120-137.
- Aning KG (2006). *The Structure and Importance of the Commercial and Village Based Poultry in Ghana Final Review Report*. Food and Agriculture Organization Rome.
- Annor S, Apiiga S, Ahiaba J (2012). *A Handbook on Guinea Fowl Production in Ghana*. Quality Type Limited, Accra.
- Arrow KJ (1965). *Aspects of the Theory of Risk Bearing*. Yrjö Jahnsson Foundation, Helsinki, Finland.
- Awunyo-Vitor D, Wongnaa CA, Aidoo R (2016). Resource use efficiency among maize farmers in Ghana. *Agriculture and Food Security* 5(1):28.
- Ayeni JSO, Ayanda JO (1982). Studies of the husbandry practices and social acceptance of guinea fowl in Nigeria. *Bulletin of Animal Health and Production in Africa* 30(2):139-148.
- Baruwa OI, Sofoluwe NA (2016). Profitability and resource use efficiency of guinea fowl (*Numida meleagris*) production under tropical conditions. *Journal of Livestock Science* 7:97-106.
- Biswas ER (1999). Guinea fowl In R Ewbank, FK Madlien, GB Hart (eds.) *Management and Welfare of Farm Animals* (4th Edition, pp. 273-277). Halstan and Company Limited, Amersham, Bucks, United Kingdom.
- Blackely J, Bade DH (1994). Guinea fowl. In *The Science of Animal Husbandry* (6th Edition. Prentice-Hall Inc., New York.
- Chukwuji CO, Inoni OE, Ogisi OD, Ogisi WJ (2006). A quantitative determination of allocative efficiency in broiler production in Delta State, Nigeria. *Agriculturae Conspectus Scientificus* 71(1):21-26.
- Effiong EO (2005). *Efficiency of Production In Selected Livestock Enterprises in Akwa Ibom State, Nigeria*. Ph.D Thesis, Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike, Nigeria.
- Ellis F (2000). *Rural Livelihoods and Diversity in Developing countries*. Oxford University Press, Oxford.
- Farrell MJ (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society, Series A General Part* 120(3):253-290.
- Food and Agriculture Organization (FAO) (2014). *Animal Production and Health Livestock Country Reviews. Poultry Sector Ghana*. No. 6. FAO, Rome.
- Ghana Statistical Service (GSS) (2013). *National Population and Housing Census: National Analytical Report*. GSS, Accra.
- Ghana Statistical Service (GSS) (2014). *National Population and Housing Census: District Analytical Report Savelugu-Nanton District*. GSS, Accra.
- Ghana Statistical Service (GSS) (2020). *Rebased 2013-2019 Annual Gross Domestic Product April 2020 Edition*. GSS, Accra.
- Karbo N, Avornyo FK, Apiiga SY (2002). Preliminary studies on the pattern and causes of Guinea fowl (*Numida meleagris*) keel losses in Garu, Bawku East District. *Savanna Farmer* 1:15-17.
- Kendall MG, Gibbons JD (1990). *Rank Correlation Methods*. Oxford University Press, New York.
- Knight FH (1921). *Risk, Uncertainty and Profit*. Houghton Mifflin Company, Boston.
- Koney EBM (1993). *Poultry Health and Production*. Advent Press, Accra.
- Kusi LY, Agbeblewu S, Anim IK, Nyarku KM (2015). The challenges and prospects of the commercial poultry industry in Ghana : a synthesis of literature. *International Journal of Management Sciences* 5(6):476-489.
- Maphosa T, Kusina J, Kusina NT, Makuza S, Sibanda S (2004). A monitoring study comparing production of village chickens between communal (Nharira) and small-scale commercial (Lancashire) farming areas in Zimbabwe. *Livestock Research for Rural Development* 16(7).
- McAinsh CV, Kusina J, Madsen J, Nyoni O (2004). Traditional chicken production in Zimbabwe. *World's Poultry Science Journal* 60(2):233-246.
- Ministry of Food and Agriculture (MoFA) (2016). *Ghana Livestock Development Policy and Strategy*. MoFA, Accra.
- Naazie A, Canacoo EA, Mwinbong C (2007). Guinea fowl production practices and marketing in Northern Ghana. *Journal of Animal Science* 2&3(1):35-44.
- Netherlands Enterprise Agency (2019). *Analysis Poultry Sector 2019 An Update on the Opportunities and Challenges*. Embassy of the Kingdom of Netherlands in Ghana, Accra.
- Nmadu J, Ogidan I, Omolehin R (2014). Profitability and resource use efficiency of poultry egg production in Abuja, Nigeria. *Kasetsart Journal of Social Science* 35(1):134-146.
- Ohajanya DO, Mgbada JU, Onu PN, Enyia CO (2013). *Technical and*

- economic efficiencies in poultry production in Imo State, Nigeria. *American Journal of Experimental Agriculture* 3(4):927-938.
- Okaeme AN (1982). Guinea fowl production in Nigeria. *World's Poultry Science Journal* 39:179-184.
- Payne WJA (1990). *An Introduction to Animal Husbandry in the Tropics*, 4th Edition. Longman, Singapore.
- Pratt JW (1964). Risk aversion in the small and in the large. *Econometrica* 32:132-136.
- Reddy EL, Reddy DR (2014). A study on resource use efficiency of agricultural input factors with reference to farm size in three revenue mandals of Nellore district, Andhra Pradesh. *Global Journal of Management and Business Research E Marketing* 14(5):13-21.
- Salifu GAN, Anaman KA (2019). A political economy analysis of income diversification activities of rural households in the Northern Region of Ghana. *Applied Economics and Finance* 6(5):10-34.
- Schultz TW (1961). Investment in human capital. *American Economic Review* 51(1):1-17.
- Schultz TW (1964). *Transforming Traditional Agriculture*. Yale University, New Haven.
- Smith A (1990). *Poultry*. Macmillan Publishers Limited, London.
- Thian G (2018). *Lecture Notes Microeconomic Theory*. Department of Economics, Texas A & M University, College Station, Texas, United States
- Varian HR (2014). *Intermediate Microeconomics A Modern Approach Ninth Edition*. W. W. Norton, New York.
- Wongnaa CA, Ofori D (2012). Resource-use efficiency of cashew production in Wenchi Municipality, Ghana. *Agris-on-Line Papers in Economics and Informatics* 4(2):73-80.
- Zhang R, Brennan TJ, Lo AW (2014). The origin of risk aversion. *Proceedings of the National Academy of Sciences of the United States of America*. <https://doi.org/10.1073/pnas.1406755111>.