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RESEARCH ARTICLE

Gender-segregated analysis of the poultry value chain in Ghana

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ABSTRACT

This study examined the poultry value chain in the Dormaa District and Sunyani Municipality in the Brong-Ahafo Region of Ghana. A multi-stage sampling procedure was used to obtain cross-sectional data from 203 value chain actors through the administration of a structured questionnaire. The poultry products considered were broilers and layers, and the value chain actors were producers, traders, and processors. The results of the Duncan's Index of Dissimilarity of ∼75% revealed that the poultry value chains are highly gender-segregated (i.e., men and women cluster at different levels of the value chain). The producer level of the value chain was dominated by men, and the trader and processor levels were dominated by women. The results regarding value addition and return on investment (ROI) revealed that the producers added the highest value in both the broiler and layer value chains. The producers' ROI was generally higher in the broiler value chain than in the layer value chain. The male value chain actors were found to add higher value compared to their female counterparts. This was because the men generally operated on larger scales than the women. The study highlights the role of the government, researchers, nutritionists and training institutions for the development of the poultry value chain.

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Agriculture; farmers; gender; livestock; Ghana

Introduction

As a developing and emerging country, Ghana's economy depends on agriculture. Ghana's agricultural sector employed ∼50% of the nation's workforce and contributed about 22.7% of the national GDP in 2012. Although the sector's performance has decreased over the years, it still plays an important role in meeting national and international policy targets (Institute of Statistics, Social and Economic Research, 2013). The livestock sector is still important to the Ghanaian economy, though its contribution to the national GDP remains low. It creates employment opportunities for the population

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and improves their rural livelihoods and food security (Food and Agricultural Organization of the United Nations, 2016a). In 2013, Ghana's livestock sector contributed about 1.5% to the national GDP and about 7% to the agricultural sector (GSS Ghana Statistical Service, 2014). The overall livestock production in the country has increased since the year 2000 and grew by 5% in 2012.

One of the larger sub-sectors of Ghana's livestock industry is the poultry sector. While cattle production increased by only 8% between 2000 and 2007, poultry production increased by 80% within that same period (Food and Agricultural Organization of the United Nations, 2014a). Policy instruments and strategies such as improving access to quality feed, improving animal health, developing commercial poultry for meat supply, and improving access to technology and financial instruments are being implemented by the Ministry of Food and Agriculture to enhance growth in the sector (Food and Agricultural Organization of the United Nations, 2016a). Poultry contributes to food security by providing meat and eggs which are rich in protein and provide additional revenue to farmers beyond their traditional crops and livestock (National Agricultural Advisory Services – Ministry of Agriculture, Animal Industry and Fisheries, Kampala, Uganda (National Agricultural Advisory Services - Ministry of Agriculture, Animal Industry and Fisheries, 2011). It also has much cultural importance, especially in traditional marriages and festivals. Ghana's poultry sector was established in the 1960s with the institution of state-owned commercial poultry farms, such as Pomadze Farms, to address the nation's shortage of animal protein supply (Flake & Ashitey, 2008). However, poultry production grew significantly during the 1980s and 1990s when it supplied about 95% of Ghana's chicken meat and eggs.

The commercial poultry sector in Ghana can be categorized into large-scale (over 10,000 birds), medium-scale (500–10,000 birds) and small-scale (50–500 birds) operations, with the large-scale farms representing ∼20% of the total poultry sector and producing mainly eggs (United States Department of Agriculture, 2008). Layer poultry farming is preferred to broiler production because farmers obtain better prices for their products as there is no competition with imported table eggs (Global Agricultural Information Network, 2013). The annual poultry production in Ghana is ∼14,000 metric tons of meat and 200 million eggs (Atuahene, Attoh-Kotoku, & Mensah, 2010). The Brong-Ahafo Region is the second largest poultry producer in the country after the Ashanti Region, with its broiler and layer production levels at a total of 10,032,871 metric tons (Food and Agricultural Organization of the United Nations, 2014a). Recent developmental policies for the poultry industry in Ghana have sought to improve the entire poultry value chain to minimize production costs and increase farmers' income share in the value chain. Banson, Muthusamy, and Kondo (2015) revealed that there are weaknesses in the domestic poultry industry as a result of competition with imported poultry products. Kuwornu, Kuiper, and Pennings (2009) examined the dimensions of transaction costs in the Ghanaian poultry industry and revealed that there was high level of asset specificity, uncertainty, and opportunism in the industry. These authors recommended contracting to improve the functioning of the poultry value chain.

A value chain can be defined as the range of activities which are needed to bring a product or service through the various stages of production, delivery to final consumers and final disposal after use (Kaplinsky & Morris, 2002; Kuwornu, Abdulai, & Osei-

Asare, 2013). An agricultural value chain is defined as a 'system of production, processing and marketing that brings individual and collective actors together to participate in coordinated activities to add value to a particular good or service, from its production until it reaches the consumer' (Garcia-Winder et al., 2009; Royal Tropical Institute, Agri-ProFocus and International institute of Rural Reconstruction, 2012). Actors in the poultry value chain perform value-adding activities until the poultry product reaches the final consumer. In general, the main actors in the poultry value chain are input suppliers, producers, traders, processors, and final consumers.

Value chain actors have both vertical and horizontal relationships with one another for the final goal of ensuring efficient product flow to meet the demands of their target clients, create fair competition in the value chain, develop the value chain, optimize productivity, and maximize profits for the value chain actors (Nguyen, 2010). The activities of the actors within a value chain can be grouped into different stages, such as production, distribution, and processing, with each stage adding value to the product (Nguyen, 2010). Value chain analysis is based on four principles as follows: mapping, governance, upgrading, and distribution (Rich, Baker, Negassa, & Ross, 2009).

A gendered approach to value chain development examines gender inequalities in a value chain. This helps to improve the weakest relations in the value chain and assure a comprehensive upgrading of its quality and growth. Though agriculture is the main source of employment for both women and men in rural areas of Africa, women are engaged in part-time and seasonal employment and predominantly earn relatively lower wages. Therefore, examining the participation of men and women in value chains is important as it reveals the male–female distribution in the value chain and how participation gains are shared between genders (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2013). Previous research revealed that gendered education differences, access to assets and the nature and value of economic activities have influenced men and women's participation in value chains and distribution of returns from the activities performed in the value chain (Coles & Mitchell, 2011).

In recent years, women and men have been known to engage in similar working activities, but in different ways. The roles they perform in society are limited to the availability of resources. In general, women in Africa are endowed with limited resources, and this adversely affects their contribution to production processes. Indeed, women in the least developed countries are generally involved in agriculture and/or agricultural-related jobs but are less represented in the industry (United Nations Industrial Development Organization, 2013). Women in Africa produce most of the food for their households' consumption and market the surplus, and those who are engaged in poultry production mostly do so to improve their households' income and food security and to enhance gender equity (Farnworth, 2011). In rural areas, women find it difficult to access capital to buy land and mostly need the assistance of men to acquire land for farming (Ingram et al., 2015). In this respect, Farnworth, López, Badstue, Hailemariam, and Abeyo (2018) revealed that strategies to support female innovators in agricultural value chains must be strongly context-specific and gender-sensitive.

In Ghana, agriculture is the most important source of employment for women and men in rural areas, but women mostly hold part-time, low-wage, seasonal employment and are sometimes paid less, even when they are qualified (Deutsche Gesellschaft für

Internationale Zusammenarbeit, 2013). In addition, women tend to be less integrated into the value chain due to gender differences in literacy, education, and skills (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2013). Moreover, women are more disadvantaged than men in value chain operations with respect to ownership of assets, negotiation, and decision making (Danish International Development Agency, 2010; Deutsche Gesellschaft für Internationale Zusammenarbeit, 2013). Also, low incomes, lack of control over the benefits from participation in value chains, and gender discrimination in access to credit, assets, and training adversely affect the productivity of women in the value chains (Farnworth, 2011). In fact, about 57% of rural women in Ghana are engaged in agriculture and agricultural value chains; however, they either earn very low incomes or are not paid at all because they are used as family laborers (Food and Agricultural Organization of the United Nations, 2012).

Globally, gender segregation and inequality in productive sectors including agriculture is a major concern and requires gender mainstreaming in policy frameworks (Adam, Osano, Birika, Amadi, & Bwisa, 2017; Bryant, 2006; Holmes & Slater, 2008; Kilu, 2017; Mbilinyi, 2016; Orr et al., 2016; Peterman, Quisumbing, Behrman, & Nkonya, 2011). Numerous studies have examined gender roles in agricultural value chains, but only few have examined the distribution of benefits by the actors in the value chains. For instance, Otte, Tivana, Phinney, Bernardo, and Davidsson (2018) investigated the importance of gender roles and relations in the case of solar fruit drying in Mozambique using gender-sensitive participatory methods that enable farmers to actively take part in the technology development process. The empirical results revealed that the costs and benefits of solar fruit drying are not shared equally between genders. Women have much less time available for using the solar fruit dryer. To the best of our knowledge, the literature on gender-segregated analysis of poultry value chains is scanty or non-existent. More specifically, the distribution of roles, value addition, margins, and return on investment (ROI) between genders have not been examined. Therefore, this study seeks to identify and describe the actors and their roles in Ghana's poultry value chains by gender; to estimate the value addition and equality in its distribution along the value chains by gender; and to identify the constraints faced by the actors in the poultry value chains.

Frameworks underpinning the study

Conceptual framework

The conceptual framework illustrates a value chain flow in the Ghanaian poultry industry (Figure 1). The main actors in the poultry value chain are input suppliers, farmers (producers), wholesalers, collectors, retailers, processors, and the consumers.

The poultry value chain begins with the production stage. The producer/farmer begins the production by purchasing inputs such as day-old-chicks, feed, feeders, and other inputs from suppliers. Birds are kept for about 8 weeks in the case of broiler production, and then sold to traders or processors, and sometimes exported. For layer production, the birds are kept for about 16 weeks before egg laying begins. The farmer then sells the eggs to traders and processors and then after about 2 years of laying, the spent layers are sold to consumers. Commercial poultry production in Ghana is mainly

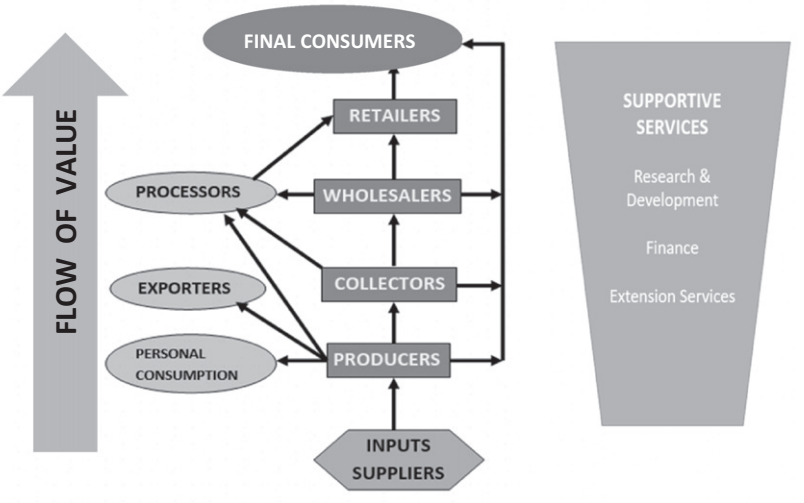

Figure 1. The conceptual framework of the poultry value chain in Ghana. *Source*: Authors.

intensive, with the deep litter system being the most common in the country's key production areas.

This study focuses on gender differences in value addition and distribution of benefits along the poultry value chain. Men generally add higher value and receive higher shares of the benefits than women. However, since women dominate the marketing of poultry products, this study sought to examine if women add more value and receive higher benefits than men at the trading and processing stages of the value chain. The conceptual framework presented in Figure 1 guides in the estimation of value addition along the poultry value chain and the distribution of benefits among actors.

Theoretical framework

Given the goal of reducing poverty in food supply chains, the promotion of access to producers' markets and improvements in agricultural production in developing countries has attracted enormous attention from researchers and policymakers. Value chain analysis has been used in understanding the creation and sharing of values among actors and in the characterization of activities performed in the chain (Kaplinsky & Morris, 2002). The framework underlying gendered value chain analysis focuses on the roles of the value chain actors, how these roles are performed, and the interventions needed to empower those that are deprived in the value chain (Laven & Verhart, 2011).

The main theory underlying this study is the sustainable food value chain development concepts (SFVC). The SFVC has three development phases, as follows:

1. Measuring Performance: assesses the value chain based on economic, environmental, and social outcomes.

2. Understanding Performance: identifies the causes of underperformance with respect to activities performed by actors.
3. Improving Performance: deals with upgrading activities that will help to improve performance (Food and Agricultural Organization of the United Nations, 2014b, 2016a, 2016b).

In this study, value addition and ROI were used as measures of performance. Profit generation is a requirement in the value creation path. Value added is defined as the total value created by the actors in the value chain. The difference between the price acquired by a value chain actor and the price that the said actor paid for the delivery of inputs by the value chain actors in the preceding stage as well as the intermediate goods such as inputs bought from the middlemen is known as the value added per unit of product (Albu & Griffith, 2005).

Value addition concentrates on determining the essential characteristics of a product that the customer needs and determining the most economical method of producing it by balancing costs with the quality of the product. ROI measures the amount received from an investment in comparison to the cost of the investment. The ROI is calculated as the investment's return (or benefit) divided by the investment's cost, and the result is expressed as a ratio or a percentage. It is a measure of performance used to assess an investment's efficiency or to compare the efficiencies of different investments. In this study, ROI was used to measure the efficiency of investments made by the various actors in the value chain. The roles and activities carried out by actors and the constraints they faced were used to understand performance and to provide recommendations to improve performance.

Gender and agricultural value chains

Most of the world's food producers are women. Estimates indicate that women make up 60–80% of the agricultural labor force in Africa and Asia, while in Latin America the estimate is 40% (Adisa & Akinkunmi, 2012). Men are known to be involved in commercial cultivation of cash crops and women are mostly found to be active in subsistence farming. Though agriculture is the main source of employment for both women and men in many rural areas, women predominantly earn low-wages, find part-time or seasonal employment and are paid less than men, even with higher qualifications (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2013; Johnson et al., 2015).

The roles played by women in agriculture differ with culture and socio-economic characteristics. Women in developing countries tend to work more hours than men with respect to house-keeping, caring for children, and fetching firewood and water. It has been estimated that women in Africa spend 16 h/d on numerous work activities; however, no economic value is placed on the work they do (whether in the farm, market or at home). Childcare work is not equally distributed between men and women, with the latter taking on the majority of this work in many societies, hampering women's ability to participate in business activities (Adisa & Akinkunmi, 2012). Women are usually involved in the value chain as employees and they are assigned to menial tasks that involve the use of low technologies and low-cost equipment. In contrast,

men take on managerial positions and use high cost, sophisticated technologies, and equipment. Women generally have difficulty in acquiring land and other physical assets due to gender-specific patterns of property and business arrangements. In addition, social norms limit their access to value chain services such as training and financial support. Gender differences in literacy and education lead to lower-skilled roles in the value chains for women. This prevents women from performing management roles and reduces their ability to negotiate with buyers and suppliers in value chains and thus limits their bargaining power (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2013).

Men usually perform manual tasks involved in crop production, such as tillage with oxen and land preparation. They play a dominant role in seed selection, which reflects their better access to information. They also undertake the seed broadcasting, fertilizer applications, and the threshing and winnowing of cereal crops. Women on the other hand are often associated with activities that require attention to detail and handiness, such as transplanting, weeding, and raising seedlings in nurseries. They also perform activities that are closely related to their household responsibilities, such as processing, value addition, and storage.

In the livestock value chains, women involved in livestock production are mostly engaged in activities related to the safety and wellbeing of the livestock, such as collecting dung and maintaining hygiene. Women also perform vital household tasks such as caring for children, cooking, fetching water and fuel wood, and cleaning the house as part of their household responsibilities (International Livestock Research Institute, 2011). This makes it difficult for them to take on other roles such as selling and processing due to unpaid household maintenance roles that consume considerable amounts of their time (Farnworth, 2011). Women are often hired as temporary or casual workers in export value chains, while men usually hold permanent working positions (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2013).

Women are more likely to use their incomes and resources to increase the overall well-being of the family, reduce child malnutrition and improve family welfare and food consumption (Chapota, 2013). Women's contribution to the welfare of the household can be strengthened through the development of the value chain by ensuring that this important responsibility is shared with men.

Women are also generally less integrated into value chains compared to men. They lack mobility and this affects their access to markets, and their interactions with other value chain actors are impeded due to social norms. Increasing opportunities for women can have a great impact on productivity and agriculture-led growth. Women are just as efficient agricultural producers as men and can achieve similar yields when given equal access to supportive resources, including training (USAID, 2011).

Materials and methods

Study area

This study was conducted in the Sunyani Municipality and Dormaa District in the Brong-Ahafo Region of Ghana (Figure 2). These study areas were selected due to their high levels of poultry production. For instance, the Dormaa District is one of the key

poultry producing areas in Ghana, especially for table egg production. On average, over 4000 tons of table eggs are produced annually in the Dormaa District, and these eggs are transported to major cities in Ghana and Ivory Coast, Burkina Faso, Mali, and Niger. At the time of data collection in December 2015–January 2016, there were 287 registered poultry farmers in the Brong-Ahafo Region of Ghana. Of this number of farmers, only 10 were women. All the poultry farms in the municipality are privately owned. There was only one hatchery in the Brong-Ahafo Region called St. Charles Farms Limited in Maasu and an egg tray factory owned by Janak Industries Limited. These facilities have worked to boost the sustainability of the poultry industry in the Brong-Ahafo Region (Owusu-Sekyere, 2011).

Sampling and data collection

A multi-stage sampling technique was used to select respondents. The first stage of the sampling involved purposively selecting the Brong-Ahafo Region as it is the second largest poultry producing region in Ghana. The second stage of the sampling involved the purposive selection of Sunyani Municipality and Dormaa District. Four communities were then randomly selected from within the Sunyani Municipality and six from within the Dormaa District, giving a total of ten selected communities. The next stage involved the selection of the actors from the various stages of the poultry value chain. This was done using the snowball sampling technique. Primary data were collected in January 2016 from 203 poultry value chain actors by administering structured questionnaires. The questionnaires for data collection were initially developed and pretested to remove all ambiguities before finalizing for the actual data collection. By this process, we ensured that quality data are obtained for the analysis (Table 1).

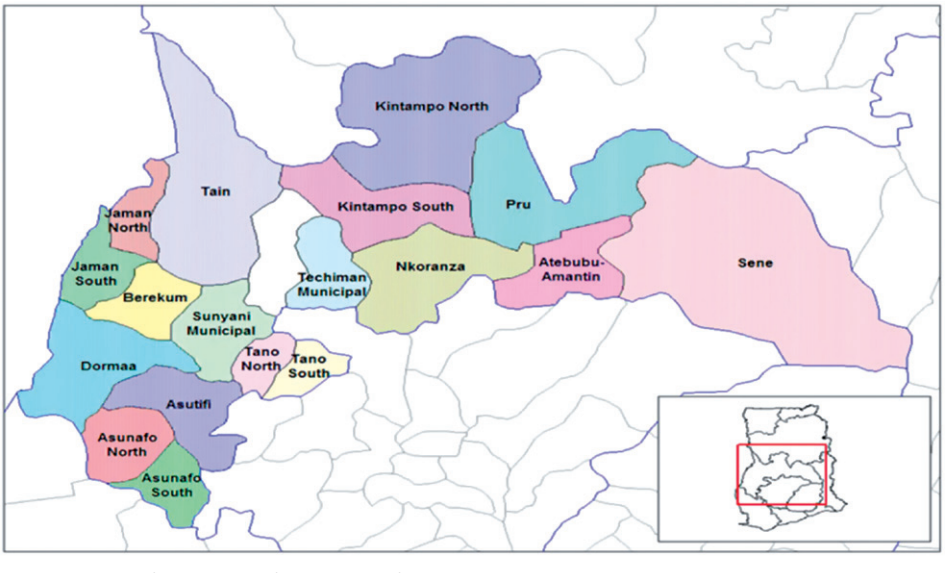

Figure 2. Map of Brong-Ahafo Region of Ghana showing the Sunyani Municipality and Dormaa District. *Source*: Rarelibra (2006) for public domain use.

Table 1. Distribution of the study sample across communities in the Sunyani Municipality and Dormaa District in the Brong-Ahafo Region of Ghana.

Community	Producers	Traders	Processors
Dormaa District			
1. Dormaa Ahenkro	16	7	15
2. Maaso	19	0	0
3. Kyeremaso	9	0	0
4. Dwene	12	0	0
5. Atesikrom	5	0	0
6. Odumase	9	0	0
Sunyani Municipality			
1. Chiraa	4	52	12
2. Sunyani New Town	1	3	12
3. Abisim	0	4	1
4. Penkwase	0	17	5
Total	75	83	45

Data analysis

Identification and mapping of the actors along the poultry value chain

The main actors along the poultry value were mapped by linking them from one operational stage to another (i.e., from input suppliers to primary producers to final consumers of the product). At every operational stage, a link is drawn between the source of the actor's major input supplier (i.e., preceding actor) and the customer of the generated product. The links show the flow of poultry products and the distribution of products among actors were indicated in percentages to determine the share to be received by each actor. Other supportive technical, financial, and governmental services that are received by the actors were also indicated on the map.

Description of the distribution and major roles of men and women at each stage of the value chain

At every operational level, the major activities that are carried out at that stage were listed and the numbers of men and women that perform an activity were stated. Frequency tables and percentages were used to indicate the major roles played by women at each stage of the value chain. Duncan's index of dissimilarity is a well-known measure of occupational segregation (e.g., Sakoda, 1981), and was therefore used to measure gender segmentation for the entire poultry value chain as follows:

$$D = 100 \times 0.5 \sum_{i=1}^{N} |f_i - m_i| \tag{1}$$

In the context of this study, Equation (1) is expanded as follows:

$$D = 100 \times \frac{1}{2} \left[\left| \left(\frac{f_{\text{prod}}}{F} - \frac{m_{\text{prod}}}{M} \right) \right| + \left| \left(\frac{f_{\text{trad}}}{F} - \frac{m_{\text{trad}}}{M} \right) \right| + \left| \left(\frac{f_{\text{proc}}}{F} - \frac{m_{\text{proc}}}{M} \right) \right| \right] \tag{2}$$

where f_i denotes the proportions of women at a value chain node, m_i denotes the proportions of men at a value chain node, F denotes the total population of the women in the value chain, and M denotes the total population of men in the value chain. The index

has a range of 0–100, where a value of 0 means a sector is not gender segregated and a value of 100 means otherwise.

Determining value addition at each stage of the poultry value chain

Value addition was estimated using the following variables: fixed cost estimation, depreciation, variable cost estimation, total cost estimation, total revenue estimation, value-added estimation, and profit estimation. The units of these estimates were in Ghana Cedis (GH₵) for 100 birds or crates of eggs per week. Value addition was assessed by estimating the incremental monetary value added to inputs at each stage to generate an output for the next level along the value chain. Figure 3 provides a diagrammatic example of value addition along a poultry value chain and how the value accumulates along the value chain.

Taking the first segment of Figure 3 as an example, a broiler producer (PP) purchases a day-old chick (DOC), rears it (i.e., feeding it, providing medication and shelter until it reaches maturity) and then sells it to the collector. As such, the value added by the producer 'a' is all the activities performed by the producer from the time the DOC was purchased to the time it was sold to the collector. The section labeled 'b' represents all the costs the producer incurred in raising the bird and section 'c' represents the benefit the producer obtains after subtracting all the costs from the selling price of the bird. This illustration is repeated for all the other actors along the value chain until the bird is sold to the final consumer.

The fixed cost estimation. The fixed cost elements considered for the poultry producers included housing, feeding and drinking troughs, spades, and wheelbarrows. The costs of layer stock are an additional fixed cost for egg producers. The cost of layer stock is considered a fixed cost because the producer keeps them for about 2 years during which the hens continually lay eggs which are sold daily or weekly. The fixed cost components for processors were gas cylinders, stoves, utensils, and other cooking equipment. No fixed cost component was recorded for poultry traders as the traders sell the birds just after purchasing from the producers or collectors. The total fixed cost for each actor was obtained by summing their various depreciated fixed cost items. The items were depreciated using the straight-line depreciation method. This is given as:

$$TFC_j = \sum_{i=1}^{n} FC_i \tag{3}$$

where TFC_j denotes the total depreciated fixed cost for actor j, FC_i denotes the depreciated fixed cost of the ith item, and n denotes the number of fixed items for actor j.

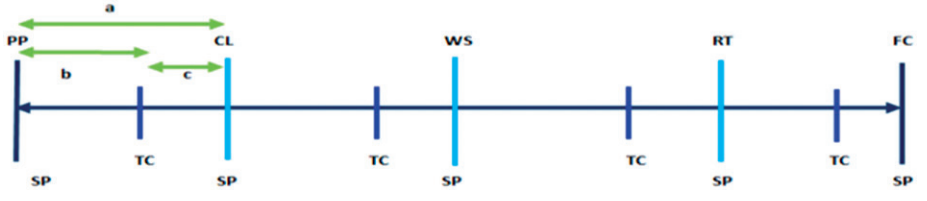

Figure 3. Value addition along the poultry value chain[1]. *Source*: Authors.

Average fixed costs for actors at the same level of the value chain were obtained by summing the total depreciated fixed costs for the actors and dividing by the number of actors.

$$MeanTFC = \frac{\sum_{j=1}^{N} FC_j}{N} \tag{4}$$

where mean TFC denotes the mean total depreciated fixed cost for actors at the same value chain level, and N denotes the number of actors at a given level of the value chain.

Estimation of variable costs. The variable cost items for the producers included feed, drugs, fuel, electricity, tax, packaging materials, transportation, labor, and broiler DOCs. All these items were estimated for 100 birds per week. Eggs, broilers, transportation, rent, drugs, tax, crates, and loading costs were among the variable cost items considered for traders. The variable cost components for the processors were water, transportation, ingredients, fuel, eggs, tax, and packaging materials. The total variable cost per actor was obtained by summing the product of the unit price of the various variable cost items and the quantity of the variable cost items. The variable cost also includes marketing expenses. The equation is given as:

$$TVC_j = \sum_{i=1}^{n} r_i x_i \tag{5}$$

where TVC_j denotes the total variable cost for actor j, r_i denotes the unit cost of a variable item, x_i denotes the quantity of a variable cost item, and n denotes the number of variable cost items for actor j.

The mean of the total variable cost for actors at a given level of the value chain is obtained as follows:

$$MeanTVC = \frac{\sum_{j=1}^{N} TVC_j}{N} \tag{6}$$

where mean TVC denotes the mean total variable cost for actors at a given level of the value chain, and N denotes the number of actors at a given level of the value chain.

Total cost estimation. The total cost incurred by an actor is the sum of the total fixed cost and total variable cost. This is given as:

$$TC_j = TFC_j + TVC_j \tag{7}$$

where TC_j denotes the total cost for actor j, TFC_j denotes the total fixed cost for actor j, and TVC_j denotes the total variable cost for actor j.

The mean total cost for all actors (Mean TC) at a given level of the value chain is given as:

$$\text{Mean TC} = \text{Mean TFC} + \text{Mean TVC} \tag{8}$$

Total revenue estimation. Total revenue was estimated by multiplying the number of crates of eggs and/or count of birds sold by an actor by the prevailing market price. Prices for the crates of eggs were determined by their grades; bigger eggs had higher prices than smaller sized eggs. Actors had a range of grades and their associated prices. The total revenue of a layer producer, for instance, was given by the number of crates of eggs he sold in a week multiplied by the associated price. The equation is given as follows:

$$TR_j = \sum_{i=1}^{n} pq_i \tag{9}$$

where TR_j denotes the total revenue for actor j, p denotes price per crate of egg or bird, and q_i denotes the quantity of birds or crates of eggs sold by actor j.

The mean total revenue for a given level of actors (Mean TR) was estimated by the following formula;

$$MeanTR = \frac{\sum_{j=1}^{N} TR_j}{N} \tag{10}$$

where N denotes the number of actors at a given level of the value chain.

Value-added estimation. Value added by traders and processors was estimated by determining the difference between the price at which a primary input was purchased from a preceding actor and the price at which they sell their finished product. The equation is given as:

$$VA_j = SP - PP \tag{11}$$

where VA denotes the value added, SP denotes the selling price of the product, and PP denotes the price of the primary input that was purchased from the preceding stage.

Value added for layer producers was estimated per week. The production cost and revenue were estimated for 100 crates of eggs per week and used to calculate the value added. The layer stock was estimated as a fixed cost item due to this stock being kept for ~2 years.

Value added for broiler producers was estimated by subtracting the cost of the primary input (which is a product of the price of a broiler DOC and the quantity [i.e., number] of DOCs purchased) from the total revenue. The result was divided by the number of weeks that the broiler was kept by the producer to obtain the value added per week. The equation is given as:

$$VA_j = TR - (PP \times n)/\text{Number of weeks} \tag{12}$$

where TR denotes the total revenue, PP denotes the price of the primary input, and n denotes the number of primary inputs.

The mean value added (Mean VA) is estimated as follows:

$$MeanVA = \frac{\sum_{j=1}^{N} VA_j}{N} \tag{13}$$

where N = number of actors at the producer level of the value chain[2].

Gross margin estimation. The gross margin represents the amount of sales revenue that the value chain retains after incurring the direct costs.

$$\text{Gross Margin,} \quad \prod = \text{SP} - \text{TC}/Q; \quad (\text{TC}/Q = \text{MC})$$
$$\prod = \text{SP} - \text{MC} \tag{14}$$

where SP denotes the selling price and MC denotes the marginal cost.

Mean profit is estimated as follows:

$$\text{Mean } \pi = \Pi/N \tag{15}$$

where N denotes the number of actors.

Benefits along the value chain

The net income or profit and the margins obtained by the various actors at a level of the value chain were estimated and used to calculate their returns on investment (ROI)/week. The paired sample *t*-test was used to examine the differences in the ROI/week between the various actors along the value chain, and between the male and female actors. For equity to exist among actors along the value chain, and between male and female actors, the paired sample *t*-test should not be statistically significant. The theory underlying equity in this study is fairness. According to the theory of Adams (1965) 'employees strive for equity between themselves and other workers. Equity is achieved when the ratio of employee outcomes over inputs is equal to other employee outcomes over inputs.'

$$\text{Net income} = \text{Total Revenue} - \text{Total Cost} \tag{16}$$
$$\text{Net income on a product} = \text{Net income}/Q$$

where Q denotes the quantity of a product sold.

Return on investment (ROI).

$$ROI = \frac{P_o - C_o}{C_o} \tag{17}$$

where ROI denotes the Return on Investment, P_o denotes the value of one unit of output, and C_o denotes the unit cost incurred in producing the output.

$$\text{ROI/week} = \frac{\text{ROI}}{T} \tag{18}$$

where T denotes the number of weeks required to produce the output.

Hypotheses.

Hypothesis 1.

H_0: There is no significant difference between the ROI of producers and processors in the poultry value chain.

H_a: There is a significant difference between the ROI of producers and processors in the poultry value chain.

Hypothesis 2.

H_0: There is no significant difference between the ROI of male producers and female producers in the poultry value chain.

H_a: There is a significant difference between the ROI of male producers and female producers in the poultry value chain.

This was repeated for other actors in the value chain. The *t*-test was used to test for differences in the means of ROI/week of men and women who performed roles at the various stages of the value chain.

Identify and rank the major constraints that actors face in the poultry value chain

The respondents were given a list of constraints to their business operations in the value chain, to rank from the most critical to the least critical constraints. Kendall's coefficient of concordance was used to test the agreement among the rankings. The rankings were collated to determine the total and the means of the rankings. The total was then used to compute the total rank score for each constraint. The constraint with the least sum score was ranked as the most pressing constraint and the one with the highest sum score was ranked as the least pressing constraint. The total rank score was used to calculate the coefficient of concordance (W) to measure the degree of agreement in the rankings. The value of W is positive and ranges between 0 and 1. W is 1 when there is maximum agreement among the rankings of the actors and 0 when there is maximum disagreement in their rankings.

The formula for the Kendall's coefficient of concordance is given as:

$$W = \frac{12S}{p^2(n^3 - n) - pT} \tag{19}$$

where T denotes the sum of ranks for each constraint being ranked, m denotes the number of respondents, and n denotes the number of rankings.

The hypothesis is given in the following section:

Hypothesis 3.

H_0: there is no agreement among rankings of the constraint

H_a: there is agreement among the rankings of the constraint

The chi-square statistic (χ^2) was used to determine the significance of the Kendall's coefficient of concordance (W).

Results and discussion

Socio-economic characteristics of the respondents

The socio-economic characteristics of actors presented include gender, age, educational level, household size, primary and secondary occupations, and membership of associations (Table 2). Most of the poultry producers (90.7%) were men. This is mainly because in the study area, commercial poultry production is regarded as a strenuous occupation

and as such that it is more appropriate for men. Also, women did not have the required capital to go into poultry production. However, most of the traders and processors were women, representing 89.2 and 84.4%, respectively. The mean ages for the producers, traders, and processors were 35.4, 39.8, and 32.1 years, respectively. This shows that the poultry sub-sector is largely dominated by people who are economically active.

Table 3 shows the socio-economic characteristic of the respondents by gender. More than 50% of the producers and processors were between the ages of 15 and 35 years, while about 35.8% of the traders fell within this age category. The average ages of female producers and traders were slightly greater than the average ages of male producers and traders. Almost all the respondents in all the three levels of the value chain had acquired at least basic education, which means that they could read instructions on poultry medications or feed to ensure provision of the recommended amounts and keep simple records. There was little difference in educational level between the male and female actors. This also disproves the notion that agriculture is for the old and uneducated members of society. Most of the actors at all levels of the value chain had a household size of at most 5. The percentages of male value chain actors' households with a household size of at most 5 were 67.6% at the producer level, 100% at the trader level, and 85.7% at the processor level. The percentages of female value chain actors' households with a household size of at most 5 were 71.4% at the producer level, 67.6% at the trader level, and 76.3% at the processor level. The average household size was ∼4 for all the actors.

Table 4 shows the characteristics of the respondents by occupation. For most of the producers (93.3%) and traders (91.6%), the poultry business was their primary occupation, while for 37.8% of the processors the poultry business was their secondary occupation. The reason processors had a higher percentage of poultry production as a secondary occupation could be attributed to the fact most of them (80%) were 'Tea

Table 2. Socio-economic characteristics of the respondents.

	Producer ($n = 75$)		Trader ($n = 83$)		Processor ($n = 45$)	
Characteristics	Frequency	%	Frequency	%	Frequency	%
Gender						
Male	68	90.67	9	10.8	7	15.6
Female	7	9.33	74	89.2	38	84.4
Age						
15–25	18	24.0	7	8.6	10	23.3
26–35	23	30.7	22	27.2	23	53.5
36–45	17	22.7	29	35.8	8	18.6
46–55	13	17.3	19	23.5	0	0.0
56–65	4	5.3	4	4.9	2	4.7
Educational level						
No schooling	1	1.3	4	4.9	2	4.4
Basic	42	56.0	55	67.1	31	68.9
Secondary	22	29.3	20	24.4	10	22.2
Tertiary	10	13.3	3	3.6	2	4.4
Household size						
1–5	51	73.9	57	70.4	29	74.4
6–10	18	26.1	24	29.6	10	25.6
Mean age	35.4		39.8		32.1	
Standard deviation	11.813		10.846		10.677	
Mean household size	4.22		4.76		4.63	
Standard deviation	2.255		2.275		2.967	

Source: Survey data (2016).

Table 3. Socio-economic characteristics of the male and female respondents.

	Producer ($n = 75$)				Trader ($n = 83$)				Processor ($n = 45$)			
Characteristics	Frequency		(%)		Frequency		(%)		Frequency		(%)	
Gender												
Male	68		90.67		9		10.8		7		15.6	
Female	7		9.33		74		89.2		38		84.4	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Age												
15–25	17	1	25.0	14.2	4	4	44.4	5.4	2	8	28.6	21.1
26–35	21	2	30.9	28.6	4	18	44.4	24.3	2	21	28.6	55.3
36–45	15	2	22.1	28.6	0	29	0.0	39.2	2	6	28.6	15.8
46–55	11	2	16.1	28.6	1	18	11.2	24.3	0	2	0.0	5.3
56–65	4	0	5.9	0.0	0	5	0.0	6.8	1	1	14.2	2.5
Educational level												
No schooling	1	0	1.5	0.0	1	3	11.1	4.1	0	2	0.0	5.3
Basic	39	3	57.4	42.9	3	52	33.3	70.3	2	29	28.6	76.3
Secondary	19	3	27.9	42.9	3	17	33.3	22.9	4	6	57.1	15.8
Tertiary	9	1	13.2	14.2	2	2	22.3	2.7	1	1	14.3	2.6
Household size												
1–5	46	5	67.6	71.4	9	50	100	67.6	6	29	85.7	76.3
6–10	16	2	32.4	28.6	0	24	0.0	32.4	1	9	14.3	23.7
	Male		Female		Male		Female		Male		Female	
Mean age	35.1		38.83		29.3		41.1		36.6		31.2	
Mean household size	4		4		3				4		5	

Source: Survey data (2016).

Joint Operators'.[3] This means they work mostly in the evenings and early mornings and so they undertook other business activities during the rest of the day to earn extra income.

In this study, the poultry producers that were considered were broiler producers, layer producers and those who produced both broilers and layers. Layer producers were dominant in the area, with a share of 88%. This was because of the ready market for eggs in the country compared to locally produced broilers. For the traders, wholesalers, retailers, and collectors were considered, and their distribution was almost even. The processors included 'tea joint operators', restaurants and boiled egg sellers.

Most of the producers (77.3%) belonged to farmer associations, very few of the traders (15.2%) were in a traders' association, and none of the processors belonged to any association simply because there was no processors association. This implies that most of the women in the value chain were not in any group or association, which could make it difficult for them to receive supportive interventions to help them in their work. Also, the lack of horizontal coordination can reduce their bargaining power, their access to information, and the opportunity to learn from one another and share risk in the value chain (Coles & Mitchell, 2011; Jitmun, Kuwornu, Datta, & Anal, 2019; Jitmun & Kuwornu, 2019; Kuwornu, 2006; Kuwornu, Kuiper, & Pennings, 2004; Kuwornu, Kuiper, Pennings, & Meulenberg, 2004, 2005, 2006a, 2006b; Kuwornu, Opoku, Kwadzo, & Mensah-Bonsu, 2009; Kuwornu, Saqib, & Moreno, 2018; Kuwornu & Saqib, 2017; Promme, Kuwornu, Jourdain, Shivakoti, & Soni, 2017; Saqib, Kuwornu, Ali, Panezai, & Rana, 2018; Sathapatyanon & Kuwornu, 2019).

Table 4. Socio-economic characteristics of the producers, traders, and processors.

	Producer ($n = 75$)		Trader ($n = 83$)		Processor ($n = 45$)	
Characteristics	Frequency	%	Frequency	%	Frequency	%
Poultry occupation						
Primary	70	93.3	76	91.6	28	62.2
Secondary	5	6.7	7	8.4	17	37.8
Respondent type						
Broiler	5	6.7				
Layer	66	88.0				
Both	4	5.3				
Wholesaler			31	37.3		
Retailer			31	37.3		
Collector			21	25.3		
'Tea Joint Operator'					36	80.0
Restaurant					4	8.9
Boiled egg					5	11.1
Association						
Yes	58	77.3	12	15.2	0	0.0
No	17	22.7	67	84.8	45	100

Source: Survey data (2016).

Mapping of actors and their roles in the value chain

Distribution of eggs and birds

Figure 4 shows the actors in the poultry value chain, their roles, and the activities they perform. It depicts the flow of poultry and poultry products as well as services from the input supplier to the final consumer. Two broad chains can be identified: the first being the layer/egg value chain, with the percentages showing distribution from producers to different actors, and the second is the broiler value chain. The directions of the arrows indicate the flow of products.

The main actors within the layer value chain are the input suppliers, poultry producers, egg collectors, wholesalers, retailers, processors, and then the final consumers. Support services were also provided by the financial institutions, veterinary and extension services, and Non-Governmental Organizations (NGOs). The main input suppliers of this value chain consist of the DOCs providers, and the feed and veterinary medicine providers. The farmers mostly source DOCs from importers and sometimes from the only hatchery in the study area known as the St. Charles Farms Limited in Maasu. This observation is consistent with the Global Agricultural Information Network (2013), in that ~90% of DOCs for the poultry sector in Ghana are imported. Accessing feed and veterinary medicine and other poultry equipment is quite easy as there are many agro-shops in the area. However, when there are shortages of feed or other important inputs, the poultry producer associations provide their members with access to those inputs.

The layer producers in the districts are mostly commercial producers, with the majority being medium-scale producers (500–10,000 birds). About 80% of the eggs produced is sold to collectors and wholesalers, whereas the remainder is distributed to the other actors in the value chain. The egg collectors are mostly from big cities such as Accra, Tamale, Sunyani, and Kumasi that demand the greatest portions of the eggs produced. They mostly take their supply from more than one producer, depending on their capacity, and transport them to the marketing centers in the cities for distribution to wholesalers.

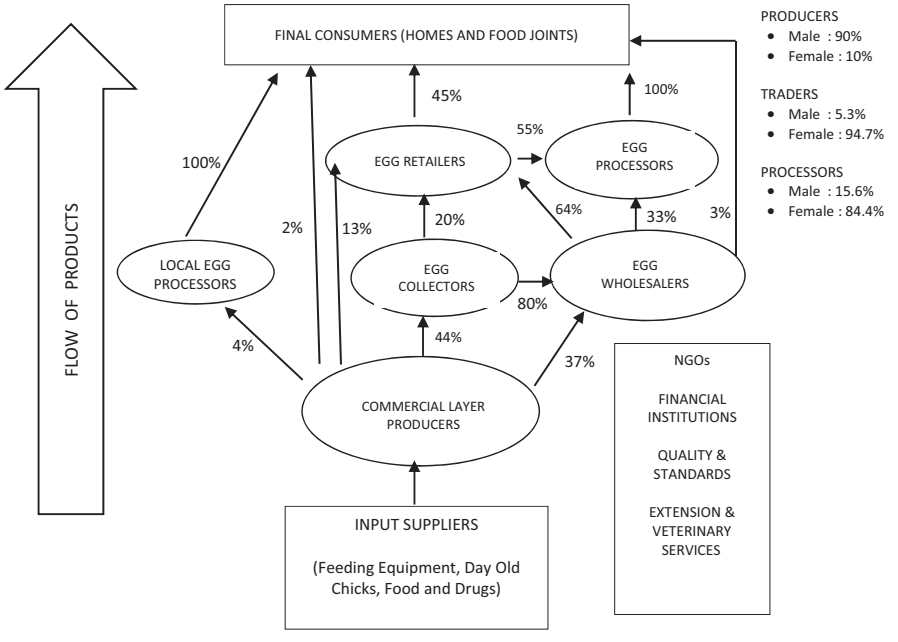

Figure 4. Map of the actors in the egg value chain, and their roles and activities. *Source*: Authors.

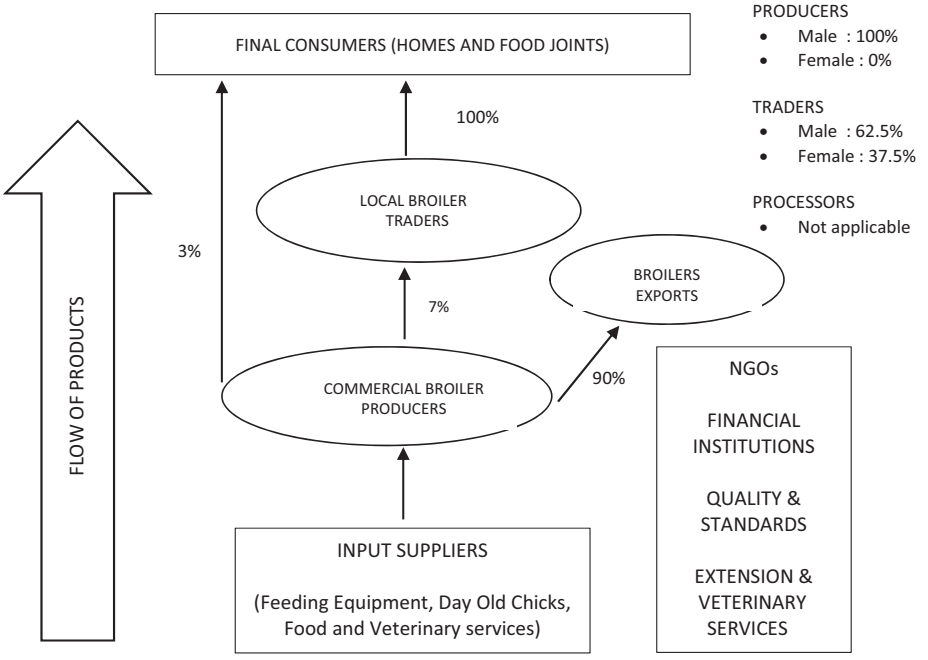

Figure 5. Map of the actors in the broiler value chain, and their roles and activities. *Source*: Authors.

The egg wholesalers get their supply either directly from the producer or collectors. During market days, other wholesalers from neighboring towns or districts come to purchase from these egg wholesalers. They also sell to retailers and processors. The egg retailers and processors have shops or stand mostly in market places where they constantly sell to individual final consumers. Only about 6% of the eggs produced are consumed within the district. Of this 6%, 4% are sold to local processors and 2% to local individual consumers.

There are few broiler producers in both districts and most of them are small-scale producers. The broiler value chain was quite short because most of the producers were in a contract relationship with a company in Cote d'Ivoire known as Fony Services. The company provides the producers with DOCs, feed, and medication and after about 6–9 weeks when the birds are matured the company would return to collect them and pay the producers for their services. Due to this arrangement, about 90% of the broilers produced in the area are exported to Cote d'Ivoire and the remaining 10% are locally distributed to traders (7%) and consumers (3%) (Figure 5).

Service providers like NGOs, and veterinary and extension officers provide farmers with training to teach them how to vaccinate their birds and administer the correct dosages of medicines. Matters on sanitation and hygiene are also discussed. The financial institutions provide loans to the value chain actors, especially to traders.

Relationships among actors in the value chain

Contractual relationships were common among the poultry producers and traders. Table 5 provides the statistics on the contract relationships among the actors in the poultry value chain. ~60% of the producers interviewed were involved in contract arrangements with other actors in the value chain. Similarly, most of the traders (61%) had contract arrangements and the most common form of contract was a verbal contract (94%). Their contracts were mainly with both the producers and other traders, and sometimes with processors. The terms of the contracts were mostly related to purchases and payments. Very few processors (28.9%) were engaged in contractual arrangements, and almost all these arrangements were verbal contracts.

Table 6 shows the form of contracts among the actors. Approximately 70% of the value chain actors who were engaged in contractual arrangements were involved in a verbal contract, with the remainder having written contracts. Among the layer producers, their contracts were mainly with the traders; the traders mostly purchase the eggs on credit and pay back the producers on agreed terms. However, according to the farmers, the traders mostly do not pay on time or adhere to the agreed terms of payment. The broiler producers were mostly engaged in contracts with the input suppliers (Fony Services).

Table 5. Contracts among actors in the poultry value chain.

	Producer		Trader		Processor	
Actors	Frequency	(%)	Frequency	(%)	Frequency	(%)
Yes	43	59.7	50	61.0	13	28.9
No	29	40.3	32	39.0	32	71.1
Total	72	100.0	82	100.0	45	100

Source: Survey data (2016).

Table 6. Forms of contract that exist among the actors.[4]

	Producer		Trader		Processor	
Contract form	Frequency	(%)	Frequency	(%)	Frequency	(%)
Verbal contract	30	69.8	47	94.0	12	92.3
Written contract	9	20.9	2	4.0	0	0
Missing	4	9.3	1	2.0	1	7.7
Total	43	100.0	50	100.0	13	100

Source: Survey data (2016).

Gender distribution, roles, and activities along the value chain

Gender roles and activities

Table 7 shows the major activities performed at the producer and trader levels of the poultry value chain and the distribution of these activities by gender. For the production level, almost all the activities (namely brooding of DOCs, medication and vaccination, feed-milling, feeding of birds, disposal and replacement of poultry litter, culling of birds, daily records keeping, dressing of birds, packaging of dressed birds, selling of poultry products, and loading and offloading of goods) were dominated by men, with the exception of grading of eggs that was almost evenly distributed between men (52.3%) and women (47.7%). Activities carried out by the actors at the trader level were, however, dominated by women, except for the loading and off-loading of goods. Processors carried out almost all the activities on their own, and these actors were dominated by women.

Almost all the producers prepared their own feed (i.e., feed-milling) rather than buying pre-prepared feed. This implies that the producers know the right ingredients to use and their correct proportions, and it enabled them to have control on the feeding of their birds. This activity was typically performed by men (97.3% of the male producers). This activity also helps to cut costs as it is a cheaper option for providing feed. About half of the farmers in the area sold their poultry litter, while the remainder burnt the litter. Disposal and replacement of litter are quite tedious. Therefore, the producers mostly hired extra labor to dispose of and replace the litter and this task was typically undertaken by men (98.4% of male producers).

At the producer level, daily record keeping was mainly performed by men (95.8% of male producers), whereas at the trader level it was mainly performed by women (71.4% of female traders). About 89% of the producers kept records on feed, medications, and sales. Packaging of dressed birds has more women (33.3%) participating at the producer level, whereas the trader level has 100% women performing this task. Collection of eggs is performed within specific time intervals to prevent the birds from breaking the eggs and was largely undertaken by men (89.4%). Grading of eggs is the only activity that had almost equal distribution between men and women. The distribution was 52.3% and 47.7% for men and women, respectively, for the producers, and 100% women for the traders. Selling of poultry products involved 73.1% men and 26.9% women at the producer level, and 22.5% men and 77.5% women at the trader level.

Loading and offloading of goods is a very strenuous activity. At the producer level, it is undertaken by men (100%), while at the trader level it is undertaken by both men (67%) and women (33%).

Table 7. Distribution of activities at the producer and trader levels by gender.

	Producer (%)		Trader (%)	
Activity	Male	Female	Male	Female
Brooding of DOCs	100	0		
Medication and vaccination	99.5	0.5		
Feed-milling	97.3	2.7		
Feeding birds	95.9	4.1		
Disposal and replacement of litter	98.4	1.6		
Culling of birds	100	0		
Record keeping	95.8	4.2	28.6	71.4
Dressing of birds	100	0	0	100
Packaging of chicken	66.7	33.3	0	100
Collection of eggs	89.4	10.6		
Grading of eggs	52.3	47.7	0	100
Marketing of products	73.1	26.9	22.5	77.5
Loading and offloading	100	0	67.0	33.0

Source: Survey data, 2016.

Table 8. Access to credit among actors in the poultry value chain.

Access to	Producers		Traders		Processors	
Credit	Frequency	(%)	Frequency	(%)	Frequency	(%)
Yes	12	15.6	12	14.5	2	4.4
No	59	76.6	70	84.3	38	84.4
Missing information	6	7.8	1	1.2	5	11.1
Total	77	100.0	83	100.0	45	100.0

Source: Survey data (2016).

The results of the distribution of gender roles and activities are consistent with findings of previous research that found men typically perform the manually strenuous work in agricultural production such as tillage and land preparation, whereas women perform less strenuous tasks such as processing and storage (International Livestock Research Institute, 2011).

Access to credit

Access to credit was very low among actors in the poultry value chain, with only about 16% of producers, 15% of traders, and 4% of processors receiving credit (Table 8). This may be attributed to the perception that access to a credit facilities is bureaucratic. For this reason and sometimes due to a lack of collateral, most of the respondents do not even apply for loans. Among all the actors, the source of credit was evenly distributed between micro-finance institutions (MFIs) and commercial banks (Table 9).

Among the producers, more men received credit than women. However, the case was different for traders and processors, where more women received credit than men (Table 10). The reason for this may be that there were more male than female producers, whereas the female traders and processors outnumber their male counterparts. There was an almost even distribution for male producers between MFIs and banks as a source of credit (Table 11). There was a similarly almost even distribution for the female traders and processors.

Table 9. Source of credit among actors in the poultry value chain.

Source of Credit	Producers		Traders		Processors	
	Frequency	(%)	Frequency	(%)	Frequency	(%)
MFI	6	50.0	6	50.0	1	50.0
Banks	6	50.0	6	50.0	1	50.0
Total	12	100.0	12	100.0	2	100.0

Source: Survey data (2016).

Table 10. Access to credit by gender in the poultry value chain.

	Producers			Traders			Processors		
Gender	Yes	No	Total	Yes	No	Total	Yes	No	Total
Male	11	53	64	1	7	8	0	7	7
Female	1	6	7	11	63	74	2	31	33
Total	12	59	71	12	70	82	2	38	40

Source: Survey data (2016).

Table 11. Source of credit by gender in the poultry value chain.

	Producers			Traders			Processors		
Gender	MFI	Banks	Total	MFI	Banks	Total	MFI	Banks	Total
Male	5	6	11	0	1	1	0	0	0
Female	1	0	1	6	5	11	1	1	2
Total	6	6	12	6	5	12	1	1	2

Source: Survey data (2016).

Gender distribution in the value chain

Using the Duncan's Index of Dissimilarity (D), the gender segmentation for the poultry value chain is given as follows:

$$D = 100 \times \frac{1}{2}\left[\left|\left(\frac{7}{119} - \frac{68}{84}\right)\right| + \left|\left(\frac{74}{119} - \frac{9}{84}\right)\right| + \left|\left(\frac{38}{119} - \frac{7}{84}\right)\right|\right] = 75.27\% \quad (20)$$

An index of 75.27% indicates that the levels (stages) of the poultry value chain are highly gender-segregated. Men and women cluster at different stages of the value chain and this is evident in the frequency of distribution of gender (Table 2). Hence, about 75% of men would have to move to other levels of the value chain to yield a more even distribution of men and women across the levels of the value chain. The concentration at the different nodes could be attributed to the fact that men are geared more toward the labor and capital-intensive stages of the chain, which in this case is the production stage, whereas women are found to concentrate at the trader and processor stages, which happen to be less laborious and capital intensive[5].

Estimation of value addition, margin, and return on investment

Fixed cost elements

The fixed cost elements that were considered for poultry producers and processors are presented in Table 12. The costs were used in the calculation of the value

Table 12. Fixed cost elements for producers and processors in the poultry value chain.

	Layer		Broiler	
Cost element	Average (GH₵/100 crates)	Standard deviation (GH₵/100 crates)	Average (GH₵/100 birds)	Standard deviation (GH₵/100 birds)
Producers				
Housing unit	159.82	253.03	150.25	361.19
Layer breeding stock	364.06	67.70		
Feeding trough	323.07	327.37	303.83	362.96
Watering trough	140.61	290.23	89.69	120.52
Wheel barrow	11.08	17.88	44.12	77.89
Spade	4.61	7.72	11.0	16.38
Total	1003.25		598.89	
Processors				
		Eggs		
Working equipment (gas cylinders, knives, cooking utensils)			60.52	148.58
Total			60.52	

Source: Survey data (2016).

addition, margin, and ROI and they were estimated in GH₵ for 100 birds per week and 100 crates of eggs per week.

The average total fixed cost for the layer producers was estimated at GH₵ 1003.25 for 100 crates of eggs per week, and that of the broiler producers was estimated at GH₵ 598.89 for 100 birds per week. The egg processors have the least fixed cost of GH₵ 60.52 because they used only basic cooking materials.

Variable cost elements

For the producers, the variable cost elements comprised feeding costs, medication costs, and transport costs. The feeding cost was the highest among the variable costs, being more than 50% of the total variable cost. The average feeding cost for layer producers was GH₵ 534.79 per week and for broiler producers it was GH₵ 645.72 per week (Table 13).

The total variable costs for the producers were GH₵ 613.81 per week for layer producers and GH₵ 1112.18 per week for broiler producers. The variable cost elements for the traders include rent, transportation, and the loading and offloading of goods. The total variable cost for the broiler traders was GH₵1275.67 per 100 birds per week and GH₵ 2417.13 per 100 crates per week for the egg traders. The egg processors had a variable cost of GH₵ 1770.46 per 100 crates per week and the cost components included ingredients, packaging, and tax.

Value addition, margin, and return on investment

Table 14 shows the results for value addition, margin, and ROI for the value chain actors. Estimations were made for 100 birds or crates of eggs per week for ease of computation along the value chain. Overall, both male and female actors in the poultry value chain generate returns to support their livelihood and that of their families.

Within the layer value chain, producers add the highest value of GH₵ 9.48 per crate of eggs, which is about 48.6% of the entire value addition in the value chain. This is

Table 13. Variable cost elements for producers, traders and processors in the poultry value chain.

	Layer			Broiler		
Cost elements	Average (GH₵/100 crates)	Standard deviation (GH₵/100 crates)	%	Average (GH₵/100 birds)	Standard deviation (GH₵/100 birds)	%
Producers						
Packaging	8.75	22.69	1.43			
Transport	13.71	33.58	2.23	25.70	36.92	2.31
Feeding	534.79	287.07	87.12	645.72	774.13	58.06
Labor	37.35	36.54	6.08	24.73	39.00	2.22
Medication	16.89	28.84	2.75	44.37	55.64	3.99
Fuel	1.19	5.12	0.19	2.63	4.94	0.24
Tax	0.80	2.20	0.13	1.67	3.39	0.15
Electricity	0.32	1.34	0.07	0.69	2.08	0.06
Broiler DOCs				366.67	96.82	32.97
Total	613.81	417.38	100	1112.18	1012.92	100
Traders						
	Birds			Eggs		
Eggs	1247.97	87.76	97.83			
Broiler				2350.80	348.89	97.26
Transport	16.66	28.10	1.30	33.02	20.38	1.37
Rent	0.49	2.07	0.04	6.11	7.77	0.25
Medication				25.12	57.45	1.04
Loading/ offloading	0.84	1.94	0.07	2.08	5.89	0.09
Tax	2.74	10.00	0.21			
Crates	6.96	13.08	0.55			
Total	1275.67	142.95	100	2417.13	440.38	100
Processors						
	Eggs					
Eggs	1239.53	299.12	70.01			
Tax	29.94	44.26	1.69			
Transport	45.11	93.01	2.55			
Ingredients	298.96	284.30	16.89			
Fuel	8.31	38.84	0.47			
Packaging	99.52	160.19	5.62			
Water	49.09	214.17	2.77			
Total	1770.46	1133.89	100			

Source: Survey data (2016).

followed by egg processors, with value addition of GH₵ 8.15 per crate of eggs. The egg traders add the least value of GH₵ 1.88 per crate of eggs, which forms just 9.6% of the full value added. This is because the producers do a lot of work like feeding, medication, and vaccination of the birds before the birds lay the eggs.

Processors also add value to the egg by boiling or frying it, which involves adding other ingredients to the egg, but traders on the other hand pick up the eggs in their raw state from the producers and sell them in that same state, which explains why they add the least value. Value addition within the broiler value chain shows that producers add the highest value of GH₵ 21.63 per bird and that traders add GH₵ 16.61 per bird. The results from both value chains indicate that producers add the greatest value along the poultry value chain, and this could be attributed to activities such as feeding, medication, and transportation. Traders in the broiler value chain obtained the highest margin of GH₵ 14.72 per bird, even though they add a lower value compared to broiler producers.

Table 14. Value addition, return on investment and margin estimation among actors in the poultry value chain.

Actors	TC	TR	Net revenue	Unit cost	Added cost	PP	SP	VA	Margin	ROI
Producer										
Layer	977.81	1312.32	334.51	9.98	6.34	3.64	13.12	9.48	3.14	0.31
Broiler	1674.03	2483.13	809.10	16.74	13.57	3.17	24.80	21.63	8.06	0.48
Trader										
Eggs	1275.67	1776.35	500.68	12.87	0.39	12.48	14.36	1.88	1.49	0.12
Broiler	2417.13	3015.31	598.17	24.17	1.89	22.28	38.89	16.61	14.72	0.61
Processor	1532.02	2072.09	540.07	15.32	2.75	12.57	20.72	8.15	5.40	0.35

Source: Survey data (2016).

Table 15. Value addition, return on investment, and margin estimation for men in the poultry value chain.

Actors	TC	TR	Net revenue	Unit cost	Added cost	PP	SP	VA	Margin	ROI
Producer										
Layer	958.37	1313.49	355.12	9.81	6.14	3.67	13.13	9.46	3.32	0.34
Broiler	1496.14	2528.57	1032.43	14.96	11.96	3.00	25.29	22.29	10.33	0.69
Trader										
Eggs	1259.31	1481.25	221.94	12.59	0.09	12.50	14.81	2.31	2.22	0.18
Broiler	2219.00	3047.29	828.29	22.19	2.99	19.20	38.60	19.40	16.41	0.74
Processor	1439.44	2142.86	703.42	14.39	1.96	12.43	21.43	9.00	7.04	0.49

Source: Survey data (2016).

For the ROI, broiler traders obtained the highest return of 61% on their investment. That means for every GH₵ 1 invested, they generate an extra GH₵ 0.61. This level of return is followed by the broiler producers, with a 48% ROI. The layer value chain has processors having the highest ROI of 35%, followed closely by the producers with 31% ROI, then the traders with a 12% ROI. The results show higher weekly ROIs for the broiler value chain than the layer value chain, and this implies that the broiler value chain is more profitable. Again, other actors along both value chains achieve greater ROIs than the producers. Policy interventions in the value chain should, therefore, target producers to help them accrue larger portions of the margin to increase their ROI.

Tables 15 and 16 present details of the value addition for men and women, respectively. The value added by the male actors was higher than female actors across both the layer and broiler value chains. For instance, on average, the value added by male broiler producers was GH₵ 22.29 and the value added by female broiler producers was GH₵ 20.90.

The male actors also received higher margins compared to the female actors. The margin for male egg traders was GH₵ 2.22 per crate of eggs, whereas for female egg traders it was GH₵ 1.40. Again, the ROI was higher for men than women. The ROI for male processors was 0.49, while female processors had an ROI of 0.33. The results indicate that men earn more in the poultry value chain than women. This could be attributed to the fact that men generally operate on larger scales due to their greater access to resources such as land and credit compared to women. This makes the cost of production for the male poultry farmers relatively lower due to economies of scale. Therefore, the male farmers create higher value and obtain higher margins. Female actors should therefore join the associations in the value chain to enhance their

Table 16. Value addition, return on investment, and margin estimation for women in the poultry value chain.

Actors	TC	TR	Net revenue	Unit cost	Added cost	PP	SP	VA	Margin	ROI
Producer										
Layer	994.71	1283.33	288.62	9.95	6.75	3.20	12.83	9.63	2.88	0.29
Broiler	1796.70	2462.00	665.3	17.97	14.22	3.75	24.65	20.90	6.68	0.37
Trader										
Eggs	1277.66	1812.12	534.47	12.90	0.43	12.47	14.30	1.83	1.40	0.11
Broiler	2747.35	2962.01	214.66	27.47	5.63	21.84	33.33	11.49	5.86	0.21
Processor	1550.02	2058.33	508.31	15.50	2.91	12.59	20.58	7.99	5.08	0.33

Source: Survey data (2016).

knowledge (through education) and skills and improve their confidence to help them acquire enough resources for their operations.

Distribution of benefits along the poultry value chain

Equity in the distribution of returns was assessed based on the percentage margins obtained by the various actors and results of the *t*-tests of the differences in the means of the ROI for these actors are presented in Tables 17–19.

The results revealed that except for the layer producers and egg processors, who did not have a significant difference in their ROIs, the difference between the means of the ROI for all the other actors were significant. The null hypothesis that there was no significant difference between the means of ROI between the actors was rejected. These results imply that there is inequitable distribution of benefits in the broiler and layer value chains. Traders had the least mean of ROI in both value chains and their ROI was significantly different from the ROI for all other actors. This is essential because they hardly perform any value addition aside from transporting products. Traders should be motivated to upgrade their products in terms of packaging and delivering in order to increase their share of the margin.

Table 20 shows the difference between the means ROI for men and women in the poultry value chain. The results revealed that there was no significant difference between the ROI of the male layer producers and the female layer producers, the male broiler producers and the female broiler producers, and the male egg processors and the female egg processors. This implies that policy interventions to increase the ROI of the value chain actors could be introduced without necessarily being gender specific. However, the ROI for the male and female traders were significantly different, for which the men obtained a higher ROI than the women. Policy interventions to assist the female egg and broiler traders to bridge this ROI gap could be introduced.

Constraints faced by actors along the poultry value chain

The last objective was to identify and rank constraints faced by the actors in the poultry value chain. Various problems that the actors in the poultry value chain face were found through pre-testing of the questionnaire and literature review. The constraints included price fluctuations of inputs, difficulty in accessing credit, lack of efficient transportation, high costs of production, disease outbreaks, and inadequate storage facilities. The constraints were grouped for the various actors to rank from the

Table 17. *t*-Test results of the difference in mean return on investment of the actors in the poultry value chain.

Actors	Mean	SD	*N*	*t*-Value	Significance level	Decision rule
Layer producer and	0.4323	0.4313	69	−6.061***	0.0000	H_0 rejected
Egg trader	0.1197	0.1009	74			
Layer producer and	0.4323	0.4313	69	0.597	0.5519	H_0 not rejected
Egg processor	0.5061	0.8718	43			
Egg trader and	0.1197	0.1009	74	3.781***	0.0002	H_0 rejected
Egg processor	0.5061	0.8718	43			
Broiler producer and	3.2870	3.4418	9	−2.172**	0.0463	H_0 rejected
Broiler trader	0.6091	0.5026	8			

***,**,*denote significance at the 1, 5, and 10% levels, respectively; *t*-critical = 1.96.
SD and *N* denote the standard deviation of the return on investment and the number of actors at each stage of the value chain, respectively.
Source: Survey data (2016).

Table 18. *t*-Test results of the difference in mean return on investment of male actors in the poultry value chain.

Actors	Mean	*SD*	*N*	*t*-Value	Significance level	Decision rule
Layer producer and	0.4400	0.4080	63	1.773*	0.0807	H_0 rejected
Egg trader	0.1809	0.1450	8			
Layer producer and	0.4400	0.4080	63	−0.667	0.5073	H_0 not rejected
Egg processor	0.5478	0.3825	7			
Egg trader and	0.1809	0.1450	8	−2.525**	0.0254	H_0 rejected
Egg processor	0.5478	0.3825	7			
Broiler producer and	4.0293	3.5887	7	2.018*	0.0712	H_0 rejected
Broiler trader	0.7298	0.4157	5			

**,*denote significance at the 5 and 10% levels, respectively; *t*-critical = 1.96.
Source: Survey data (2016).

Table 19. *t*-Test results of the difference in mean returns on investment of female actors in the poultry value chain.

Actors	Mean	SD	*N*	*t*-Value	Significance level	Decision rule
Layer producer and	0.4685	0.5880	6	4.618***	0.0000	H_0 rejected
Egg trader	0.1123	0.0930	66			
Layer producer and	0.4685	0.5880	6	−0.0741	0.9413	H_0 not rejected
Egg processor	0.4980	0.9416	36			
Egg trader and	0.1123	0.0930	66	−3.313***	0.0013	H_0 rejected
Egg processor	0.4980	0.9416	36			
Broiler producer and	0.6888	0.3646	2	1.935	0.1484	H_0 not rejected
Broiler trader	0.2154	0.2030	3			

***denotes significance at the 1% level; *t*-critical = 1.96.
Source: Survey data (2016).

Table 20. *t*-Test results of the difference in mean returns on investment of male and female actors in the poultry value chain.

Actors	Mean	SD	OBS	*t*-Value	Significance level	Decision rule
Female layer producer and	0.4685	0.5880	6	0.157	0.8757	H_0 not rejected
Male layer producer	0.4400	0.4080	63			
Female broiler producer and	0.6888	0.3646	2	−1.253	0.2505	H_0 not rejected
Male broiler producer	4.0293	3.5887	7			
Female egg trader and	0.1123	0.9300	66	−1.846*	0.0690	H_0 rejected
Male egg trader	0.1809	0.1450	8			
Female broiler trader and	0.2154	0.2030	3	−1.962*	0.0975	H_0 rejected
Male broiler trader	0.7298	0.4157	5			
Female egg processor and	0.4980	0.9416	36	−0.136	0.8922	H_0 not rejected
Male egg processor	0.5478	0.3825	7			

*denotes significance at the 10% level; *t*-critical = 1.96.
Source: Survey data (2016).

Table 21. Ranking of constraints by poultry producers.

Constraints	Mean rank	Rank
High cost of production	1.05	1
High rate of diseases	2.04	2
Lack of credit facilities	3.06	3
Bird flu scare	4.17	4
Competition with imported chicken	4.68	5
Sample size $N = 75$, Kendall's $W = 0.898$, chi-square = 269.452, df = 4.		

Source: Survey data (2016).

Table 22. Ranking of constraints by poultry traders.

Constraints	Mean rank	Rank
Difficulty in transporting products	1.34	1
Inadequate storage facilities	2.23	2
Lack of a readily available market	2.80	3
High transport fees	3.89	4
Bird flu scare	4.74	5
Sample size $N = 83$, Kendall's $W = 0.723$, chi-square = 231.287, df = 4.		

Source: Survey data (2016).

most pressing constraint to the least. The ranks and the mean ranks are presented in Tables 21–23 for producers, traders, and processors, respectively.

Constraints faced by poultry producers

Table 21 shows the constraints ranked by the poultry producers. The producers ranked high cost of production as the most pressing constraint and they attributed it to the high cost of inputs, especially feed. According to the farmers, feed costs contribute about 70% of their production cost. This was followed by the high rate of diseases as the second constraining factor. Some farmers complained that some of their birds are lost through diseases and in some cases the disease can kill an entire batch of birds. Lack of credit facilities and bird flu scare were ranked as the third and fourth most pressing constraints, respectively. However, the farmers indicated that there has never been an outbreak of bird flu in the area. The least constraining factor was competition with imported frozen chicken, and this could be because most of the respondents were layer producers and the few broiler producers have contract relationships with other actors, which assured them of a ready market.

The estimated Kendall Coefficient of Concordance (W) was 0.898 (Table 21). This implies that there was ~90% agreement among the ranking of constraints by the producers, meaning almost 9 out of 10 producers agree on the rankings of the constraints. The estimated chi-square was 269.452 and this exceeds the chi-square critical value. Therefore, the null hypothesis that there is no agreement among the ranking of constraints by the farmers is rejected in favor of the alternate hypothesis.

Constraints faced by poultry traders

The results show that the most pressing constraint confronting the poultry traders was the difficulty in transporting products (Table 22). Most of the broiler traders complained that it was difficult to get vehicles to transport their birds because of the bird droppings and due to this they are sometimes forced to pack the birds in a limited space. Most of the birds arrive at the markets very weak and some even die due to

Table 23. Ranking of constraints by egg processors.

Constraints	Mean rank	Rank
Lack of a ready market	1.42	1
Inadequate storage	2.27	2
Poor transportation network	3.13	3
High transport fees	4.03	4
Irregular supply inputs	4.34	5
High cost of labor	5.80	6
Sample size $N = 45$, Kendall's $W = 0.701$, chi-square $= 157.732$, df $= 5$.		

Source: Survey data (2016).

the means of transportation. For the layer producers, some of the eggs break on the way to the market due to the poor transportation system. The second most constraining factor was inadequate storage facilities. Most of the traders get their produce once a week from the producers and sometimes the quantities may be too much for their storage room capacity. Usually, the traders keep the rest of the product with friends who have more space in some cases but sometimes they had to manage with their limited space and most of the eggs eventually crack or break.

The third constraining factor was the lack of ready market. The market is usually good during festive seasons but after that it slows down. The forth-constraining factor was a high transportation cost which was a result of limited transportation options. Drivers who are willing to transport the birds charge very high rates because they had to clean the vehicle after transporting them. The least constraining factor was bird flu scare, which was because there has never been an outbreak in the area. Despite this, the traders also complained that announcements of bird flu outbreaks greatly disrupt the market, even if the outbreak is not in the immediate area.

The estimated Kendall Coefficient of Concordance (W) was 0.723, implying that there was ~72% agreement among the ranking of constraints by the traders. The estimated chi-square was 231.287 and this exceeds the critical chi-square value. Therefore, the null hypothesis that there is no agreement among the ranking of constraints by the traders was rejected in favor of the alternate hypothesis.

Constraints faced by poultry processors

The lack of ready market was ranked as the most constraining factor by the processors (Table 23). This was followed by inadequate storage as the second most pressing factor. The high cost of labor was ranked as the least constraining factor and this was because the processors hardly used hired labor. They personally undertook most of the work and sometimes receive help from family members.

The Kendall Coefficient of Concordance (W) estimated was 0.701, implying that there was ~70% agreement among the ranking of constraints by the processors. The estimated chi-square was 157.732 and this exceeds the critical chi-square value. Therefore, the null hypothesis that there is no agreement among the ranking of constraints by the processors was rejected in favor of the alternate hypothesis.

The producers were mainly men and the traders and processors were mainly women. Therefore, the key pressing constraints pertaining to producers including high cost of production, high rate of diseases, and lack of credit facilities were more applicable to men than women. On the other hand, the key constraints confronting traders

and processors including difficulty in transporting products, inadequate storage facilities, and lack of a readily available market were more applicable to women than men.

Conclusions

This study examined gender segregation in the poultry value chains in the Dormaa District and Sunyani Municipality in the Brong-Ahafo Region of Ghana. A multi-stage sampling procedure was used to obtain cross-sectional data from 203 value chain actors through the administration of a structured questionnaire. The poultry products considered in the study were broilers and layers, and the value chain actors were producers, traders, and processors.

The results of the Duncan's Index of Dissimilarity of ~75% indicates that the poultry value chains are highly gender-segregated (i.e., men and women cluster at different levels of the value chain). The men performed almost all the major roles at the producer level of the value chain, whereas the women performed menial tasks, such as the grading of eggs and cooking for the men. However, both the men and women carried out the same activities at the trader and processor levels of the value chain.

In the context of gender segregation in the value chain, the study examined value addition, ROI, and margins at each stage of the value chain. The results revealed that the producers added the highest value in the poultry value chain. All the value chain actors (i.e., producers, traders, and processors) obtained positive margins and ROIs. Nevertheless, the male value chain actors obtained higher margins than the female value chain actors. Also, the men obtained a higher ROI in the poultry trading and processing businesses than the women. Regarding the constraints faced by the value chain actors, the poultry producers indicated high costs of production as the major constraint, traders indicated transporting difficulties as the major constraint, and the processors indicated the lack of a ready market as the major constraint.

The study provides the following policy recommendations.

- Ghana's poultry producers are confronted with high costs of production as their major constraint, and feed cost is the major component. Therefore, researchers and nutritionists should develop more efficient but cheap feed components to reduce the feed cost. This will in turn reduce production costs and ultimately the prices of poultry products for consumers.
- The policy interventions for the poultry industry should target the entire value chain, rather than just the production stage. This will be of benefit to both male and female value chain actors, since the value chain is highly gender-segmented, with the women being highly concentrated at the trader and processor stages. In this respect, public investment in better infrastructure (e.g., feeder roads, highways, and railways), which might have nothing to do with the agriculture or poultry policies, would benefit the women more than the men in the poultry industry as many of the poultry traders are women. Other forms of investment to support the innovation of women in the value chain must be strongly context-specific and gender-sensitive (Farnworth et al., 2018). This would enable the female actors to increase

their ROI as there was a significant difference in ROI between the male and female value chain actors, especially at the trader stage of the value chain.

- The government and individual businesses should help to establish poultry processing factories in the districts to create more market avenues for broiler producers. The broiler value chain was more profitable than the layer value chain; however, the farmers were not willing to engage in broiler production because they complained of inadequate local markets for the broilers. This policy will help the farmers to earn more income and ultimately support a reduction in poverty. It could also be used as an economic empowerment tool for women.
- The Ghanaian government's Export Trade, Agricultural and Industrial Development Fund (EDAIF) grant for the poultry farmers currently targets the sector's large-scale farmers. It is imperative that the administrators of this fund also consider the small-scale commercial and female poultry farmers. This would enable these farmers to acquire the needed financial capital to establish and run successful poultry farming businesses. Other private businesses should provide traders with appropriate and affordable transportation to convey their products.
- It is important that NGOs and the Agricultural Extension Division of Ghana's Ministry of Food and Agriculture should organize training for women at the production stage of the value chain. This activity would empower the women to improve the performance of their activities, thereby encouraging more women to engage in poultry production.
- Government policies for the poultry sector should take gender disparities into consideration, to provide men and women with equal access to resources and their use. In general, enhancing equality and the innovation capacities of male and female actors in agricultural value chains is important for development (Kantor, Morgan, & Choudhury, 2015).

While the study's results cannot be generalized to all poultry-producing regions of Africa, they do provide interesting insights into the distribution of the roles and benefits between women and men as well as the constraints faced by the actors in the poultry value chains in a key poultry-producing region of Ghana.

It is important to note the study's limitations. This study was restricted to the Dormaa and Sunyani Municipalities in the Brong-Ahafo region of Ghana which is the second highest producer of poultry in the country, and the highest producer of eggs. Broiler and layer were the only poultry products considered in this study. Therefore, extending the research to other regions and countries to provide more generalizable conclusions is an excellent opportunity for future research. Also, the main actors considered in this study were producers, traders, and processors for the layer value chain, and producers and traders for the broiler value chain, but input suppliers and broiler processors were not considered. Therefore, the inclusion of these actors in the poultry value chain is another opportunity for future research. In this study, the size of the firm or production/trading volumes, educational attainment and other characteristics of the value chain actors were not controlled for in the comparison of the indicators across the gender groups. Therefore, the inclusion of the size of the firm or production/trading volumes, and the socio-economic and farm-level level characteristics of

the value chain actors would be another excellent opportunity for future research. Finally, we are mindful of the assertion by Currie and Vernooy (2010) that gender is relational, and interlocked with class, caste, race, ethnicity, and other hierarchical relations. Analysis based on this view of gender is beyond the scope of this study, as we did not examine the difference between female actors in the poultry value chain. Similarly, we also did not examine the difference between male actors in the value chain.

Notes

1. Where, PP is primary producer, CL is collector, WS is wholesaler, RT is retailer and FC is final consumer. TC and SP represent total cost and selling price, respectively, and 'a' denotes the value addition, 'b' denotes the production cost and 'c' denotes the benefit.
2. This approach was applied to estimate *the value added* and *the mean value added* at the trader and processor levels of the value chain.
3. 'Tea Joint Operators' are businesses involved in the preparation of tea for sale to customers. Usually, the tea is sold together with egg, bread, and vegetables.
4. Figure '0' in the Table 6 indicates no contract.
5. Please note that in this study, nodes, stages, and levels are used interchangeably.

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References

Adam, R. I., Osano, P., Birika, J., Amadi, A. A. N., & Bwisa, H. (2017). The situation of women in the agribusiness sector in Africa. *Development in Practice*, *27*, 892–898. doi:10.1080/09614524.2017.1338670

Adams, J. S. (1965). Inequality in social exchange In L. Berkowitz (Ed.), *Advances in experimental psychology* (Vol. 2, pp. 267–299). New York, NY: Academic Press.

Adisa, B. O., & Akinkunmi, J. A. (2012). Assessing participation of women in poultry production as a sustainable livelihood choice in Oyo state, Nigeria. *International Journal of Plant, Animal and Environmental Sciences*, *2*, 73–82.

Albu, M., & Griffith, A. (2005). *Mapping the market: A framework for rural enterprise development policy and practice* (pp. 36). Warwickshire, UK: Practical Action.

Atuahene, C. C., Attoh-Kotoku, V., & Mensah, J. J. (2010). Poultry production in Ghana: Prospects and challenges. *Ghanaian Journal of Animal Science*, *5*, 92–97.

Banson, K. E., Muthusamy, G., & Kondo, E. (2015). The import substituted poultry industry; evidence from Ghana. *International Journal of Agriculture and Forestry*, *5*, 166–175. doi:10.5923/j.ijaf.20150502.11

Bryant, L. (2006). Marking the occupational body: Young women and men seeking careers in agriculture. *Rural Society*, *16*, 62–79. doi:10.5172/rsj.351.16.1.62

Chapota, R. (2013). *An introduction to agricultural value chains; The role of radio in the agricultural value chain approach: The case of the groundnut value chain in Malawi*. Ontario: Farm Radio International.

Coles, C., & Mitchell, J. (2011). *Gender and agricultural value chains – A review of current knowledge and practice and their policy implications* (ESA Working Paper No. 11–05). Rome, Italy: FAO Development Economics Division.

Currie, D. H., & Vernooy, R. (2010). Social and gender analysis in development practice lessons from the field. *Gender, Technology and Development*, *14*, 1–23. doi:10.1177/097185241001400101

Danish International Development Agency. (2010). *Evaluation study: Gender and value chain development* (The Danish Institute for International Studies (DIIS) 'Global economy, regulation and development). Copenhagen, Denmark: DANIDA.

Deutsche Gesellschaft für Internationale Zusammenarbeit. (2013). *Gender and value chains: Division rural development; agriculture; food security*. Bonn, Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit. Federal Ministry for Economic Cooperation and Development (BMZ).

Farnworth, C. R. (2011). *Gender-aware value chain development. Enabling rural women's economic empowerment: Institutions, opportunities and participation*. Leicester, UK: Pandia Consulting.

Farnworth, C. R., López, D. E., Badstue, L., Hailemariam, M., & Abeyo, B. G. (2018). Gender and agricultural innovation in Oromia region, Ethiopia: From innovator to tempered radical. *Gender, Technology and Development*, *22*, 222–245. doi:10.1080/09718524.2018.1557315

Flake, L., & Ashitey, E. (2008). *Ghana's poultry and products annual report* (USDA foreign agriculture services GAIN report). Washington, DC: USDA.

Food and Agricultural Organization of the United Nations. (2012). *Gender inequality in rural employment in Ghana*. Rome, Italy: FAO.

Food and Agricultural Organization of the United Nations. (2014a). *Poultry sector Ghana* (Food and agricultural organization: Animal production and health livestock country reviews. No. 6). Rome, Italy: FAO.

Food and Agricultural Organization of the United Nations. (2014b). *Developing sustainable food value chains: Guiding principles*. Rome, Italy: FAO.

Food and Agricultural Organization of the United Nations. (2016a). *Review of the livestock/meat and milk value chains and policy influencing them in Ghana* (Food and agricultural organization and economic community of West African states). Rome, Italy: FAO.

Food and Agricultural Organization of the United Nations. (2016b). *Developing gender-sensitive value chains – A guiding framework*. Rome, Italy: FAO.

Garcia-Winder, M., Riveros, H., Pavez, I., Rodriguez, D., Lam, F., Arias, J., & Herrera, D. (2009). *Agrifood chains: A tool for strengthening the institutional framework of the agricultural and rural sector* (Article in 'perspectives' May – August 2009). San José, Costa Rica: Inter-American Institute for Cooperation on Agriculture IICA.

Global Agricultural Information Network. (2013). *Ghana poultry annual report. Global agricultural information network report USDA foreign agricultural service* (GAIN Report No. 1304). Washington, DC: GAIN.

GSS Ghana Statistical Service. (2014). *Ghana statistical service: National accounts statistics - gross domestic product 2014*. (Final 2012 gross domestic product & revised 2013 gross domestic product). Hyderabad: GSS.

Holmes, R., & Slater, R. (2008). Measuring progress on gender and agriculture in the 1982 and 2008 world development reports. *Gender & Development*, *16*, 27–40. doi:10.1080/13552070701876110

Ingram, V., Yago-Ouattara, E. L., Lartey, A., Mogre, D., Jo, H. M., & Wijnands Van Den Berg, J. (2015). *Gender dynamics in cashew and shea value chains from Ghana and Burkina Faso* (pp. 5). (LEI Report 2015–039). Wageningen, Netherlands: LEI Wageningen UR (University & Research Centre).

Institute of Statistics, Social and Economic Research. (2013). *The state of the Ghanaian economy for 2012*. Accra, Ghana: University of Ghana.

International Livestock Research Institute. (2011). *Empowering women through value chain development: Good practices and lessons from IPMS experiences*. Nairobi, Kenya: International Livestock Research Institute. Gender IPMS Ethiopia.

Jitmun, T., & Kuwornu, J. K. M. (2019). Factors influencing the choice of marketing channels: Evidence from dairy farmers in Thailand. *International Journal of Value Chain Management*, *10*, 123–140. doi:10.1504/IJVCM.2019.099102

Jitmun, T., Kuwornu, J. K. M., Datta, A., & Anal, A. K. (2019). Farmers' perceptions of milk collecting centres in Thailand's dairy industry. *Development in Practice*, *29*, 424. doi:10.1080/09614524.2019.1568394

Johnson, N., Njuki, J., Waithanji, E., Nhambeto, M., Rogers, M., & Kruger, E. H. (2015). The gendered impacts of agricultural asset transfer projects: Lessons from the manica smallholder dairy development program. Gender *Technology and Development*, *19*, 145–180. doi:10.1177/0971852415578041

Kantor, P., Morgan, M., & Choudhury, A. (2015). Amplifying outcomes by addressing inequality: The role of gender-transformative approaches in agricultural research for development. *Gender, Technology and Development*, *19*, 292–319. doi:10.1177/0971852415596863

Kaplinsky, R., & Morris, M. (2002). *A handbook for value chain research*. Brighton, England: Institute of Development Studies, University of Sussex.

Kilu, R. H. (2017). Beyond the barriers: Witnessing shifting gender dynamics in multinational mine jobs in Ghana. *Gender, Technology and Development*, *21*, 206–216. doi:10.1080/09718524.2018.1434992

Kuwornu, J. K. M. (2006). *Risk, incentives and coordination costs in agri-food chains in the presence of futures markets* (PhD thesis). Wageningen University, Wageningen, Netherlands. ISBN: 90-8504-356-5.

Kuwornu, J. K. M., Abdulai, A. N., & Osei-Asare, Y. B. (2013). Financial viability, value addition, and constraint analyses of certified organic pineapple production and marketing in Ghana. *African Journal of Basic & Applied Sciences*, *5*, 12–24.

Kuwornu, J. K. M., Kuiper, W. E., & Pennings, J. M. E. (2004). Time series analysis of a principal-agent model to assess risk shifting in agricultural marketing channels: An application to the Dutch ware potato marketing channel. In G. Van Huylenbroeck, W. Verbeke, & L. Lauwers (Eds.), *Role of institutions in rural policies and agricultural markets* (pp. 255–271). New York, NY: Elsevier.

Kuwornu, J. K. M., Kuiper, W. E., & Pennings, J. M. E. (2009). Agency problem and hedging in agri-food chains: Model and application. *Journal of Marketing Channels*, *16*, 265–289. doi:10.1080/10466690902934557

Kuwornu, J. K. M., Kuiper, W. E., Pennings, J. M. E., & Meulenberg, M. T. G. (2004). Agency theory, futures markets and risk shifting in commodity marketing channels. In H. J. Bremmers, S. W. F. Omta, J. H. Trienekens, & E. F. M Wubben (Eds.), *Dynamics in chains and networks* (pp. 510–517). Wageningen, Netherlands: Wageningen Academic Publishers.

Kuwornu, J. K. M., Kuiper, W. E., Pennings, J. M. E., & Meulenberg, M. T. G. (2005). Time varying hedge ratios: A principal-agent approach. *Journal of Agricultural Economics*, *56*, 417–432. doi:10.1111/j.1477-9552.2005.00021.x

Kuwornu, J. K. M., Kuiper, W. E., Pennings, J. M. E., & Meulenberg, M. T. G. (2006a). Strategic interactions, risks and coordination costs in food marketing channels: The mediating role of futures markets. In M. Fritz, U. Rickert, & G. Schiefer (Eds.), *Trust and risk in business networks* (pp. 551–564). Bonn, Germany: Universität Bonn, ILB Press.

Kuwornu, J. K. M., Kuiper, W. E., Pennings, J. M. E., & Meulenberg, M. T. G. (2006b). Risk management using futures contracts: The impact of spot market contracts and production horizons on the optimal hedge ratio. In M. Fritz, U. Rickert, & G. Schiefer (Eds.), *Trust and risk in business networks* (pp. 341–350). Bonn, Germany: Universität Bonn, ILB Press.

Kuwornu, J. K. M., Opoku, M. K., Kwadzo, G, T. M., & Mensah-Bonsu, A. (2009). Assessing the dimensions of transaction costs in the poultry industry: The case of Ashanti Region of Ghana. *Journal of Food Distribution Research*, *40*, 97–103.

Kuwornu, J. K. M., & Saqib, S. E. (2017). Assessment of bargaining power, market risk, and coordination costs in the Thailand cassava marketing channel. *International Journal of Value Chain Management*, *8*, 307–324. doi:10.1504/IJVCM.2017.10010281

Kuwornu, J. K. M., Saqib, S. E., & Moreno, M. L. (2018). Bargaining power, market risk, and coordination costs in the Thailand cassava starch marketing channel: A three stage principal-agent model and application. *International Journal of Value Chain Management*, *9*, 166–186. doi:10.1504/IJVCM.2018.092393

Laven, A., & Verhart, N. (2011). *Addressing gender equality in agricultural value chains: Sharing work in progress*. On track with gender. Amsterdam: Development Policy Review Network.

Mbilinyi, A. (2016). Analyzing the history of agrarian struggles in Tanzania from a feminist perspective. *Review of African Political Economy*, *43*, 115–129. doi:10.1080/03056244.2016.1219036

National Agricultural Advisory Services – Ministry of Agriculture, Animal Industry and Fisheries. (2011). *User guide on poultry rearing* (National agricultural advisory services ministry of agriculture, Animal industry and fisheries). Kampala, Uganda: NAADS.

Nguyen, N. A. (2010). *Better poultry value chain development through microfinance in Vietnam*. Bruxelles, Belgium: Solvay Brussels School of Economics and Management.

Orr, A., Kee-Tui, S. H., Tsusaka, T., Msere, H., Thabani, D., & Senda, T. (2016). Are there 'women's crops'? A new tool for gender and agriculture. *Development in Practice*, *26*, 984–997. doi:10.1080/09614524.2016.1226264

Otte, P. P., Tivana, L. D., Phinney, R., Bernardo, R., & Davidsson, H. (2018). The importance of gender roles and relations in rural agricultural technology development: A case study on solar fruit drying in Mozambique. Gender *Technology and Development*, *22*, 40–58. doi:10.1080/09718524.2018.1444442

Owusu-Sekyere, A. (2011). *The contribution of Agricultural Development Bank (ADB) to the growth of the poultry sector: A case study of Dormaa municipality* (dissertation). Institute of Distance learning, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Peterman, A., Quisumbing, A., Behrman, J., & Nkonya, E. (2011). Understanding the complexities surrounding gender differences in agricultural productivity in Nigeria and Uganda. *Journal of Development Studies*, *47*, 1482–1509. doi:10.1080/00220388.2010.536222

Promme, P., Kuwornu, J. K. M., Jourdain, D., Shivakoti, G. P., & Soni, P. (2017). Factors influencing rubber marketing by smallholder farmers in Thailand. *Development in Practice*, *27*, 865–879. doi:10.1080/09614524.2017.1340930

Rich, K. M., Baker, D., Negassa, A., & Ross, R. B. (2009). *Concepts, applications, and extensions of value chain analysis to livestock systems in developing countries*. Paper prepared for presentation at the International Association of Agricultural Economists Conference, Beijing, China.

Royal Tropical Institute, Agri-ProFocus and International institute of Rural Reconstruction. (2012). *Challenging chains to change. Gender equity in agricultural value chain development. Royal tropical institute*. Amsterdam, Netherlands: KIT Publishers.

Sakoda, J. M. (1981). A generalized index of dissimilarity. *Demography*, *18*, 245–250.

Saqib, S. E., Kuwornu, J. K. M., Ali, U., Panezai, S., & Rana, I. A. (2018). Price risk management using forward contracts: The case of farmers in Pakistan. *International Journal of Value Chain Management*, *9*, 241–256. doi:10.1504/IJVCM.2018.093888

Sathapatyanon, J., & Kuwornu, J. K. M. (2019). Assessment of the role of cooperative networks in the fruit supply chain in Thailand. *International Journal of Value Chain Management*, *10*, 53–83. doi:10.1504/IJVCM.2019.096563

United Nations Industrial Development Organization. (2013). *Converting commodities into products: The role of women in least developed countries (Ldcs)*. Paper presented at Least Developed Countries Ministerial Conference, Lima, Peru

United States Department of Agriculture. (2008). *Ghana poultry and poultry products. United States Department of Agriculture USDA Foreign Agricultural Service* (GAIN Report No. GH 8006). Washington, DC: USDA.

USAID. (2011). *Women & Agriculture. Improving Global Food Security*. Produced in coordination with the Bureau of Public Affairs, U.S. Department of State.