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Improving broiler farm competitiveness in Ghana and Senegal: insights from comparative analysis with Germany and the Netherlands

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Abstract

Background Chicken meat plays a crucial role in food and nutrition security across many African countries, serving as an affordable and high-quality source of animal protein. Driven by population growth and economic development, the demand for chicken meat in African countries has increased, resulting in significant gaps between supply and demand. To address this imbalance, several countries have turned to importing larger quantities of frozen chicken meat. However, concerns have been raised regarding these imports, as low-cost chicken meat entering African markets is seen as potentially disruptive to local markets. The study employs the typical farm approach, utilizing synthetic farms known as 'typical farms', to measure the competitiveness of broiler farms in Ghana (a country which is highly reliant on imports) and Senegal (a country with a complete import ban), relative to farms in European countries (Germany and the Netherland) that are significant exporters of chicken meat.

Results The study revealed that typical broiler farms in Ghana and Senegal are less competitive than those in Germany and the Netherlands due to lower farm performance (e.g. higher Feed Conversion Ratios and mortality rates) and higher cost of production. Typical Ghanaian broiler farms face substantial cost disadvantages. Their production costs are 180% to 219% higher than the typical German farm and 144% to 178% higher than the typical Dutch farm. While Senegalese farms perform somewhat better, they still lag behind the typical German and Dutch farms, with production costs 39% to 90% higher than the typical German farm and 21% to 66% higher than the typical Dutch farm, respectively. Furthermore, farm-level modeling indicates that improving farm performance alone may not sufficiently reduce production costs in Ghana and Senegal to levels comparable with those in Germany and the Netherlands.

Conclusions The study concludes that improved farm management practices and lower input prices are necessary to improve the competitiveness of broiler farms in Ghana and Senegal. Additionally, small-scale producers, who are least competitive, require targeted support in order to increase their competitiveness.

Keywords Broiler, Chicken, Competitiveness, Production, Poultry

JEL Classification Q12, Q13, Q18

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Background

Chicken meat is beneficial to human food and nutrition security as it is an important source of high-quality animal protein [1, 2]. The consumption of chicken meat has been rapidly increasing in many African countries [3]. An increase in population and economic development are the key factors driving the consumption of chicken meat in the region [4]. Although chicken meat demand is increasing in many African countries, domestic production has struggled to meet this demand. To meet demand, some countries import frozen chicken meat, usually in the form of cut pieces (e.g., thighs, leg quarters, and drumsticks), mainly originating from the European Union (EU), Brazil, and the United States of America (USA) [5, 6]. Imports contribute to food and nutrition security by providing consumers with a cheap and convenient source of protein, but producers, civil society organizations, the media, and other stakeholders frequently criticize them [3, 6, 7].

Different West African countries have had different policy responses to low-priced imports. On the one hand, some countries have implemented protectionist policies to protect their domestic poultry producers from import competition. For instance, in 2002, Nigeria prohibited the import of poultry meat products following a surge in imports in the late 1990s [8, 9]. In 2005, the Ivory Coast imposed an import tariff of FCFA 1000 (equivalent to EUR 1.536[1]) per kilogram on poultry, resulting in a significant decrease in poultry imports [10]. In 2006, Senegal banned the import of uncooked poultry meat to protect the country from avian influenza outbreaks [11]. On the other hand, other countries, such as Ghana, Benin, and Liberia, have embraced the import of low-priced frozen chicken meat as a way to provide affordable protein to their citizens and boost their economies through trade [6, 12]. Although frozen chicken meat has been imported to West African nations for more than two decades, the issue remains contentious, especially in countries that follow an open import policy [12].

The ability of countries in the European Union (EU) to export frozen chicken meat to African countries at low prices raises important questions regarding market dynamics and competitiveness. More specifically, the following questions: how does the competitiveness of broiler farms compares across export and import countries and what policy measures may be useful for improving the potentially lower competitiveness of importing countries. To the best of our knowledge, there are no published studies that compare the international competitiveness of broiler farms in West African countries with that of broiler farms in key chicken meat exporting countries in the EU.

In this context, this study investigates whether differences in the competitiveness of conventional broiler farms in Ghana, Senegal, Germany, and the Netherlands provide insights into why domestically produced chicken meat in West African countries such as Ghana and Senegal is more expensive than frozen chicken meat imports from the EU. Ghana was selected because it is a West African country that is highly dependent on frozen chicken imports. Ghana imports an estimated 79% of its total poultry meat supply [5]. In contrast, since 2006, Senegal has banned the import of all forms of uncooked poultry meat. Furthermore, Germany and the Netherlands were selected for international comparison because they are among the largest producers and exporters of chicken meat in the EU.

This paper consists of five sections. In the second section, we examine the literature on competitiveness in general and with special focus on the international competitiveness of broiler production systems. In Sect. "Materials and methods", we describe the typical farm approach used to construct and quantify conventional broiler farms used for international farm comparisons. Sect. "Results and discussion" presents and discusses the results. Finally, in Sect. "Conclusions and policy recommendations", we present some policy recommendations and conclusions.

Competitiveness in broiler production

Defining competitiveness

Despite its common usage, competitiveness remains an ambiguous concept with no universally accepted definition. Bhawsar and Chattopadhyay [13] explain that competitiveness is multifaceted, as it is understood from the perspective of different disciplines, such as economics, history, management, culture, and politics. For instance, Michael Porter famously defines competitiveness based on productivity [14]. Ketels [14] explains that Porter uses microeconomic foundations to determine the competitive advantage of nations, regions, and clusters. Drescher and Maurer [15] define competitiveness as the ability of a firm or industry to maintain or improve its position against competitors within the same market.

Measuring the competitiveness of broiler farms across countries

Due to its multifaceted nature, competitiveness can be measured using various methods that significantly differ in terms of data requirements and methodologies [16]. These methods can be broadly categorized into two types: those that measure past performance (ex-post) and those that assess potential competitiveness

[1] Euro to CFA franc based on OANDA Corporation. Historical Exchange Rates: https://www.oanda.com/fx-for-business/historical-rates.

(ex-ante). Ex-post competitiveness can be measured using indicators such as market share (based on trade data), real exchange rates (applied to the entire economy), and Foreign Direct Investment (FDI). In contrast, ex-ante competitiveness can be evaluated using methods such as accounting techniques (measuring production costs and/or gross margins) and mathematical models. Consequently, the choice of method depends on the level of competitiveness being investigated (e.g., farm, sector, or national level) and the main objective of the study [16].

In this study, we employ an accounting method known as the typical farm approach. Accounting methods like the typical farm approach utilize production costs to compare the competitiveness of farms focused on a single commodity across different regions and countries. This approach enables us to compare the competitiveness of broiler farms in West Africa (Ghana and Senegal) with those in Europe (Germany and the Netherlands). Some existing studies on broiler farm competitiveness such as Menghi et al. [17] and van Horne [18] also use accounting methods to compare the competitiveness of broiler farms in Europe with those of key broiler-producing countries such as Brazil, the USA, Argentina and Thailand. In these studies, the competitiveness of broiler farms in different countries was measured by comparing the: (1). Broiler farm management (performance) indicators such as the feed conversion ratios (FCRs) and mortality rates; (2). Economic indicators such as production costs and profitability. Similar to our study, the comparisons were performed using "representative farms" or "typical farms". Siqueira and Duru [19] explain that a typical farm is a synthetic farm that represents the technical and economic characteristics of most farms in a given region. Therefore, instead of using farm survey data, Menghi et al. [17] and van Horne [18] construct one or two representative farms for each country and then compare the performance, costs of production and profitability. Typical farms have also been used to investigate the international competitiveness of other products. For instance, Ndambi and Hemme [20] use typical farms to compare the competitiveness of dairy farms in South Africa, Morocco, Uganda and Cameroon. Lasner et al. [21] also use typical farms to study the international competitiveness of rainbow trout farms in Germany, Denmark and Turkey. It is important to emphasize that the use of a typical farm is not the same as just collecting data from one individual farm because a typical farm is constructed to represent a specific production system in a particular region [22].

Materials and methods

The Typical Farm Approach (TFA) was used to investigate the competitiveness of the broiler farms in Ghana, Senegal, Germany and the Netherlands. The approach was applied through following the *agri benchmark* standard operating procedure (SOP) which is outlined by Chibanda et al. [22]. The SOP is composed of five steps (see Fig. 1): identifying relevant production regions, identifying typical production systems, collecting farm data, analyzing typical farm data, and updating farm data. Chibanda et al. [22] explain that the *agri benchmark* SOP can be adjusted depending on the type of crop or livestock and country context.

Study areas

The study was conducted across four countries: Ghana, Senegal, Germany, and the Netherlands. In Ghana, the typical farms were constructed in Accra, Kumasi, and Dormaa. Accra and Kumasi are the two biggest cities in Ghana and Dormaa is a border town located between Ghana and Ivory Coast. Although Dormaa is not a big city, its proximity to Ivory Coast facilitates the convenient import of day-old chicks (DOCs) and the sale of live birds to Ivorian poultry traders [23]. Similarly, in Senegal, conventional broiler production is concentrated in urban areas. As a result, typical farms were constructed to represent farms in Dakar and Thiès, the country's largest cities. Additionally, broiler farms are predominantly located along the Senegalese coast in the Niayes zone, which extends from Dakar to St. Louis. This region is particularly well-suited for poultry production due to its relatively cooler climate compared to other parts of Senegal [24]. In Germany, the typical farm was established in Emsland, a district in the federal state of Lower Saxony. Most broiler farms in Germany are situated in Lower Saxony, where large-scale operations dominate, with average barn spaces of 58,000 birds. In the Netherlands, the typical farm was established in the Noord-Brabant province, located in the southern part of the country. Noord-Brabant is a key region for conventional broiler production.

Sampling techniques and sample size

The convenience sampling method, a non-probability sampling method, was used to select participants for multi stakeholder workshops, focus groups, semi-structured interviews, and expert consultations. This technique allowed for the selection of relevant participants based on their accessibility and knowledge of the broiler production and the poultry value chain. The convenience sampling was done in consultation with extension officers and poultry consultants who were knowledgeable

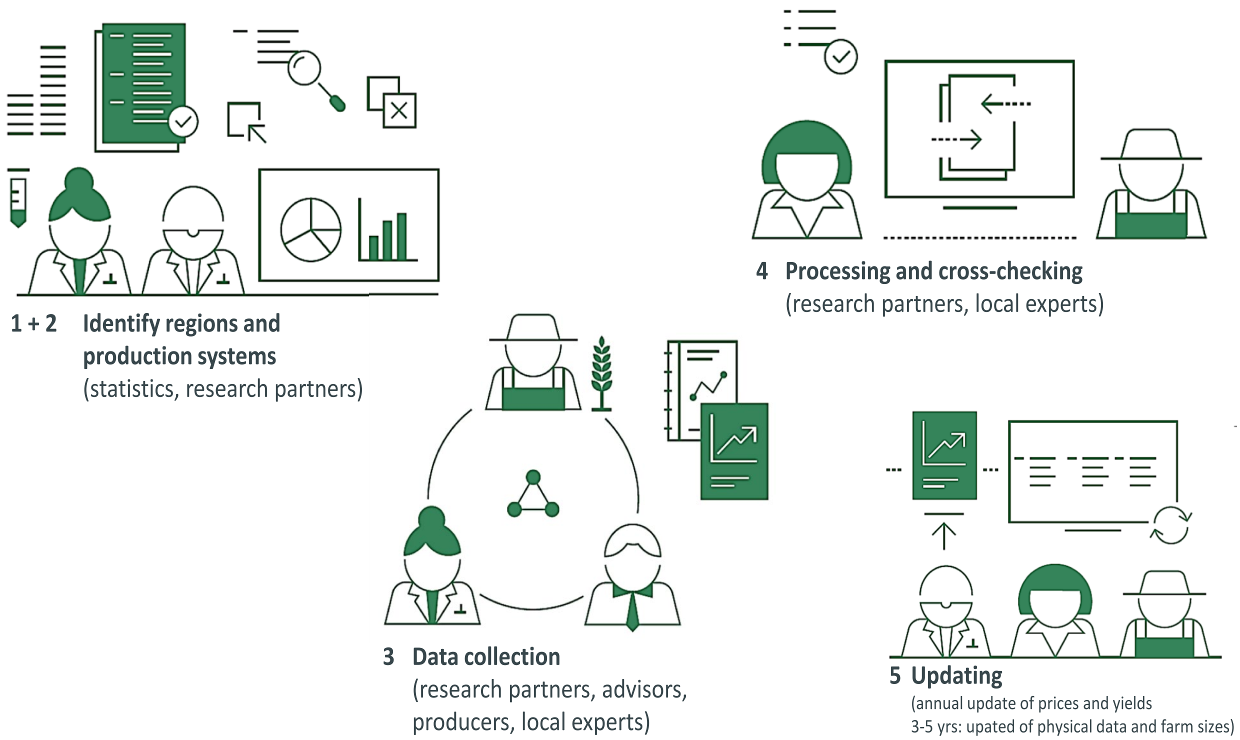

Fig. 1 Overview of the typical farm approach (agri benchmark SOP). Source: Chibanda et al. [22]

about the regions and production systems in each country. A total of 89 participants participated in the multi-stakeholder workshops held in Ghana and Senegal. In Ghana, 15 poultry producers, nine local experts (extension or veterinary officers), and six local researchers were selected to participate in focus group discussions. A total of nine poultry consultants were engaged in Senegal [6], Germany [2] and the Netherlands [1]. Eight producers were selected for semi-structured interviews that were held in the four countries.

Data collection

Data were collected through a desk research, multi-stakeholder workshops, semi-structured interviews, focus group discussions, and expert consultations.

Desk research

This was the initial step to identify the most common conventional broiler production systems and the key regions for broiler production in the four countries studied. In contrast to Ghana and Senegal, in Germany and the Netherlands, the availability of national statistics made desk research sufficient to pinpoint the hotspots of conventional broiler production. In Germany, Emsland (Lingen) was identified as a production hotspot, while Noord-Brabant was identified as the key region in the Netherlands. Broiler production systems in Germany and the Netherlands were not categorized by scale due to the highly standardized production processes in Western European countries, where conventional broiler farms exhibit minimal variation in production methods regardless of their scale [22].

Multi-stakeholder workshops

Multi-stakeholder workshops can be effective for gathering data or validating findings in qualitative research [25]. Given the limited research on broiler production systems in Ghana and Senegal, multi-stakeholder workshops were utilized to complement existing literature and to identify the main conventional production systems and key broiler production regions in the two countries. The workshop in Ghana was attended by 44 participants, including producers, policymakers, researchers, and processors. Through this workshop, Greater Accra, Kumasi, and Dormaa were identified as major broiler production regions, and small, medium, and large-scale integrated broiler production systems were recognized as prevalent. In Senegal, the workshop was attended by 45 participants, comprising representatives from producer groups, civil society, processors, international organizations, and researchers. Thiès and Dakar were identified as the primary broiler production regions in Senegal, with small-scale, medium-scale, and large-scale integrated systems identified as the most common broiler production systems.

Semi-structured interviews

Semi-structured interviews were conducted with broiler producers across all four countries to gather detailed data on husbandry practices, farm performance, and production costs. One producer was selected from each identified region, representing a specific production system. This resulted in three farms being selected in Ghana, three in Senegal, and one each in Germany and the Netherlands. It is important to note that, despite identifying the large-scale production system as common in Senegal, we were unable to visit a large-scale farm due to suspected cases of H5N1 bird flu, which led to restrictions on farm visits. Therefore, two medium-scale producers in different regions were identified instead.

Focus groups

Focus groups were utilized to construct typical farms in Ghana by "typifying" the individual farm data collected through semi-structured interviews. The process of typifying involved focus group members reviewing and discussing each data point from the individual farms, and then replacing farm-specific figures with values that are prevalent in the broader production system in that region. A total of three focus groups were conducted, one for each of the three identified production systems. Each focus group consisted of ten participants, including five poultry producers, three local experts (extension or veterinary officers), and two local researchers.

Expert consultations

In contrast to the approach taken in Ghana, the farm data collected from individual farms in Senegal, Germany, and the Netherlands were "typified" through consultations with poultry experts, including extension officers and poultry consultants. The typification process involved reviewing the data and adjusting any farm-specific details that did not reflect the most common conditions for the respective farm type in each region (for example, an individual farmer might report a mortality rate of 10%, but experts familiar with the broader regional context might adjust this figure to 3.5% if it is more representative of typical conditions). To ensure accuracy and eliminate potential bias, the typified data were cross-checked with producers in each region and for each production system.

Data analysis

The Technology Impact Policy Impact Calculations (TIPI-CAL) model was used for analyzing the typical farm data. Chibanda et al. [22], Kress and Verhaagh [26] and Ndambi and Hemme [20] explain that the TIPI-CAL model is a production model that can be used for analyzing the status quo of production systems, benchmarking (international comparisons), practice change analysis and policy analysis. In this study, we used the model for international comparisons and simulating different scenarios related to the impact of improved farm performance.

The TIPI-CAL model was used to calculate and compare farm management and economic indicators of typical broiler farms in Ghana, Senegal, Germany and the Netherlands. The farm management indicators included the feed conversion ratio (FCR), the broiler farm economy index (BFEI), the mortality rate, and the number of cycles per year. The FCR measures the amount of feed used to produce a kilogram of meat [27]. The BFEI combines a number of indicators to assess the overall efficiency of a broiler farm [28]. The equations below show how the FCR and BFEI were calculated:

$$BFEI = \left(Average\ live\ weight\left(kg\right) \times \%\ livability\right) \div \left(FCR \times growing\ period\left(days\right)\right) \tag{1}$$

$$FCR = \left(Cumulative\ feed\ in\ take\left(kg\right)\right) \div \left(Total\ weight\ gain\left(kg\right)\right) \tag{2}$$

The economic indicators that were calculated include production costs and profitability. Two types of production costs were calculated, namely, cash costs and non-cash costs. Chibanda et al. [23] define cash costs as monetary payments made at the time production inputs or services are used (e.g., payments for day-old chicks, medicines, veterinary services). In contrast, non-cash costs are not instant cash payments because they may not be made at all (in the case of opportunity costs) or the payment is spread out over time (in the case of depreciation costs) [23]. A key advantage of using the TIPI-CAL model for farm economic analysis is that it allows for the analysis of profitability at different levels. The model is able to calculate short-, medium- and long-term profitability. Short-term profitability was calculated by deducting cash costs from total returns. Cash and depreciation costs were subtracted from total returns to determine the medium-term profitability. Long-term profitability was calculated by deducting cash, depreciation, and opportunity costs from total returns.

Results and discussion

Overview of the typical conventional broiler farms

A total of eight typical farms were constructed. The typical farms were named according to their respective country codes and the total number of chickens they produce annually. The suffixes k and M indicate 1000 and million, respectively. Table 1 shows that the German and Dutch farms rear far much more chickens than those in Ghana and Senegal. Interestingly, Ghanaian farms typically produce fewer birds than Senegalese farms. Producers who participated in the focus groups in Ghana explained that they tend to have small flocks of birds per cycle because they struggle with marketing their birds. Therefore, rearing large flocks will result in them taking a long period to sell all the birds.

Comparison of farm management indicators

Feed conversion ratio (FCR)

Figure 2 shows that the typical German farm (DE_1M) and Dutch farm (NL_660k) have the lowest FCRs, implying that they are the most efficient farms in terms of feed use. SN_38k and SN_36k, the two Senegalese medium-scale farms, have FCRs that are comparable to those of DE_1M and NL_660k. The Senegalese small-scale farm (SN_9k) and the Ghanaian farms (GH_3k, GH_12k, and GH_27k) have the highest FCRs.

Broiler farm economy index (BFEI)

Table 2 shows that DE_1M and NL_660k have the highest BFEIs, 4.56 and 3.74, respectively. This finding implies that the two typical farms have better overall farm management than the Ghanaian and Senegalese farms. In contrast, SN_9k, GH_3k, GH_12k and GH_27k have low BFEI values, ranging between 1.9 and 2.43, reflecting lower overall farm management.

Mortality rates

Table 2 shows that DE_1M and NL_660k have the lowest mortality rates. GH_27k has the highest mortality rate of 10%. Focus group participants attributed the high mortality rates observed on the typical large-scale broiler farm in Ghana to the use of poor-quality, domestically hatched chicks. Interestingly, GH_3k also has a low mortality rate that is comparable to that of DE_1M and NL_660k. The focus group participants explained that GH_3k has low mortality because it rears high-quality chicks that are imported from Europe (the Netherlands and Belgium).

Number of cycles per year

Table 2 also shows that DE_1M and NL_660k run 7,80 and 7,60 production cycles per year, respectively. SN_9k, SN_36k, and SN_38k run approximately 6,00 production cycles per year, which is double the number of production cycles that the Ghanaian farms run. These findings suggest that conventional broiler production in Ghana is typically a seasonal activity, while it is a year-round activity in Senegal, Germany, and the Netherlands. Focus group participants from Ghana explained that broiler production in Ghana is seasonal because farmers typically rear chickens to sell during the three festive seasons (i.e., Christmas, Easter, and Eid Al-Fitr). Producers do this because they usually only have a reliable market for their chickens during the festive seasons when consumers are willing to spend more on local chickens, which are more expensive [23]. These findings are consistent with the results of several consumer studies [30, 31], which established that Ghanaian urban consumers regularly consume frozen chicken meat imports because they are more affordable and convenient because they are available in cut pieces that are ready for cooking.

The results showed that all the Ghanaian farms and SN_9k are not performing well in terms of the farm management indicators. Focus group participants and poultry experts from Ghana and Senegal attributed the poor farm performance to the use of low-quality DOCs, low quality feed, long production cycles, and poor poultry husbandry practices. These authors explained that small-scale producers in Ghana rarely buy ready-made feed from commercial feed mills. Instead, they purchase feed ingredients and use "informal" commercial feed millers who prepare customized feed mixes. According to Andam et al. [32], these informal feed mills are called "service feed mills" as they typically serve small-scale producers and only produce feed based on their ingredients. Andam et al. [32] further explain that these mills cannot guarantee the quality of their feed since they rarely perform quality control on their ingredients (such as tests for aflatoxin, moisture, and toxicity). Therefore, some feed used by small-scale producers is of poor quality since it is made from ingredients such as maize and soya beans that are either moldy, contain high levels of aflatoxins, or contain a large amount of moisture. Aflatoxin toxins have long been proven to negatively affect farm performance [33].

The issue of poor-quality locally hatched DOCs is more relevant in the case of GH_27k. Focus group participants explained that locally hatched chicks often do not grow well and have a high mortality rate. These observations are supported by experiments conducted by Yeboah et al. [34], who showed that locally hatched DOCs in Ghana have lower weight gain and greater mortality than imported DOCs. Chibanda et al. [23] explain that local hatcheries often produce inferior quality chicks because Ghana does not have laws that ensure the regulation and monitoring of hatchery activities.

Furthermore, extension officers explained that poor husbandry practices and low biosecurity measures also contribute to poor performance on broiler farms, especially small-scale farms. For example, extension officers highlighted that farm workers who are primarily responsible for feeding chickens usually do not do so properly.

Table 1 Key characteristics of the typical conventional broiler farms in Ghana, Senegal, Germany and the Netherlands

Farm name	**Ghana**			**Senegal**			**Germany**	**The Netherlands**
	GH_3k	**GH_12k**	**GH_27k**	**SN_9k**	**SN_36k**	**SN_38k**	**DE_1M**	**NL_660k**
Conventional production system	Small scale	Medium scale	Large scale integrated	Small scale	Medium scale	Medium scale	Large scale integrated	Large scale integrated
Farm location	Accra	Dormaa	Kumasi	Thiès	Dakar	Thiès	Emsland	Noord-Brabant
Farm size (birds sold/year)	3613	12,086	27,000	8527	35,263	37,571	1,028,903	659,053
Biosecurity measures	Low	Moderate	Moderate to high	Low	Moderate	Moderate	Very high	Very high
Origin of day-old chicks (DOCs)	Often imported from Europe	Often imported from the Ivory Coast	Own hatchery	Chicks are sourced from local hatcheries	Chicks are sourced from local hatcheries	Chicks are sourced from local hatcheries	Farm has a contractual arrangement with a hatchery to supply chicks	Farm has a contractual arrangement with a hatchery to supply chicks
Feed source	Informal feed-mills	Commercial feed-mills	Own feed-mills	Commercial feed-mills	Commercial feed-mills	Commercial feed-mills	Commercial feed-mills	Commercial feed-mills
Type of housing	Open, naturally ventilated poultry house	Open, naturally ventilated poultry house	Open, naturally ventilated poultry house	Open, naturally ventilated poultry house	Open, naturally ventilated poultry house	Open, naturally ventilated poultry house	Climate-controlled housing	Climate- controlled housing
Marketing channels	Sells live birds at the farmgate or in live bird markets	Sells live birds in live bird markets	Slaughters its birds and sells them to retailers and restaurants	Live birds are sold to traders, individuals, and small restaurants	Birds are either slaughtered on the farm or sold as live birds	Birds are either slaughtered on the farm or sold as live birds	Birds are sold to a slaughterhouse which has a contractual arrangement with the farm	Birds are sold to a slaughterhouse which has a contractual arrangement with the farm

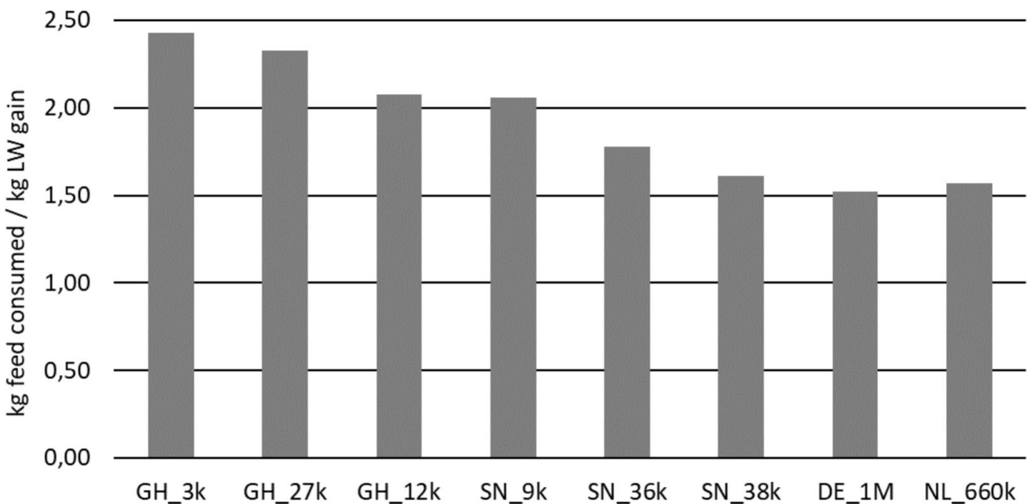

Fig. 2 Graphical representation of the feed conversion ratios (kg feed consumed per kg live weight gain)

Table 2 Comparison of farm management indicators

	Ghana			Senegal			Germany	Netherlands
	GH_3k	GH_12k	GH_27k	SN_9k	SN_36k	SN_38k	DE_1M	NL_660k
Final live weight (kg)	3.00	2.00	2.20	2.00	2.00	2.00	2.69	2.50
Broiler Farm Economy Index (BFEI)*	1.90	2.01	2.03	2.43	2.67	3.42	4.56	3.74
Mortality at farm level (%)	2.88	4.08	10.00	5.00	5.00	3.50	2.35	3.40
Feeding period (days)	63.00	45.50	42.00	38.00	40.00	35.00	37.80	41.00
Number of cycles per year	3.72	3.00	3.00	6.00	6.20	6.10	7.80	7.60

* BFEI values greater than 2 indicate good overall farm management [29]

The officers explained that, based on their observations, workers often put too much feed in the feeding trays. This often results in feed wastage as some of the feed is discarded when it is wet. However, this feed is usually accounted for by farm owners as feed given to the chickens, while in reality, it is wasted. Additionally, the use of homemade feeders and drinkers also affects feed and water consumption, which results in poor performance. Observations by extension officers are consistent with those of Fall et al. [35] and FAO [36], which indicates that a lack of knowledge of appropriate husbandry practices is one of the main challenges facing small-scale broiler producers in Ghana and Senegal. In contrast, the German and Dutch farms use high-quality inputs (feed, DOCs), use modern equipment (automated drinkers and feeders), and have high levels of biosecurity measures and husbandry practices.

Comparison of economic indicators

Production costs

Figure 3 illustrates a clear hierarchy in production costs among the analyzed typical broiler farms. The German farm (DE_1M) exhibits the lowest production costs, followed by the Dutch farm (NL_660k), then the Senegalese farms (SN_38k, SN_36k, SN_9k), and finally the Ghanaian farms (GH_12k, GH_3k, GH_27k). The disparity in costs is substantial, particularly when comparing African farms to their European counterparts. Typical Ghanaian farms (GH_12k, GH_3k, GH_27k) face production costs that are 184%, 219%, and 180% higher than DE_1M, respectively. When compared to NL_660k, these same Ghanaian farms' costs are 144%, 178%, and 148% higher. Senegalese farms also experience higher production costs, albeit to a lesser extent than their Ghanaian counterparts. The typical farms in Senegal (SN_38k, SN_36k, SN_9k) have production costs that are 90%, 39%, and 39% higher than the German farm, and 66%, 21%, and 21% higher than the Dutch farm, respectively. Notably, across all the typical conventional broiler farms studied, feed and chick costs constitute the majority of production expenses.

Appendix 1 provides the absolute values that were used to calculate the costs of production.

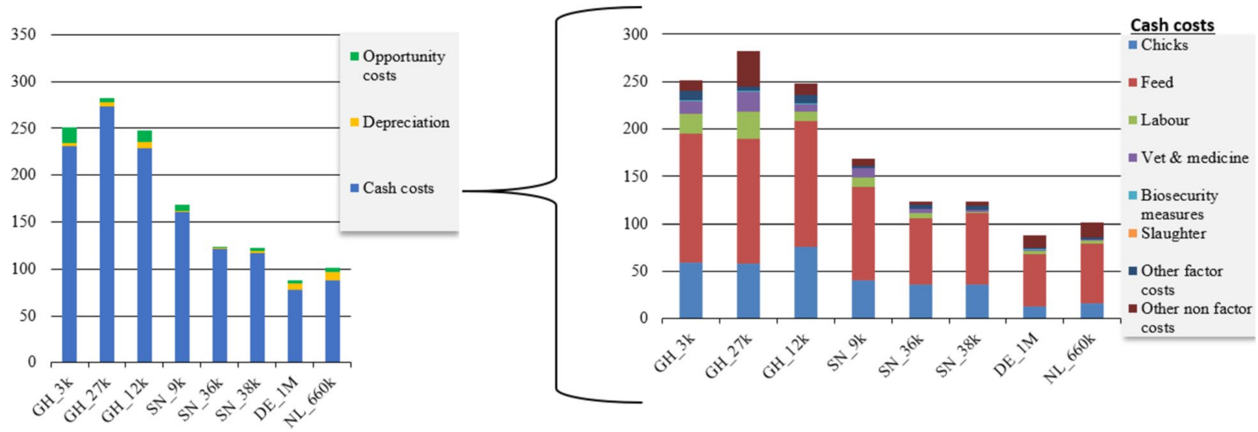

Fig. 3 Comparison of production costs (EUR/100 kg live weight). Other cash costs include disinfection, bedding, transport, and picking. Opportunity costs: costs of foregone alternative use of family labor, own land and own capital. Depreciation cost: account for the decreasing value of farm assets (e.g., buildings and machinery)

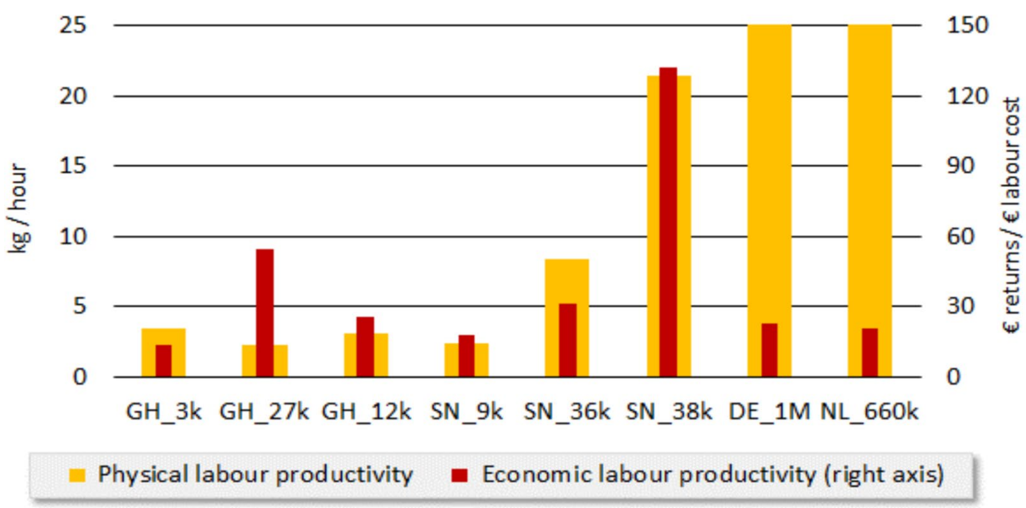

Fig. 4 Physical and economic labor productivity

Feed costs: are the most important cost component for all farms. For the Ghanaian farms, they account for 48–59% of the total production costs, for Senegalese farms they represent 57–64%, for DE_1M they represent 71%, and for NL_660k they account for 66%. Although feed costs represent a lower proportion for Ghanaian farms, Ghanaian farms have the highest feed costs, followed by the Senegalese farms. There are several factors that are responsible for the high costs of feed in Ghana. At the farm-level, our previous findings showed that the Ghanaian farms are the most inefficient in terms of feed-use.

Day-old chick (DOC) costs: the results show that the typical broiler farms in Ghana spend significantly more on DOCs than all other farms. This can mainly be attributed to the fact that GH_3k and GH_12k use DOCs that are imported from the Netherlands and Ivory Coast, respectively. This implies that the reliance on imported DOCs by Ghanaian producers has significantly contributed to the high production costs.

Labor structure and costs: physical labor productivity measures the quantity of chicken meat produced per hour labor input. Figure 4 reveals that the large-scale broiler operations in Germany and the Netherlands have the highest physical labor productivity. The high physical labor productivity on these farms can be attributed to more investments in equipment that reduce labor input. All farm scales in Ghana have low labor productivity due to the limited production cycles per year and overall poor management indicators. Labor productivity,

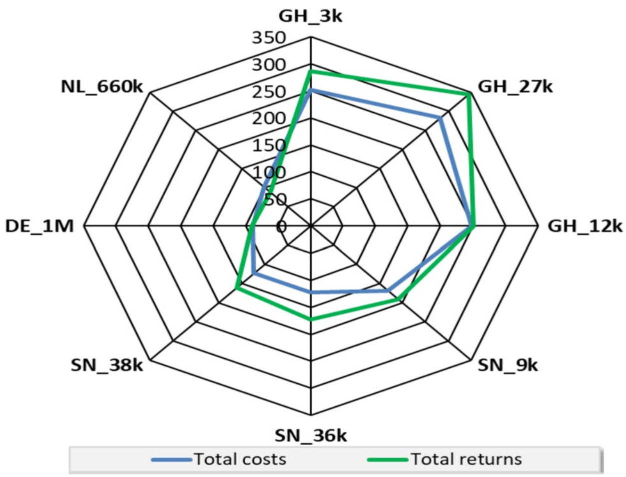

Fig. 5 Total costs and returns (EUR/100 kg live weight)

as a comparison factor, can be more meaningful factor by considering wage levels. Lower wage levels make a low labor physical productivity less relevant in the comparison. Consequently, economic labor productivity was introduced to show how much Euro (€) return can be made per Euro (€) total labor cost. Comparing the results of the physical and economic labor productivity shows that broiler farms in Ghana and Senegal, with low wage levels, in some cases have even higher economic labor productivity than the European farms. Farms in Germany and the Netherlands, with high physical labor productivity but high wage levels are on relatively lower economic productivity levels.

Comparison of profitability

Figure 5 compares the farms' profitability by displaying total returns and costs. Figure 5 indicates that broiler meat from the Ghanaian and Senegalese farms is sold at a much higher price than that from the German and Dutch farms. For instance, the findings reveal that the selling prices of liveweight chickens at farmgate are 93% to 116% greater in Ghana than in Germany. Focus group participants in Ghana explained that producers are able to sell their chickens at high prices because production usually targets festive holidays where consumers are willing to pay high prices. Although not as high as in Ghana, the selling prices are also high in Senegal. Therefore, although the Ghanaian and Senegalese have high production costs, they are profitable due to high selling prices. However, unlike in Senegal, broiler production in Ghana is profitable as a seasonal activity.

Next, profitability for different time spans is shown as total returns; not only total costs (short-term perspective) but also depreciation costs (medium term) and opportunity costs (long term) are deducted. Thus, as Fig. 6 shows, all the typical conventional broiler farms except for NL_660k are profitable in the short, medium and long term. Moreover, NL_660k is profitable only in the short term. This means that it can cover only its cash

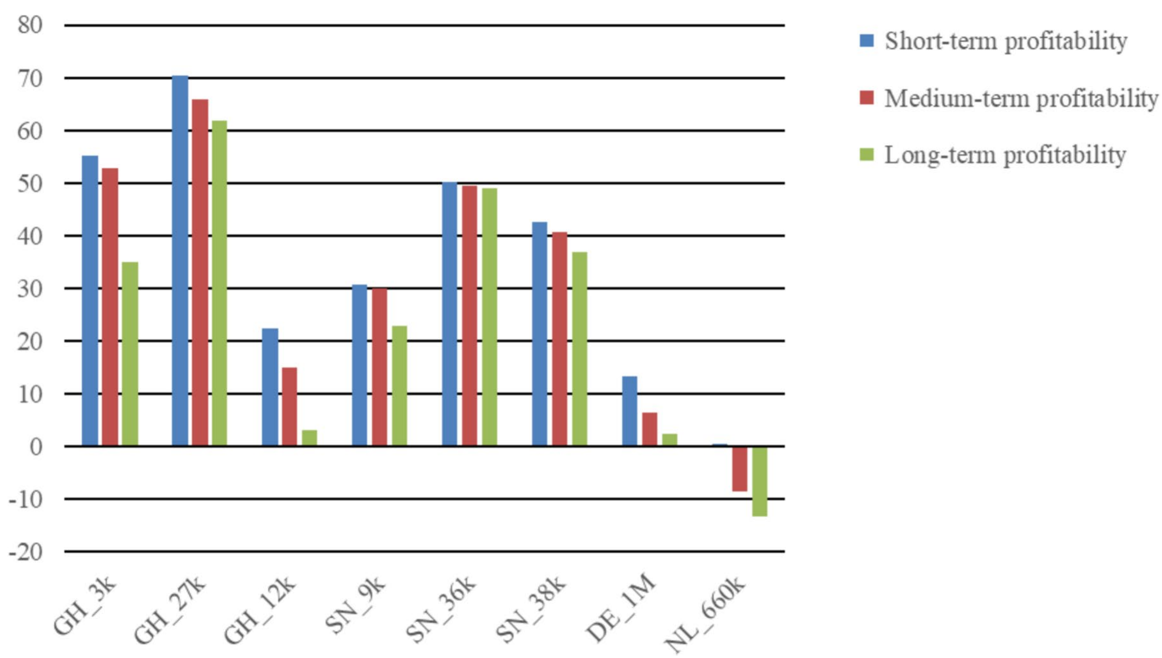

Fig. 6 Short, medium and long-term profitability (EUR/100 kg live weight). Short-term profitability = total returns—cash costs. Medium-term profitability = total returns—cash costs—depreciation costs. Long-term profitability = total returns—cash costs—depreciation costs—opportunity costs

Table 3 Summary of key baseline and scenario data for simulations of the Ghanaian and Senegalese farms

	Ghana						Senegal					
	GH_3k	**GH_3k Scenario**	**GH_27k**	**GH_27k Scenario**	**GH_12k**	**GH_12k Scenario**	**SN_9k**	**SN_9k Scenario**	**SN_36k**	**SN_36k Scenario**	**SN_38k**	**SN_38k Scenario**
Final age (days)	65	65	42	42	46	46	38	38	40	40	35	35
Final weight (g)	3000	4907	2200	2857	2000	3229	2000	2482	2000	2671	2000	2191
Total feed consumed per bird (g)	7216	10,000	5078	4715	4066	5606	4035	3877	3509	4288	3157	3287
FCR	2.44	2.06	2.35	1.68	2.08	1.76	2.06	1.59	1.79	1.63	1.60	1.53

The optimum FCRs and attainable weights for farms rearing the Cobb 500 breed (GH_27k, GH_12k, SN_9k, SN_36k and SN_38k) were obtained from Cobb [37] and for the farm rearing Ross 308 (GH_3k) from Aviagen [38]. GH_27k scenario: For this scenario to be more realistic, we assumed that the quality of the locally reared DOCs reared by GH_27k would improve to the same level as those from the Ivory Coast that were reared by GH_12k. In accordance with this assumption, the mortality rates were adjusted from 10 to 5%, and the chick prices increased from 1.15 EUR/chick to 1.43EUR/chick. Source: Own calculations, Cobb [37], Aviagen [38] costs and cannot cover depreciation and opportunity costs. The low profitability of the Dutch farm can be generally attributed to the low selling prices of broiler meat.

Appendix 2 provides the absolute values used to calculate the profitability levels.

Simulation of the effects of improving feed-use efficiency (lowering FCRs)

The results previously presented established that SN_9k, GH_3k, GH_12k, and GH_27k are not efficient in terms of feed use. Based on these findings, we simulate a scenario for each farm in Ghana and Senegal in which FCRs improve to the optimal level. The simulation was performed by adjusting the feed consumed by the chickens on each farm until the optimum FCRs, which are indicated by Cobb [37] and Aviagen [38], were attained in the TIPI-CAL model. Simultaneously, the final weights were increased to the optimum levels (recommended by Cobb [37] and Aviagen [38]) that are expected after the typical feeding period. It is important to note that the feeding period was kept constant because it is largely determined by market conditions. The model was then run with the new FCRs. To achieve optimal FCRs, we assumed that the farms improved their husbandry practices and used high-quality inputs (DOCs and feed). Table 3 provides key details of the baseline and scenarios for each farm.

The results of the simulation (Fig. 7) show that the production costs of the Ghanaian and Senegalese farms could decrease through improved feed-use efficiency (lower FCRs). Approximately 25% of the total production costs could be reduced for each Ghanaian farm. The production costs of SN_9k, SN_36k, and SN_38k could be reduced by 21.27%, 15.59%, and 6.44%, respectively. Thus, Ghanaian farms and the Senegalese small-scale farm (SN_9k) will experience the greatest reductions in costs, as they are the least efficient farms in terms of feed use.

A comparison of the production costs (Fig. 8) of the Ghanaian and Senegalese scenario farms with DE_1M and NL_660k shows that the Ghanaian and Senegalese farms would still have higher production costs even when having improved their feed-use efficiency to optimum levels. These findings can be explained by our previous findings that showed that the high costs of production in Ghana and Senegal are linked to two key issues: (1) feed-use inefficiency and (2) high input prices. Therefore, as demonstrated by the simulation, improving only the feed-use efficiency without reducing the input prices is not sufficient to enable the farms in Ghana and Senegal to be competitive with those in Germany and the Netherlands.

Conclusions and policy recommendations

Our study examined the competitiveness gap between broiler farms in Ghana, Senegal, Germany, and the Netherlands, providing insights into why domestically produced chicken meat in a West African country that allows chicken meat imports, such as in Ghana, is more expensive than imported frozen EU chicken. The assessment considered farm management and economic performance indicators. In terms of farm management, broiler farms in Ghana and the typical small-scale farm in Senegal were found less competitive than German and Dutch farms, while typical medium-scale farms in Senegal, using high-quality inputs, showed performance approaching that of German and Dutch counterparts. Regarding production costs, broiler farms in Ghana and Senegal faced significantly higher costs due to feed and DOC expenses, primarily driven by feed-use inefficiency and high input prices.

Our simulations revealed that while improving feed-use efficiency could lower production costs for Ghanaian and Senegalese farms, these reductions would be insufficient to achieve competitiveness with German and Dutch farms. This suggests that enhancing husbandry practices and input quality alone will not suffice. Therefore, a more comprehensive approach, combining improvements in farm management with strategies to reduce feed and DOC prices, is necessary to improve competitiveness. In Ghana, Andam et al. [32] demonstrated potential for reducing feed costs by increasing white maize productivity, which could be supported through improved seed use and year-round irrigation policies. Conversely, Senegal's reliance on imported feed ingredients due to unfavorable agroclimatic conditions makes domestic production increases unlikely, and feeding grains to poultry can exacerbate food security issues. Reducing DOC costs, however, presents a more feasible option, as domestically hatched DOCs from imported parent stock could be nearly half the cost of those from imported eggs. Given the high initial investment and expertise required for parent stock rearing, policy initiatives could focus on offering low-interest credit and breeder training programs [39].

The findings indicated that small-scale broiler farms in Ghana and Senegal exhibit the lowest performance and highest production costs. To address this, policymakers could implement targeted interventions framed within a food systems approach, offering holistic solutions that also enhance livelihoods and food security. Potential measures include (i) extension programs to improve biosecurity and feeding practices, (ii) access to tailored credit schemes, and (iii) policies promoting market access, such as responsible contract farming.

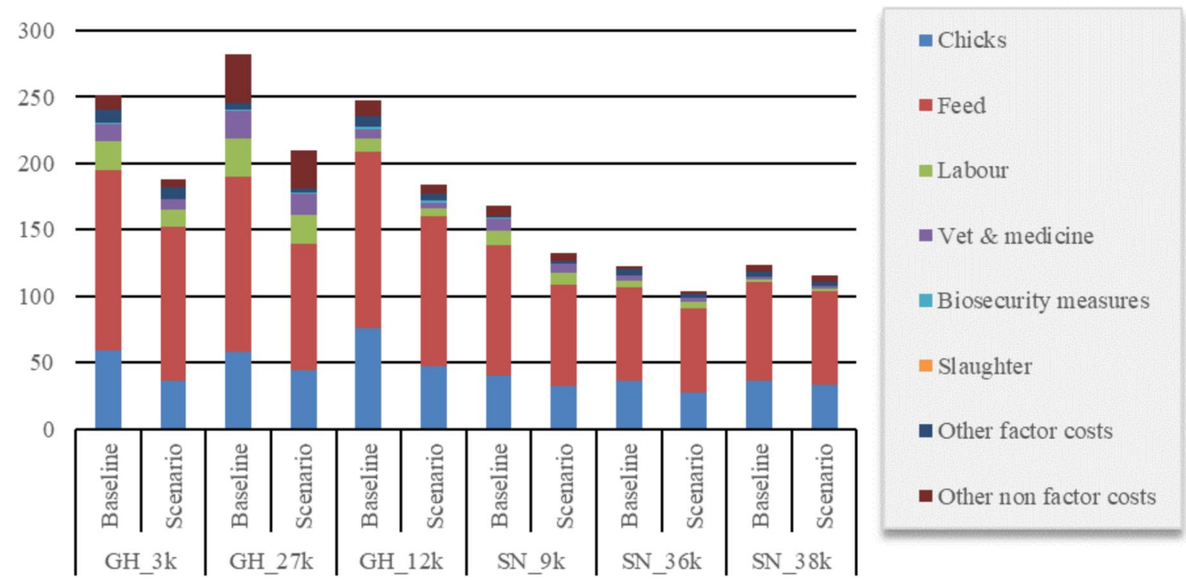

Fig. 7 Comparison of production costs of typical Ghanaian and Senegalese broiler farms under different scenarios (€/100 kg live weight)

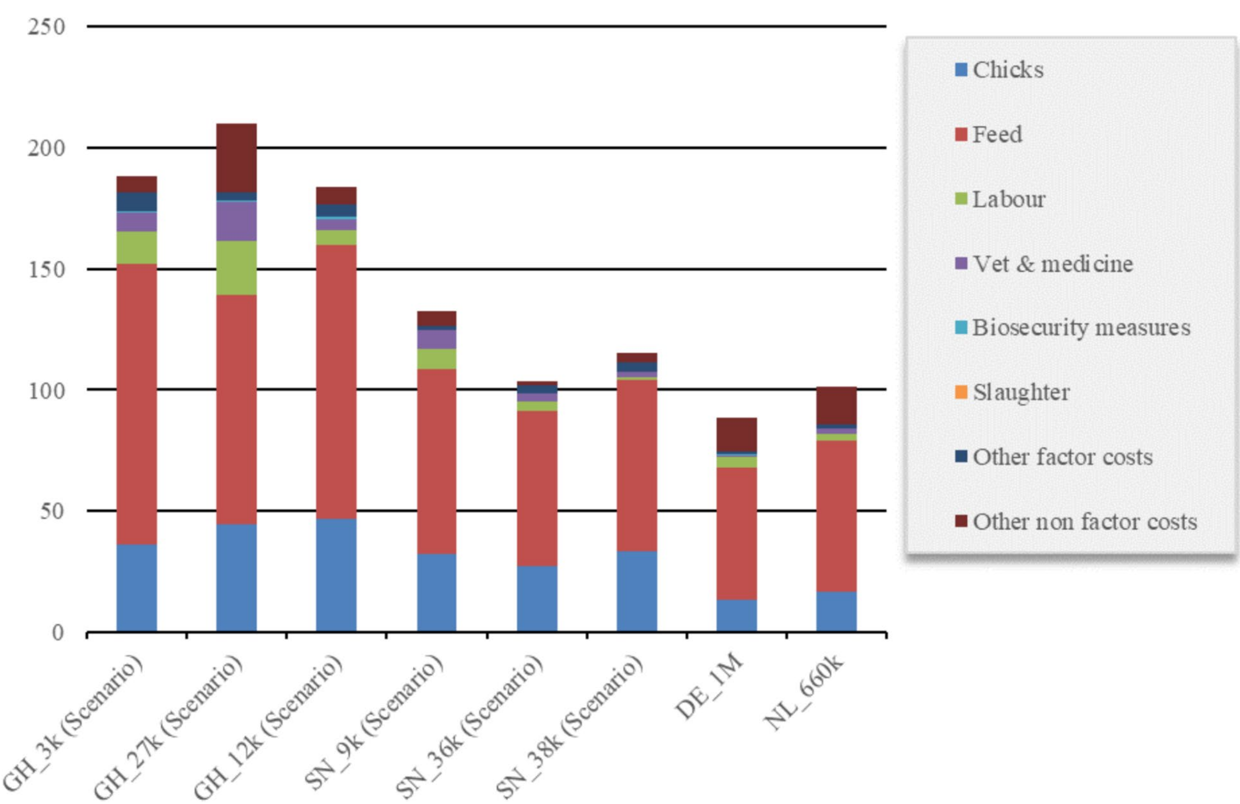

Fig. 8 Comparison of production costs of the Ghanaian and Senegalese scenarios with those of the German and Dutch farms (€/100 kg live weight)

While this research provides important insights into the competitiveness of broiler farms across the focus countries, it is limited by its exclusive focus on farm-level dynamics, excluding slaughterhouses and other value chain entities. Addressing coordination challenges in future research could clarify sector-wide approaches to reducing chicken prices in Ghana and Senegal.

Appendix 1

See Table 4

Table 4 Comparison of production costs (EUR/100 kg live weight)

	GH_3k	GH_27k	GH_12k	SN_9k	SN_36k	SN_38k	DE_1M	NL_660k
Day-old chicks	59.09	57.89	75.41	40.12	36.11	36.33	13.32	16.71
Feed	135.98	131.98	133.45	98.42	70.18	74.61	54.78	62.07
Labor	21.42	28.91	9.72	10.73	5.45	1.22	3.97	3.30
Vet & medicine	13.13	20.99	7.16	9.03	4.01	2.52	0.93	1.70
Biosecurity measures	0.51	0.72	1.91	0.43	0.27	0.01	0.48	0.06
Other factor costs	10.78	4.56	8.08	1.92	4.28	3.95	1.20	1.83
Other non-factor costs	10.62	37.14	11.83	7.68	2.65	4.47	13.74	15.68
Total costs	251.53	282.19	247.57	168,32	122.95	123.10	88.41	101.35

The production costs in Ghana and Senegal were collected in the local currencies, the cedi (GHS) and CFA Franc (XOF) respectively. They were the converted into EUR for comparison with those for the German and Dutch farms. The conventions were done using Oanda Historical Exchange Rates (https://www.oanda.com/fx-for-business/historical-rates)

Appendix 2

See Table 5

Table 5 Comparison of cost indicators, returns and profitability (EUR/100 kg live weight)

	GH_3k	GH_27k	GH_12k	SN_9k	SN_36k	SN_38k	DE_1M	NL_660k
Production costs								
Cash costs	231.30	273.72	228.41	160.55	121.76	117.46	77.56	87.50
Depreciation costs	2.52	4.48	7.38	0.72	0.75	1.93	6.90	9.16
Opportunity costs	17.70	3.98	11.77	7.06	0.44	3.72	3.95	4.70
Total production costs	251.53	282.19	247.57	168.32	122.95	123.10	88.41	101.35
Returns								
Broiler returns	286.57	343.89	250.75	190.56	171.50	160.07	90.88	88.00
Manure returns	0	0	0	0.67	0.48	0	0	0
Total returns	286.57	343.89	250.75	191.23	171.98	160.07	90.88	88.00
Profitability								
Short-term	55.27	70.28	22.34	30.68	50.22	42.61	13.32	0.63
Medium-term	52.75	65.80	14.96	29.96	49.47	40.68	6.42	− 8.53
Long-term	35.04	61.81	3.19	22.91	49.03	36.97	2.47	−13.23

Short term profitability = total returns—cash costs. Medium term profitability = total returns—cash costs—depreciation costs. Long term profitability = total returns—cash costs—depreciation costs—opportunity costs

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Author contributions
CC contributed to conceptualization, literature review, data collection, model development, data analysis, drafting the original draft and made all the necessary revisions. PT participated in data collection, model development, data analysis, editing of original draft and revisions. MIA contributed to data collection, literature review, model development, data analysis, visualization, editing of the original draft and made all the necessary revisions. PVH participated in data collection, editing of original draft and revisions. CD contributed to the acquisition of funding, conceptualization, data collection, model development, drafting the original draft and made all the necessary revisions. CW contributed to conceptualization, drafting the original draft and made all the necessary revisions. All authors approved the final submission for publication.

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Data availability
The datasets during and/or analyzed during the current study available from the corresponding author on reasonable request.

Declarations

Ethic approval and consent to participate
The ethics approval was granted by the Thünen Institute of Farm Economics.

Consent for publication
Not applicable.

Competing interests
The authors declare no conflict of interest.

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